Only Eleven Percent

A collection of Blogs by Dr. Steven Fawkes on Energy Efficiency, Energy Efficiency Financing, the Energy Transition and a few other subjects.

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www.onlyelevenpercent.com

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Acknowledgements

Productive work comes from collaboration. The ideas and thinking expressed in these collected blogs are the synthesis of many years of collaboration with many people in many organisations of all types, experience of many projects and situations in many countries and cultures, and years of education and creative systematic thinking based on study and observation. One of the highlights of my professional life has been to collaborate with many people in many countries and cultures and I am glad that this continues, despite the recent years when physical travel has been much more difficult. I would like to acknowledge all those individuals I have interacted with over the years.

About the Author

Dr. Steve Fawkes has over 30 years experience in energy efficiency including delivering large energy management programmes, co-founding two energy service companies, implementing innovative energy services transactions, and advising governments. He founded EP Group in 2012 to accelerate investment into energy productivity and the company advises corporates, investors, governments and multi-lateral institutions on energy services, investing in energy efficiency and net zero. EP Group's JV with the Indian government's super-ESCO EESL has invested more than £65m into UK energy efficiency companies since March 2017. The EP Group's ESCO-in-a-box® business model is now being deployed in UK and Kenya. Steven also sits on the Investment Committee of the London Energy Efficiency Fund, advises several other energy efficiency funds in Europe, and has received awards from the Energy Institute, the American Council for an Energy Efficient Economy and the India Business Group. He has written more than 350 publications on energy efficiency including three books and the influential blog ***www.onlyelevenpercent.com***

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1 Introduction

I started writing my blog 'Only Eleven Percent' in 2013 as a way of capturing and sharing some of the things I had learnt over the years about energy efficiency and particularly the financing of energy efficiency. At that time financing efficiency was a nascent subject, and it could be argued it still is, and there was a lot of really developments in the USA which for various reasons I got plugged into and I wanted to share some of the learnings, as well as my observations on the whole area of energy efficiency, energy management, energy technologies, and the energy transition which were (and are) founded on an education focused on energy, (BSc Science of Resources from the University of Birmingham, 1980, and a PhD entitled 'The potential for energy conserving capital equipment in UK industry' from the University of Stirling in 1985) and a career spent in energy management, energy services and more latterly the finance sector focused on the energy transition and clean technology.

The blog gave me a personal as well as professional creative outlet and supported the development of my company EnergyPro Ltd, which has now evolved into the ep group. I have decided to collect many of the blogs into one volume here to make access easier and provide the information to a new audience. I have also included some personal blogs as well as a few on my other interests including aviation, space exploration and Formula 1. The majority of the pieces however reflect on energy efficiency, energy efficiency financing and how to increase global investment into efficiency. They have been arranged in rough themes and the volume can be dipped in and out of rather than read as a whole book. They all cover subjects that are dear to my heart.

Energy efficiency remains the most under-exploited resource we have. Many formal academic studies have looked at why this is and the area of 'barriers to energy efficiency' remains a rich field of research with an extensive literature. The fact that it is 'invisble', being a reduction in the use of an energy source, and it is realised through many small measures and investments, rather than exciting, large pieces of technology definitely play a role in society's failure to truly exploit the resource.

It is now recognised that improved energy efficiency has a vital role to play in reducing emissions of greenhouse gases. It can also reduce and optimise investment into energy supply systems. But over and above the energy and environmental benefits improved energy efficiency can brings with it many many additional, non-energy benefits. The existence, and indeed measurement of, these multiple benefits has advanced considerably since their first review of the subject by the IEA in 2012. The fact that many of these benefits can be much more strategic in nature than just energy cost savings, and therefore interesting to decision makers, is now increasingly recognised due to the work of Catherine Cooremans and others. The identification and evaluation of multiple benefits is an essential part of building better business cases for energy efficiency which will increase the flow of capital into efficiency led projects.

The next decade will be vital for the achievement, or not, of global targets to cut emissions and hence limit the global temperature rise. We need to increase the rate of investment into energy efficiency by a factor of four. I hope that at least some of the material from onlyelevenpercent.com can help illuminate some of the problems and the solutions that can make that happen, and that it does it in an interesting and occasionally entertaining way. Inevitably in some areas my views have changed and evolved – it is after all an energy transition.

For future updates please subscribe to *onlyelevenpercent.com* and you may also be interested in my book '*Energy Efficiency*', published by Routledge (ISBN 978-1409453598).

Steven Fawkes

January 2022

2 Energy efficiency

The blogs in this section cover various aspects of energy efficiency, ranging from what it is, through terminology, to policy and the old chestnut of the Jevons Paradox. It includes some of my earliest blogs as well as some of the most commented on such as '*Elegance and Energy Efficiency*' in which I argue that efficiency solutions to providing the services we need are so much more elegant than inefficient ones. We should never forget the need for elegance and beauty in the world.

2.1 Welcome to Only Eleven Percent. 1 Feb 2013

It's called 'Only Eleven percent' because, despite all our centuries of technological progress, we've reached the stunning global energy efficiency of about 11 per cent! In anyone's books this is pretty poor progress. But it's not so surprising when you think about how we built industrial society on cheap energy. What's more most things are designed in a very traditional way and bought on lowest-first cost rather than lifetime costs. There are of course limits to how efficient we can make real machines but 11 per cent really is poor. The effects of this are huge; billions of pounds wasted (trillions globally); additional environmental impacts; the need to import more fuel which means less energy security; and big health effects in poorly heated, inefficient houses.

On this site I want to try to expand on what I think about energy efficiency; where we are; what the big stories really mean; what has worked elsewhere; what the future holds and why we should be bothered at all. I'm not an evangelist and I'm a pretty grounded person so you won't find any sweeping statements or weird ideas. But because I've been in this industry a long time, I've got a great deal of information in my head that's useful; I've got a good overview of the issue and challenges, technologies and processes, and the advent of the internet now means I can pass some of that on.

Improving energy efficiency, and specifically the rate of improvement, has so many advantages for individuals, organisations and nations, that it is sometimes hard to see why it is not given greater attention and resources than it currently receives. Energy Efficiency is important. It's vital to all of us and it's going to become more so as time goes on. The good news is that we can do something about it. We all have a choice about how energy efficient we are, our technologies, our organisations and our societies are – it is not out of our control. I hope that this blog will add to the debate, offer my opinions and perhaps help individuals and businesses, policy makers and stakeholders take a fresh look at energy efficiency and see how exciting the future could be.

2.2 Asking the right questions. 4 Feb 2013

I still hear the question: If energy efficiency is so profitable, why isn't it happening?

Every time I hear it I think it's completely the wrong question! It's the question asked by people who aren't out there in the market. Energy efficiency is happening. And it's happening in a big and rapidly growing way.

So what are the right questions? The first one is: How do we accelerate the uptake of energy efficiency? The second one is: How can we embed it into our systems and processes so that it is a permanent and normal part of management and everyday life?

These questions should be the concern of governments, as well as industry and commerce, householders and NGOs. Accelerating the uptake has been proven to provide multiple benefits in terms of reduced costs, reduced impact of energy price volatility, less need to invest in energy supply infrastructure, increased energy security, job creation and reduced global and local environmental impact. Governments, working with each industry sector and sub-sector, need to work out what are the enabling conditions that will lead to an increase in

demand for energy efficiency. They need to find out how to increase the supply of energy efficiency goods and services and the flow of investment into energy efficiency.

Embedding energy efficiency processes is essential so that the current wave of activity is maintained and built upon. This will be vital if we do have lower prices as a result of shale gas. Note, however, that most energy efficiency investments can still be very profitable even at energy prices that are lower than we have today. McKinsey's 2008 global study (The Case for Investing in Energy Productivity showed the effect of investing $170 billion per annum with an average IRR of 17% at an oil price of $50 per barrel. At today's c.$100 per barrel the average IRR will be much higher than 17% and the frontier of the potential is now also so much bigger. We don't want to build up lots of productive energy management capacity and then lose it all just because energy prices come off a bit for a few years. Improving energy efficiency needs to be a long-term activity. That is why standards such as the ISO50001 Energy Management standard and The International Performance Measurement & Verification Protocol are so very important.

Personally, having lived through the 1980s boom in energy efficiency, or 'conservation' as it was incorrectly called back then, I am optimistic that this time it is different and that we are embedding efficiency into the energy mix to a greater extent than ever before. My optimism is based on the following five factors:

- Growing interest in energy efficiency within the investor community
- The realisation that this efficiency is a huge and valuable opportunity
- The VC and PE investments in EE that have been made over the last five years
- The growing range of cost-effective efficiency technologies in all sectors
- Environmental and sustainable development pressures

I know that every time someone says 'this time it's different' it turns out not to be – witness the dot com boom of the 1990s and the debt bubble of the 2000s. Of course, only time will tell. Personally I am optimistic that this time energy efficiency will become recognised as the cheap, clean and fast energy resource it really is and we will achieve levels of efficiency far greater than our current official energy scenarios show. As Winston Churchill said: 'For myself I am an optimist – it does not seem to be much use to be anything else.'

2.3 The 'known knowns', the 'known unknowns' and the 'unknown unknowns'. 8 March 2013

In February 2002 the then US Secretary of Defense Donald Rumsfield made a very famous speech in which he said: 'There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say, we know there some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know'. He was roundly criticized for this but somewhat unfairly. Geoffrey Pullum, who is a Professor of Linguistics at both Edinburgh University and Browns University disagreed, saying the quotation was 'completely straightforward' and 'impeccable, syntactically, semantically, logically, and rhetorically'.

It is a statement that we can usefully apply to energy efficiency. First of all let's think about the known knowns. The biggest one is surely the huge economic potential for energy efficiency to improve productivity, reduce costs, improve energy security, create jobs and reduce carbon emissions. For 30 years there have been so many reports from credible bodies that no-one can realistically challenge the potential. Likewise the generic barriers to achieving the potential have been studied to death.

If we want to scale up energy efficiency we need to scale up three things: demand, supply and the flow of finance into efficiency investments of all types. A big known unknown is how do we increase demand, particularly in the residential sector. Schemes like the Green Deal and equivalents have to face the facts that sometimes even when insulation and other measures are free people don't take them up and – however much we may like them to do

– the average consumer does not wake up in the morning and say, 'I want to buy some efficiency today'. It is not sexy, cool and desirable – however much we complain about our energy bills. For every market segment we need to understand the enabling conditions that do make people buy energy efficiency in whatever form – the industry is a long way from that right now.

On the supply side there are a number of known unknowns, one being how do we standardize evaluation techniques and models. Models that produce building energy use or Energy Performance Certificates (EPCs) can give widely differing answers for very similar buildings. In California residential evaluation models have been found to be 50 per cent out 25 per cent of the time. One major supermarket in the UK questioned the widely differing results for Energy Performance Certificates for sets of similarly sized, designed and constructed buildings. On investigation much of the variation came down to the different software models being used and of course the parameters being fed into the models. Standardizing models and input parameters greatly reduced the variation.

On the finance side the big known unknown is how do we get long-term low cost third party finance into energy efficiency. Again a lot of this is around standardization of evaluations, contracts and documentation. The money is there, it wants to invest, the industry needs to give investors the structures and the assurances that they needs and that comes from standardization.

So, that is just a few of the known unknowns. As for the unknown unknowns – well who knows? One thing is guaranteed – there will be surprises out there.

2.4 Resource efficiency – the only way. 14 March 2013

I recently attended a meeting of the Chop Sticks Club – a group that has been promoting Anglo-Chinese relations for the last twenty years. Although of course the projected future where the Chinese economy continues to grow dramatically may not be totally assured its phenomenal growth over the last twenty years, along with similar rapid transformations in many other countries, coupled with a lack of growth in Western economies, certainly means global growth will be driven by the developing countries.

Here in the West there is only one clear path to growth and job creation – exploiting the huge potential for resource efficiency – especially energy – that we know exists. In buildings alone the UK spent in 2011 £42 billion. We know that we can achieve savings of c.10% by better management (much more in many cases), c.20% by low cost investment in better controls and monitoring technologies, and far more by extensive investment in holistic retrofits. A 20% saving would produce £8 billion saving for consumers. Studies from the USA suggest $1m spent on energy efficiency produces something like 20 jobs. If we assume 20 jobs per £1 million and capex to produce the £8 billion of £40 billion, that would produce 800,000 jobs and free up a lot of cash flow for consumers.

2.5 The Jevons paradox and the importance of energy productivity. 26 March 2013

As soon as there is discussion of energy efficiency and the potential for improving energy efficiency, someone counters with the argument that reducing energy use per unit of output only leads to more energy use as people and firms spend some (or all) of the money saved by greater efficiency on more consumption, resulting in more energy use. This is the Jevons Paradox – first put forward by William Stanley Jevons in 1865 in his book, '*The Coal Question*'. Jevons pointed out that coal consumption in England soared after James Watt introduced his steam engine which greatly improved on the energy efficiency of existing steam engines which used Thomas Newcomen's technology.

Numerous referred papers, articles, blog posts and even whole books have been dedicated to the Jevons paradox and some people have used it without really understanding it to

rubbish energy efficiency. I don't want to start any more debates but I would say that that we don't say the same things about the use of other resources e.g. metals – you do not hear the argument that we shouldn't improve productivity of metal use as it will only result in more metals use. It may be equally true in metals as it is in energy but the argument isn't made nearly so often.

Fundamentally improving the productivity of resource use, whether it be metals or energy or land, is one of the basic drivers of increasing wealth. Another driver is our ability to create resources out of 'thin air' by creative thinking, for example, turning something that has no value or is currently thought of as waste into a productive resource.

There is an interesting area for research, as yet under-researched, on the importance of improving energy efficiency in driving economic growth. Some recent research from Skip Laitner and the American Council for an Energy Efficient Economy suggest that it may be more important than we generally think.

2.6 What do we really mean by 'energy efficiency'? 19 April 2013

There is still often confusion about what we really mean by energy efficiency. It is a phrase that comes with a lot of baggage and associations with doing less and sacrifice – the old idea of 'energy conservation'. It even gets confused with renewable energy sometime which is strange given renewables are a means to generate energy and not a way to improve efficiency.

First of all 'energy' itself in the way that we use it today is a relatively modern and confusing term – we should really talk of fuel and electricity as they are very different and incompatible sources of services – you can't put petrol in your laptop. Physicists and engineers also know that energy is always conserved in any process so the terms, 'energy conservation', 'saving energy' and even 'consuming energy' are technically incorrect.

The term 'energy efficiency' incorporates two concepts. The first is energy efficiency in its technical sense – useful energy out/energy in – which is usually reported as a percentage – and can only be applied to devices that convert one type of energy to another such as engines (chemical energy to motion), electric motors (electricity to motion) or light bulbs (electricity to light). The second concept is energy productivity, usually reported as energy in/useful output, which applies to passive devices such as buildings which convert energy into other services such as comfort. We are familiar with some everyday measurements of energy productivity, such as miles per gallon or litres per 100 kilometre for car fuel efficiency and others including energy input to a building per square metre to produce a certain temperature for a certain period of time; energy use per passenger mile for aircraft; or energy per one thousand tins of beans produced in a factory. So what we normally call 'energy efficiency' is really a combination of energy efficiency in its technical sense and energy productivity.

Just to add to the story, when we commonly talk about energy efficiency in a macro-sense we often mean a series of processes rather than a status at a single point in time. The energy efficiency of all technologies tends to improve over time because there is a basic human desire to spend less, invent new technologies and improve existing technologies. As well as the constant incremental technological (and behavioral) changes, there are the major paradigm-busting changes such as a compete change of an industrial process that work to improve energy efficiency over time.

So to sum up, the phrase 'energy efficiency' is a combination of technical energy efficiency and energy productivity, and it is also a process of continuous improvement.

2.7 The energy efficiency cool wall. 22 Oct 2013

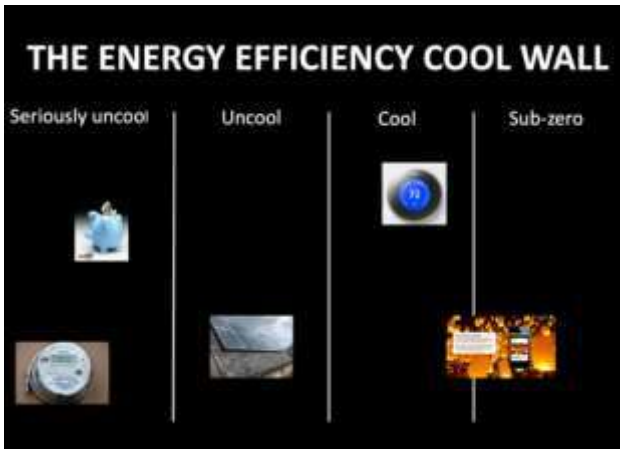
Here is my latest blog which unveils a new concept – the Energy Efficiency Cool Wall which addresses the fundamental problem that energy efficiency is so dull!

Despite all the years of discussion about the barriers to wider scale implementation of energy efficiency measures, the one big elephant in the room that does not get talked about very often is simply this – energy efficiency is so boring! Writing as someone who has worked in and around the topic since 1980 (it can't possibly be!) this is a hard thing to say, but it is true for several reasons. Firstly, energy efficiency is all about cost saving or saving money which, however much we as individuals want to save money on our energy bills or as businesses we want to cut costs, is always pretty dull. Just ask yourself which is more fun – saving some money in the bank, or going out to spend money on something you want.

For businesses, 'offensive' spending such as new product development or marketing is always going to be more exciting – and better for people's careers – than 'defensive' spending such as investment in greater energy efficiency. No-one, or very few of us at least – me included – wake up and think "I want to buy some energy efficiency today". We wake up and think things like "I really want to buy that new smartphone/tablet/car/house", or something along those lines.

That's the real problem with programmes like the UK Green Deal here and around the world. Energy efficiency is usually seen as one of those worthy things we should do for our own or the common good – but usually don't – like eating the right food and exercising more.

Secondly, energy efficiency is all about technologies such as controls and insulation, all of which are pretty dull.



The Energy Efficiency Cool Wall

Thirdly, energy efficiency professionals tend to be technical types who are not good at marketing or developing winning customer propositions. Often they have come into energy efficiency for good reasons based on doing something that is environmentally and socially beneficial – even the non-technical ex-investment banker types who have discovered the subject in recent years!

On top of all that energy efficiency is really abstract – energy itself is abstract enough but energy efficiency is SERIOUSLY abstract – savings are hard to measure. All in all there is no way getting round it – energy efficiency is dull.

I had been thinking about how to highlight this point and outline what we need to do when I came up with the concept of the Energy Efficiency Cool Wall – which had its world premier at the *Smart Buildings Conference* in London on the 15th October and had a second outing the next day at *Ecosummit* London.

It was inspired by the Cool Wall that used to be on the hugely popular TV show Top Gear – (350 million views a week in 170 countries according to Wikipedia!). Jeremy Clarkson and

usually Richard Hammond argued about whether a particular car was either Seriously uncool, Uncool, Cool or Sub Zero – and then placed them appropriately on the Cool Wall.

So here is my first take on the Energy Efficiency Cool Wall. Everyone will of course have their own opinion as to what is cool – responses and suggestions are welcome.

Smart meters – Seriously uncool

There is no business model that justifies them (at least not in the UK). They really benefit the energy supplier and yet the consumer is being asked to pay for them. At best they provide a level of accuracy and reliability that we take for granted for buying anything else. Even when linked to in-home displays they are uncool – people may use the in-home displays for a while but then interest rapidly fails. The concept of MTKD, a parallel to the more familiar MTBF (Mean Time Between Failures) applies to in-home displays. MTKD is Mean Time to Kitchen Drawer, i.e. the time it takes until an in-home display ends up in that drawer that everyone has with old mobile phones, batteries and miscellaneous connectors that no longer fit any of your devices.

Saving money generally (despite the recession) – Seriously uncool

PVs on your roof – this one is perhaps more debatable

The technology has been around for decades and I don't think it is cool in itself anymore. Usually there is no integration and the panels are very visible. Getting a cheque for electricity sales could be considered cool I suppose. What would be really cool would be a paint or a coating that you can buy in a hardware store that generates power coupled with a storage device the size of a normal gas boiler or smaller – science fiction? Maybe and maybe not – science fiction has a habit of coming true.

The NEST thermostat – Cool

The only thermostat ever to sell out, the NEST is a cool product that appeals to design conscious professionals. It created a real buzz when it came out and helped grow the smart thermostat market.

Philips VUE lighting or similar systems – definitely Sub-Zero

These systems allow you to record the light quality and spectrum wherever you are on a smart phone app and then return to your home and have your lighting system, based on tunable LEDs, imitate that quality. Think about great holiday places, the light quality and spectrum is often part of the experience and now you can re-create (nearly?) that when you get home.

This is a seriously cool "I want it" type product that when you tell people about it, they just instinctively say "wow" or "that's neat". The fact that the system could significantly reduce lighting energy consumption and cost by facilitating a switch to LEDs is a side benefit – albeit one that we as energy efficiency professionals and indeed society as a whole – should applaud and encourage. The energy saving, however, doesn't sell it.

So what is the lesson of the Cool Wall?

Energy efficiency, however important it is for our future, is in itself fundamentally boring. If it is to become the mass market we know it could be and should be we need entrepreneurs and business to develop new products and new business models that are seriously cool and deliver efficiency gains.

Just maybe the place to start when thinking about energy efficiency is not "how can we make something more efficient?" but rather "how cool is this product or service to the target market (consumer or business)?" For the energy supply industry, which is ripe for disruption, the related question is "what is the mix of technologies (energy efficiency, distributed generation, storage), services and finance that can be combined into a new business model that makes energy cool – and improves energy efficiency?"

2.8 The energy efficiency revolution. 4 June 2014

At whatever level you look, globally, regionally, nationally, or even locally, we are facing a complex inter-related set of energy crises including:

- an additional three billion people entering the global middle class in the next twenty five years who will all demand more energy using goods and services
- domestic energy demand in oil producing countries like Saudi Arabia is growing rapidly and could possibly reach production levels by the mid-2030s
- in the UK and many other places we have millions of people who have trouble paying their energy bills – the problem of fuel poverty caused by a combination of high energy prices and poorly performing buildings
- the high economic cost of importing energy – the EU imports €500 billion worth of energy a year and the UK imports about £25 billion, a number which has swung from exports of £3.3 billion in 2003 and is likely to increase as UK Continental Shelf production continues to fall
- the security risks of importing energy which have once again been brought into sharp focus by the events in Ukraine – energy dependence leads to a position of insecurity and weakness
- the need to invest heavily in new energy infrastructure (particularly electricity) in developed countries where the basic infrastructure is thirty to fifty years old.
- the need to invest heavily in energy supply infrastructure in developing countries where demand growth often outstrips supply
- the fact that 1.2 billion people in the world still don't have any access to electricity
- local and global pollution that comes from energy use – not just the threat of climate change but terrible smogs as experienced in Beijing and elsewhere with all the attendant impact on human health as well as local pollution from mining and energy extraction.

The most cost-effective way of addressing these problems is to accelerate the improvement in energy efficiency or productivity. Improving energy efficiency is a good investment simply in terms of the energy cost savings to capital invested ratio but it often also brings many co-benefits including increased productivity, increased comfort, improved energy security, reduced need to invest in energy supply infrastructure as well as job creation and many others.

We have known for a long while that the potential for energy efficiency is huge and in fact we have always used energy efficiency as a resource without noticing it or thinking about in those terms. Without any great effort, except between the mid-1970s and the mid-1980s, improved energy efficiency effectively delivered more energy services in the US and the UK than any other source of energy – but it is hardly ever mentioned as an energy resource. Just imagine what we can do if we really focus on it. The challenge now is to turn much more of the huge economic potential into actual, usable and used energy services which as well as direct economic benefits would bring many co-benefits in health, productivity and job creation. The signs are that we are at the beginning of a revolution in energy efficiency which could be just as important, if not more so, than the revolution in shale gas. That revolution has three fronts, technology, design and finance.

In technology we are seeing the rapid development of smart technologies that bring intelligence to dumb systems such as heating and air conditioning as well as electricity distribution and manufacturing. Intelligence can greatly improve efficiency by making sure equipment only operates when it is really necessary and operates to a set condition more accurately. In the home examples of "the internet of things" like the NEST thermostat (it is much more than a thermostat of course) have demonstrated the potential both for energy saving and to make efficiency "cool" and attractive to the consumer, helping to drive Googles $3.5 bn acquisition of NEST. As well as smart systems there is also a wealth of new and smart materials coming out such as glass from companies like VIEW that change their

thermal and optical characteristics in response to changes in the environment and can cut energy demand by 20% as well as peak air conditioning load by 20% – which can enable smaller electrical feeds into buildings and reduces capital costs for the building owner and the network operator.

In design leading edge companies have demonstrated the benefits of using integrative design techniques. Proper integrative – or holistic – design can lead to capital cost savings as well as energy savings. The example of the Empire State Building retrofit shows the value of integrated design, the incremental capital on a normal refurbishment had a three-year payback and the savings were 38% on a very difficult building to retrofit. A conventional approach to design would not have achieved either the savings or the return on investment – and therefore almost certainly the opportunity to make savings in energy use would have been lost for another twenty or thirty years. Many examples of using integrative design have shown savings of more than 70% compared to the baseline. New building designed to Passivhaus standards can run on only 10% of the energy use of a normal house. Why are we still designing houses the old-fashioned way? The design profession needs to do more to promote integrated design and regulators and customers need to be better aware of what is possible and what the advantages of using integrated design are. Integrated design also applies in industry and The Sustainable Energy Authority of Ireland (SEAI) has done some very good work in promoting Energy Efficient Design (EED) which uses an integrative design approach and has been proven to result in lower energy costs, lower operational costs and capital costs and can be integrated into existing design processes.

EED has been proven to be highly productive. In the case of Lakeland Diaries, analysis of heat and cooling processes led to avoiding capital investment for additional cooling plant, reduced cooling and heating loads, reduced peak electrical loads, and to the development of a heat recovery project with an estimated payback period of six months. Energy savings achieved by applying EED have reached 50 per cent. Despite the advantages of integrative design the architectural and engineering professions are slow to change and more needs to be done to educate them as well as clients in what is possible and how to achieve it.

The final front of the efficiency revolution is finance. Energy efficiency is now beginning to be recognised an as investment opportunity, in venture capital, private equity and project finance. In 2013 VC investment in energy efficiency reached $1.3bn in 2013, about 20% of all clean tech VC investment, and the acquisition of NEST by Google for $3.5 billion and the IPO of Opower in 2014 – both successful exits – have helped build interest. In the UK the sale of Matrix Sustainable Energy was a success for its PE backer LDC who have gone onto invest in another energy efficiency company. In the world of energy efficiency projects interest in various forms of sharing savings is growing. Traditionally this has been mainly through Energy Service Companies (ESCOs) and Energy Performance Contracts (EPCs) but the EPC model doesn't really address many of the problems such as the split incentive and the fact that many building owners often can't take on more debt. In the USA a wave of innovation has introduced new contract forms such as ESA and MEETS which promise to be much more successful than EPCs as they address the real issues of clients and of course investors. A lot of institutional money is drawn to energy efficiency because of its safe returns and the fact that unlike renewable energy it does not rely on subsidies.

We know the scale of the investment needed to significantly accelerate energy efficiency and it is roughly equivalent to the amount invested in renewables ($213 billion in 2013) and so the quantum of investment is very achievable. Whatever the subsidies or lack of them large investors could only invest institutional funds into renewables once standardised ways of developing and documenting projects had been developed. This happened in wind power in the 1990s. In conventional oil and gas it evolved before that. In energy efficiency there have been many technical and energy management standards but until now they have not been put together into a coherent protocol for developing and documenting projects. The Investor Confidence Project (ICP) (**www.eeperformance.org**) addresses that problem directly by working with stakeholders from the energy efficiency and finance industries to develop

protocols for developing and documenting projects in different categories of buildings. After a few years of development the ICP has great traction in the US with more developers, investors and government agencies specifying it's use and work will start on a European version soon. Moving towards a common approach will, just like in the renewables business and the oil and gas business, reduce transaction costs, reduce project performance risk, allow banks and investors to build human capacity to process transactions, and reduce the cost of capital by facilitating access to a secondary market and securitisation. Energy efficiency is well suited to the bond markets except for the fact that the projects are too small and there is no standardisation. Development of standards through the Investor Confidence Project will allow aggregation of projects and ultimately once the scale is there, access to the bond markets

So progress is being made on all three fronts of the energy efficiency revolution, technology, design and finance. Continued progress and the combination of all three together promise a more efficient future with major positive impacts for the economy, companies, society, industry, individuals and the environment – but regions, countries or energy suppliers who don't see it coming and adapt accordingly will face ever growing energy and business problems.

2.9 Shining a light on invisible energy. 3 February 2015

In one of my presentations on the barriers to accelerating energy efficiency I talked about "the ribbon problem", the fact that one of the barriers to energy efficiency is that it is invisible and not very photogenic, unlike renewables or conventional power stations, making it hard for politicians to be photographed cutting a ribbon or standing in front of some dramatic installation. Try searching for energy efficiency in any online photo library and there are very few images for energy efficiency, mostly there are low energy light bulbs, a box of some description or some kind of naff logo often including a hand grasping a lightning flash. Efficiency is also invisible because it is not metered. This invisibility problem also extends to the long-term effects of energy efficiency in the economy – despite the huge scale of the effects they can't easily be seen and people rarely talk about them. Because of this energy efficiency is under-valued at all levels from policy makers down.

The latest excellent report from the Association of Decentralised Energy (ADE), formerly the CHPA, is entitled "*Invisible Energy*" and does an excellent job of highlighting some of the benefits of energy demand side activities, what we christened a few years back D3, Demand Management (permanent reduction of demand), Demand Response (short term shifting of demand) and Distributed Generation. The rationale for the report was to clearly demonstrate and explain the multiple benefits of improving efficiency and related demand side activities, to celebrate the achievements and help to change the language around the demand side. (It was tempting to say shine a light on the benefits – an LED light of course).

I have written before about how the impact of improved efficiency was completely overlooked by the energy industry and policy makers in the 1980s (see **Surprise! You are living in a low energy future…. (almost)**) The ADE report shows how the UK's GDP has doubled since 1980 while energy use has remained largely flat or declined. If the economy had the same overall level of energy intensity as in 1980 the UK would be using twice as much energy as it actually does. The ADE report that this would require an additional 14 power stations and importing twice as much gas as we currently do. Consumers would be spending an additional £37 billion on energy compared to what they are currently spending.

Critics will say that some of this change is due to the change in industrial structure and offshoring and these are real factors – but a significant proportion was down to fundamental improvements in efficiency – a result that was achieved without, it can be argued, any real policy commitment to improving energy efficiency for much of the period, except for the decade or so between the mid-1970s and the mid- to late 1980s. As I have said before, just imagine what we could do with a real sustained and comprehensive policy commitment.

The ADE report also looks at the potential for improving the demand side up to 2020. It is clear from this and many studies in many countries and regions that the economic potential for improving efficiency remains large (even massive), even in a world with $50 (or less) a barrel oil. By valuing the energy savings and the co-benefits properly, investing to improve efficiency at a national and organizational level is a "no-brainer" and a much better (higher return, lower risk) option than investing in increasing energy supply. Improvements in efficiency will continue to occur, as they have done for decades, even without improved policy interventions and irrespective of the price of energy. The challenge for policy makers, and leaders in all organizations, is how to accelerate the rate of that improvement to address the serious challenges of energy security, costs and the environment.

Congratulations to ADE on the report and their new name.

P.S. I subsequently discovered a previous use of the title Invisible Energy – a book by David B. Goldstein of the Natural Resources Defense Council.

2.10 Conscious uncoupling? 9 March 2015

Gwyneth Paltrow made the term "conscious uncoupling" famous when she split from Coldplay's Chris Martin (ed. who he?) but now perhaps the time has come to adopt it in the energy world. I have written before about the decoupling of energy use and GDP (see **here**). When I was first learning about energy and economics in the late 1970s it was an article of faith that the link between energy use and GDP was fixed and therefore that as economies grew wealthier they would use ever more energy. This fed into (and still feeds into) all official projections of energy use (see **here** for example), as well as the technical fantasies of the government of the day and bodies such as the old CEGB. The Department of Energy, for example in 1976 estimated energy demand by 2000 would be up 43%, instead it rose by 3%. More recently the decision to proceed with Electricity Market Reform was primarily driven by unrealistic scenarios of greatly increased electricity use – for details see "A Corruption of Governance" by ACE and Unlock Democracy.

Over the last few years there has been mounting evidence that the link between GDP and energy use has been broken in mature economies including the UK, Europe and the USA. The latest figures from DECC, released on the 26 February 2015, just add to this evidence base. To quote: "Primary energy consumption on a fuel input basis decreased by 7.0 per cent, and on a temperature adjusted basis, was down 3.1 per cent continuing the downward trend of the last nine years." About 1 per cent of this change (both temperature adjusted and unadjusted) is accounted for by a switch from coal generation to wind as wind and solar are measured as energy output, while losses are recorded in transforming coal to electricity.

UK GDP grew 2.6 per cent in 2014 and so the energy ratio (energy consumption per unit of economic output) has fallen by around 5.6 per cent, above the average of 3 per cent per annum since 2000. UK GDP grew 67 per cent between 2000 and 2014 while primary energy consumption (temperature adjusted) fell by 18 per cent.

In Europe there is a similar story. According to Eurostat Europe's total gross energy consumption is down 9 per cent from its historical peak in 2006 and is currently at a level last seen in the early 1990s (**see here**).

This is a great result but I probably should have titled the piece "unconscious uncoupling" because I don't think we have been very conscious about accelerating energy efficiency over that period. There is an underlying "natural" rate of improvement in energy efficiency that comes about through the introduction of more efficient products and buildings as capital stock turns over – that has been going on over centuries of technological progress. Then overlaying that is the "accelerated" rate of energy efficiency improvement that comes about from active policies and programmes to encourage further gains. I am starting to believe that we have actually improved both of these over the last few years as entrepreneurial talent and investment has increasingly moved into energy efficiency technologies and regulations have forced underlying assets like cars to be inherently more

efficient. Having said that we have not yet aggressively set out to accelerate the rate of improvement.

Having sounded a positive note, it is clear from surveying the current energy and energy efficiency scene that there is still a massive potential to improve overall energy efficiency and that there is still too much focus on energy supply side solutions. Efforts like the **Investor Confidence Project** and new contract structures are helping to make energy efficiency more investable, making it look more like any other source of energy services, and if we can deliver these solutions at scale then we will see further significant improvements in energy per GDP, probably at a level that will greatly surprise the energy supply establishment and governments.

There were some other interesting numbers in the DECC statistical release. Fossil fuel dependency has fallen to 83 per cent, a record low. More alarmingly, given the long-term prospects for the global energy market, and the more immediate geopolitical concerns around Russia and the Middle East, is that import dependency once again increased, reaching 48.7 per cent in Q3 2014, up 5.7 percentage points from Q2 2014 – despite the growth in renewables. Our import dependency, driven by rapidly declining UK Continental Shelf oil and gas production, is a big concern as it leaves us vulnerable to supply disruptions and limits our degrees of freedom on the global stage – a particularly important point at this time. In Europe the energy security situation is even worse with import dependency of 53 per cent and an expenditure on energy imports of more than €500 billion in 2013, that is €1.3 billion a day that was shipped out of Europe. Even with the fall in oil prices this is a major security and economic issue.

It is increasingly clear that our best solution to import dependency and the associated energy supply risks, as well as other energy supply related problems, is to reduce energy demand by aggressively targeting even larger rates of reduction in energy per GDP through accelerating energy efficiency across the economy. Doing so would bring multiple benefits at individual, local, national and global levels.

To learn more about conscious uncoupling see **here** and **here**.

2.11 Let's ditch energy efficiency? 14 Dec 2015

For those of us who have worked in energy efficiency a long time it sometimes seems as if the moment has come, the moment when the world has finally recognized the value of improving efficiency, the fact that there is huge potential which is economic today using today's technologies with no subsidies, and that improving energy efficiency brings with it massive non-energy benefits such as job creation, productivity and improved health and well-being. All, and I say all lightly as it is no small task, we need to do now is work out how take advantage of that huge economic potential that we know is out there. We are advancing quickly on that journey with projects like the Investor Confidence Project, the continuation of the work of the Energy Efficiency Financial Institutions Group (EEFIG) on establishing a common under-writing framework for energy efficiency (supported by the EU), and new business models. An increasing amount of capital is committed to finding ways of investing into efficiency – now we just need to make it possible for that investment to flow by breaking down the institutional and cultural barriers.

In the UK the energy policy reset has dealt with supply options (mainly promoting new nuclear and shale gas) but remains silent on efficiency. For the record I am against new nuclear (especially with unproven French or Chinese technology) because of cost and security concerns. I am in favour of shale gas on energy security grounds assuming we can exploit it cheaply. In any event, these supply options will take at least a decade (almost certainly more in the case of new nuclear) to take effect. Meanwhile we are sitting on a huge reserve of very cost-effective energy efficiency potential that is not being exploited and which could be unlocked very quickly. Almost every day we see cases of buildings, in some cases very new buildings, making savings of 10 to 30%, often with little or no investment. Everyone talks about the declining cost of solar but we also need to recognize

the declining cost of delivering efficiency. We need to build on that base of activity and accelerate demand, supply and financing of efficiency and hence rebalance the emphasis on supply options.

One way of doing that may be to stop using the term energy efficiency all together. Having worked in the field for so long, and finally having the subject get more recognition, this may seem like a strange proposal but energy efficiency has all kinds of problems as a label. It is a confusing technical term, it is boring to most people, it still has negative connotations of saving and getting by on less, it threatens energy suppliers, it is invisible, it does not lend itself to photo opportunities and big political announcements, and it leads to all kinds of pointless, endlessly resurfacing, debates based on the Jevons paradox.

We need to truly reset energy policy and focus on energy productivity –the amount of value we create out of a given amount of energy (GDP/energy input). Productivity is positive. Improving productivity generates wealth. No-one can be against improving productivity. Of course for any particular country energy productivity is made up of two elements, the overall structure of industry and the economy, and the level of actual energy efficiency.

In the UK tackling the country's poor productivity record is core to the Chancellor's economic strategy – we need to make sure energy productivity is part of that discussion and so far it clearly isn't.

In July the Treasury published a document, "*Fixing the Foundations: Creating a More Prosperous Nation*". Chapter 6 is called "*Reliable and low-carbon energy at a price we can afford*". This does start by talking about "improving productivity in energy generation, production, supply and usage" (a good start). It then goes on to talk about more competitive markets and introducing the ability to switch suppliers within 24 hours. Competitive markets are generally good but the problem we have is that energy efficiency cannot compete with energy supply – there is no market for efficiency, only markets for stuff that results in efficiency. We now have the technology to meter efficiency and California is moving towards a market where efficiency can be measured, metered and truly compete in the energy market. We are developing new business models based on this idea. Personally I fail to see how 24 hour switching contributes to productivity. The rest of the points in this chapter mention supply, oil and gas, shale, new nuclear, and the EU's Energy Union. In a strange final bullet point printed in red the now on-going review of business energy tax was flagged. It is almost as if they ran out of ideas and this chapter wasn't quite finished.

So, apart from the statement "improving productivity in energy generation, production, supply and usage" there is no mention of productivity and no linkage to overall energy productivity – and no mention of energy efficiency. Efficiency is mentioned in the chapter on Planning and housing – flagging the decision not to proceed with zero carbon homes and saying they will keep energy efficiency standards under review. The energy chapter is the old 1970s style supply side dominated model in new clothes – "the economy will grow and we will provide whatever energy we need" – rather than focusing on improving energy productivity.

We need to start talking about energy productivity at the macro and the micro level, recognize the economic benefits that come from improved energy productivity (arising from energy cost savings, improved energy security, improved health, reduced need to invest in new supply options etc etc), and set national targets for energy productivity. To support that we need to aggressively promote energy efficiency (that is to say energy productivity at plant and building level) and really start to exploit the massive cost-effective energy reserve the efficiency potential represents, a reserve which is cheaper than any supply-side option, faster to bring on-stream, and by far cleaner than any other option.

So maybe we shouldn't forget about energy efficiency all together, just rename it energy productivity.

Fixing the Foundations can be found at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443897/Productivity_Plan_print.pdf

Information on the Investor Confidence Project: europe.eeperformance.org

The EEFIG report can be found ***here:***

2.12 Fawkes's Laws Of Energy Efficiency. 21 Dec 2015

The end of the year always brings the pressure of whether or not to write something seasonal. This year I thought I would do something different by formulating my Laws of Energy Efficiency. Sir Isaac Newton and the great Arthur C. Clarke stopped at three Laws so I apologize for coming up with 12. They echo some of the themes I have covered in the blog over the last three years.

1. Energy efficiency is boring and seriously uncool to most people most of the time
2. Never talk about energy efficiency without mentioning the non-energy benefits which can be seriously cool
3. Talk about energy productivity and not energy efficiency
4. If you are supposed to be an energy journalist never headline a story about renewables with something about "energy efficiency"
5. If you put ten people from ten ESCOs in a room there will be 15 different definitions of what an ESCO is
6. If you have five energy auditors survey any building you will end up with reports in five different formats with savings calculated five different ways, even if they are all recommending the same measures
7. Energy Performance Contracts and ESCOs are not the magic bullet some enthusiasts and failed investment bankers looking for the next big thing think they are
8. Never call energy efficiency a "no brainer" or "low hanging fruit"
9. An exciting energy or energy efficiency discovery in a lab somewhere is not the same as a viable technology, which is not the same as a commercial product, which is not the same as a successful product that has meaningful impact in the world
10. Any politician who finishes an energy speech by saying "and don't forget energy efficiency" will promptly forget it the next time he or she meets an energy supply lobbyist
11. Energy forecasting is easy, getting it right is difficult. The corollary to this law is that prices can go down as well as up – never forget that in 1986 oil went below $10/barrel oil only months after oil industry bosses said "oil will never sell for less than $20/barrel again" and "our doomsday forecast is $20-25 a barrel"
12. When a distinguished but elderly economist says "what about the Jevons Paradox", ask him or her if they think improving productivity is a bad idea.

2.13 The urgent need for energy productivity. 22 Nov 2016

I heard the Chancellor of the Exchequer Philip Hammond yesterday morning talking about the Autumn statement and the need to build resilience in the UK economy. At the same time there has been a lot talk about productivity since the change of government. The Chancellor himself said at the Conservative conference: "to deliver that strong, prosperous, economy……requires long-term, sustainable growth. And long-term sustainable growth requires us to raise our national productivity."

Given these kinds of statements, and the energy situation we have, it is time to prioritise a policy and a target that would both improve resilience (to economic shocks) and improve productivity – specifically energy productivity, and put in place policies and programmes that drive energy productivity. In the old world energy was an input to the economy and the demand for energy was driven by growth in the economy. Now improving energy productivity itself has been shown to be a driver of economic growth.

Energy productivity is defined as GDP per unit of energy, how much value we create from every unit of energy. At the end of the day we all want increased GDP. I know it is an imperfect measure of welfare but making people richer is what drives improvement in the human condition, here in the U.K. and everywhere else. (Yes – I know that wealth also creates problems but we are not going to get out of those problems by becoming poorer – we will only get into other deeper problems). Given the energy issues that the UK is facing – including declining domestic energy production, increase reliance on imports, very tight electricity supply margin, environmental impacts that lead to health problems (a global impact through CO_2 emissions and local impacts through air pollution), and poor energy efficiency in housing that leads to fuel poverty – adopting an energy productivity target and strategy should be a priority.

Energy productivity goes beyond the traditional perspective of energy efficiency and is more than a simple reframing of the energy efficiency agenda. Ultimately the trajectory of energy productivity in an economy is driven by three factors; the energy productivity of existing capital stock, the energy productivity of new capital stock, and the structure of the economy.

Increasing energy productivity of the existing stock, (which is normally the province of energy efficiency and energy management), all other things being held equal will increase the energy productivity of the economy. The methods to do this at the macro level are the subject of energy efficiency policy – which we know how to do and is well documented.

Increasing energy productivity of new stock entails ensuring that new stock, across all sectors, is as efficient as possible within the definition of economic. Although new stock, new buildings for example, will tend to be more efficient than old stock due to advances in technology and tightening regulations, many cost-effective energy efficiency opportunities are missed due to many factors. This lever of energy productivity can be affected by regulations that are normally considered part of energy efficiency policy e.g. building codes, but importantly, and largely neglected to date, it can also be changed by finance and investment policies – areas outside conventional energy efficiency policy. For example public infrastructure funds could have a policy of only investing in high energy productivity stock, (for instance top quartile performance) and working with project sponsors to identify cost-effective energy efficiency opportunities – as has been practiced by the EBRD for many years. Investing in new stock that has an energy productivity higher than the average (for the economy or the sector) will increase overall energy productivity. Other finance and investment policies that would drive improvements in energy productivity include requiring banks to assess the energy productivity of their loan portfolio, facilitating the growth of the green bond market for high energy productivity assets, and reducing capital reserve requirements for high energy productivity assets.

The third driver of energy productivity is diversification within the economy e.g. a move towards higher energy productivity activities. This is the province of economic development and industrial strategy policies. Energy productivity can be applied to all sectors of the economy and it is an integrating policy.

At a corporate level adopting an energy productivity target also drives activity in the three areas; retro-fit, refurbishment and new build – and helps to balance them within a coherent, and strategic policy. Strategic issues always get more attention than non-strategic things and are not subject to the same short payback criteria normally applied to retrofit. Energy management is usually only concerned with retrofit and is consigned to the boiler room rather than the board room – making it part of a strategic policy keeps it in the board room.

Adopting an energy productivity target would put the UK at the forefront of energy policy. It would drive growth in the economy and innovation in policy and programmes, it would really start to address our mounting energy problems, and it would greatly contribute to the Chancellor's goals of increasing resilience and creating sustainable growth.

2.14 Let's build a market for energy efficiency. 8 Nov 2018

At the recent IEA Energy Efficiency Conference EnergyPro contributed to a side meeting The Role of Energy Efficiency in Europe's Flexibility Agenda. The session was designed to discuss new business models and technologies that enable efficiency to contribute to flexibility. In particular we, along with Matt Golden, focused on *OpenEE* (now ***Recurve Inc***) which enable utilities, network operators and programme managers to meter the effect of energy efficiency in time and location. This technology is now being applied in a growing number of US states to measure and value the impact of energy efficiency programmes and enable pay for performance programmes, where payment is directly related to energy savings rather than based on capital spent or deemed savings.

There is much talk about the barriers to fully utilising the massive potential for cost-effective energy efficiency but a fundamental problem is that there is no market for energy efficiency, only various diverse markets for stuff that we hope save energy. Functioning markets need standardised units, standardised contracts, known risks and liquidity – and energy efficiency traditionally has none of these. OpenEE provides the standardised units through its open source calculations – it is a weights and measures system for energy efficiency. Once you can measure and reward the effect of energy efficiency measures you can enable any technology and target programmes more effectively. Everyone know that the electricity market is changing rapidly, as diverse and distributed energy sources increase the need for flexibility will increase even further and OpenEE enables network operators to treat energy efficiency like any other distributed energy resource.

With the rapid changes in energy markets and technologies our traditional views of energy efficiency have to change, if they don't we will still be lamenting the under-utilised cost-effective energy resource in another forty years as we have done for the last forty years. This means energy efficiency should be treated like other energy sources and be allowed to compete on a level playing field in a functioning market. This means energy efficiency will have different values in different places and different times. It means developers need to recognise and capture the various sources of value at different levels; host and distribution system. It means developers will need to use more standardised ways of developing and documenting projects. It means we will have to use standard contracts like PPAs to buy negawatt hours and PPAs are financeable instruments, this will open up new ways of financing efficiency.

It is time to build a functioning market for energy efficiency.

2.15 Elegance and energy efficiency. 14 Jan 2019

Elegance: The quality of being pleasingly ingenious and simple; neatness. (Oxford Dictionary)

The economic and environmental advantages of energy efficiency are extremely well documented. As well as the value of avoided energy use we now recognise the economic and social value of multiple non-energy benefits as diverse as increased productivity, improved health and better learning outcomes. The case for low energy, high performance buildings, and for retro-fitting existing buildings to achieve high levels of performance is clear. Furthermore the combination of near zero energy design, local generation through solar PV and demand response technologies mean that we are moving into an age where buildings are becoming prosumers, both producers and consumers, of energy rather than simply consumers.

There is another little explored characteristic of energy efficiency and that is elegance. In all areas, not only buildings, we have the technology and the know-how to design systems that are highly energy efficient, even energy positive – but we don't typically use them because we engineer systems using conservative thinking and standard techniques. These systems are clunky (defined as "solid, heavy and old fashioned") in their use of materials and energy, much of which is simply wasted. Think about a conventional UK house, which even though today's Building Regulations are much improved, is still typically heated by a gas boiler feeding radiators and leaks heat like a sieve. The 'boiler' takes in gas, sets fire to it, and heats water which is pumped around panel radiators which heat up the rooms until a thermostat, often positioned badly and many of which are still based on the technology of bi-metallic strips (invented in the 1830s), and most of which are certainly not "smart" by any stretch of the imagination, detects that the temperature has been reached and sends a signal to turn off the boiler. The "bang bang" nature of the control leads to imprecise control with overshoots and lags, leading to more wastage. The construction of the house allows heat to leak away through the structure and via air infiltration, resulting in the consumer having to pay excessive energy bills and creating unnecessary carbon dioxide emissions and local heating effects.

Considering the wider system, the house takes in gas from a gas distribution system which is fed by the transmission system. Gas is fed into the system having been extracted from under the ground and treated to remove non-methane hydrocarbons and impurities such as carbon dioxide and hydrogen sulphide. Each of these steps involve massive equipment and capital expenditure, use significant amounts of energy and produce by-products and waste streams. They can be amazing pieces of chemical engineering but they are not elegant.

Now contrast that clunky system with a house designed to Passive House standards. It will have very high levels of insulation, higher performance windows and doors, a vapour barrier and a mechanical ventilation system with heat recovery. It will use 5-10% of the energy of a comparable house built to normal standards. The residents will feel more comfortable thanks to the internal surfaces having a higher temperature and the absence of draughts. They will also live in cleaner, healthier air. Imported energy will be electricity from a decarbonizing grid, (admittedly with all of its own inherent complexities and in-elegance), or in the case of a zero-energy building from solar PVs linked to battery systems.

Simply put, as well as a number of other advantages such as low running costs, healthier environment and greater resilience, a Passive House building has elegance; the quality of being pleasingly ingenious and simple; neatness.

It is not only in building design that we see these characteristics. Many industrial systems use components that are based on primitive engineering such as process water bath heaters, the design of which dates back many decades. Newer, elegant systems can reduce energy usage by 50% or more. Internal combustion engine powered cars are miracles of industrial engineering but with their thousands of components and maintenance requirements, albeit much reduced over the years, they appear positively clunky compared to an electric vehicle.

As well as elegance in the final output there is something elegant about a design process itself that seeks high performance with the minimum amount of energy and resources. It requires real thought and effort compared to producing a standard "off the shelf" design. It requires thinking about what can be taken away, in the words of Antoine de Saint-Exupéry the French pilot and author; "a designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away." In a similar vein Matthew E. May, a consultant on lean development has said: "The goal of elegance is to maximize effect with minimum means" and that "Elegance is a stop doing something strategy". It is time we demanded elegance in design and stopped accepting conventional, clunky, energy guzzling buildings, industrial systems, vehicles and other stuff.

2.16 Shifting the paradigm. 6 Sept 2019

For anyone wanting to understand how the world changes Thomas Kuhn's concept of paradigm shifts, as put forward in his 1962 book '*The Structure of Scientific Revolutions'*, is essential reading, even though it was originally applied to shifts in scientific thinking it is applicable far beyond science.

In its entry on Kuhn, the *Encyclopaedia Britannica* explains his concept:

"Scientific research and thought are defined by 'paradigms', or conceptual world-views, that consist of formal theories, classic experiments, and trusted methods.

"Scientists typically accept a prevailing paradigm and try to extend its scope by refining theories, explaining puzzling data, and establishing more precise measures of standards and phenomena. Eventually, however, their efforts may generate insoluble theoretical problems or experimental anomalies that expose a paradigm's inadequacies or contradict it altogether.

"This accumulation of difficulties triggers a crisis that can only be resolved by an intellectual revolution that replaces an old paradigm with a new one. The overthrow of Ptolemaic cosmology by Copernican heliocentrism, and the displacement of Newtonian mechanics by quantum physics and general relativity, are both examples of major paradigm shifts."

In short the concept says that things change in paradigm shifts rather then gradually. In the period that Kuhn called 'normal science', everything looks fine. Then cracks appear when some evidence arrives that things are not quite how they appear to be. In that phase the majority of people who are attached to the paradigm resist, rubbishing the people attacking the existing theory. Over time the weight of evidence builds until the new paradigm emerges and is accepted by the majority.

The idea transformed scientific debate and modelling.

Clearly the world of energy supply has undergone a paradigm shift over the last 10 to 20 years. In the old paradigm renewables were regarded as expensive and only ever to be a small percentage of supply, people who argued otherwise were criticised by the energy establishment for being unrealistic. Now we are seeing renewables under-cutting fossil fuelled generation and generating a growing proportion of electricity supply. The defenders of the old paradigm, particularly people like Trump and the coal companies in the US, continue to attack the new paradigm but it is now clear that they are on the wrong side of history. It is normal during a paradigm shift for the 'old guard' to fight hard to defend their view of the world, even as the evidence mounts that it is wrong. Attacks on those working to shift the paradigm are normal. Other aspects of the old energy paradigm that are breaking down include; supply reacts to demand, there is a merit order in which generators bring on different supply sources with coal and nuclear delivering 'base load', and electricity cannot be stored.

We are also now seeing a shift in thinking about energy efficiency that heralds a paradigm change. The old paradigm was dominated by the idea that efficiency needed encouragement over and above market forces. It was also based on the idea that efficiency projects were developed in non-standard ways and that the measurement of the result was difficult, and that large programmes came with large measurement and verification costs. In the US a whole industry developed to estimate the results of efficiency programmes. As specific project measurement was rare the actual results of many projects were unknown. Furthermore, often when they were measured results were a long way from what was planned, the 'performance gap'.

Other characteristics of the old and emerging paradigms are shown below.

Old paradigm	*Emerging paradigm*
Energy efficiency is a 'cause' or a 'campaign' that needs special support programmes	Energy efficiency can operate in a market where it truly competes with energy supply
Measurement of individual projects result is expensive and hard	Measurement of individual project results, and portfolios of projects, is cheap and easy
The outcomes of projects have large uncertainties	Uncertainties can be reduced by standardisation of project development and implementation, as well as by learning from results
Efficiency is evaluated purely on value to the end user	Efficiency is evaluated on value to the end user and the energy distribution system
Efficiency is somehow special and separate to other areas such as demand response and distributed generation	Efficiency is one of several tools for optimising costs, energy use and emissions for the end user, and also for the energy distribution system
Savings from an energy efficiency measure are considered to be spread out equally over a year. All units saved have the same average value	Savings from an energy efficiency measure occur at specific times, times that have an impact on the supply system. Therefore units saved have different values at different times
Buildings and other users are simple consumers of energy	Buildings and other users can be consumers or suppliers of energy
Energy demand patterns are fixed	Energy demand patterns are flexible
The value of energy efficiency is simply cost and emission reductions	There are multiple, strategic sources of value for an energy efficiency investment
There are diminishing returns in efficiency investment	Through integrative design it is possible to have an expanding, declining cost efficiency resource

In the US the emergence of the new paradigm is being enabled by policy switches to support metered efficiency programmes in which results of investments are measured and payment is based on results, Pay for Performance. If we are to achieve the real potential of efficiency to reduce emissions, as well as make our use of energy, more productive, policy makers everywhere need to take this approach, despite the resistance of the old guard.

EnergyPro is looking to work with forward looking energy suppliers, energy service companies, efficiency product companies, or others wanting to explore the new business opportunities the paradigm change is creating globally.

If you are not prepared for the paradigm change, once it happens, you may well be out of business.

2.17 Escaping the horns of a dilemma. 21 April 2020

"Phaedrus, however, because of his training in logic, was aware that every dilemma affords not two but three classic refutations, and he also knew of a few that weren't so classic, so he smiled back." Zen and the Art of Motorcycle Maintenance

For the last few years there has been a lot of discussion about how to decarbonize heat in the UK. The argument is presented as: do we go down the heat pump route or the hydrogen in the gas network route. These two choices are presented as an either/or and both have

their issues – they are the horns of a dilemma. In a blog last year I came out in favour of '**electrify everything**' – which caused a surprising amount of reaction and even amusement from followers and friends. It just seems clear to me that electrifying everything is the right way to go. Rather than just 'reinventing fire' we should be eliminating it. As my friend and veteran energy guru Walt Patterson said, **leaving fire behind** may determine our future on earth.

I first started studying hydrogen and the promise of the hydrogen economy in the late 1970s, and researched hydrogen as an **aviation fuel as an undergraduate dissertation** in 1980. Much as I like the idea of the ubiquitous hydrogen economy, probably inspired by my interest in space exploration and the use of liquid hydrogen as rocket fuel, hydrogen has some serious technical issues. Using it for domestic heating frankly makes no sense for several reasons including those set out by **David Toke**. Using hydrogen in the gas grid is an understandable effort by the gas industry to maintain their position, typical behavior of proponents of the status quo when the tectonic plates of a paradigm shift are in motion. Having said that the possible roles of hydrogen for transport and industrial use such as steel production are developing and a number of demonstration projects show real promise. Use of green hydrogen generated from off-shore wind with storage in salt caverns is also being actively developed in Denmark and elsewhere. Some of these projects will probably form part of Europe's green response to the COVID-19 crisis and we are pleased to be associated with some of them. However, the hydrogen economy will be more specialised and fragmented than the technological dreams of previous decades when electricity generation was still high carbon and electricity storage was 'not possible' other than through pumped hydro-electric stations.

But on the other side of the dilemma heat pumps are unlikely to suit all situations, particularly in retrofit situations, and the overall seasonal performance is still not necessarily as good as advertised. Changing over to heat pumps in all buildings is just not going to be possible.

But as Phaedrus, the alter ego of the protagonist in Robert Pirsig's excellent 'inquiry into values', '*Zen and the Art of Motor Cycle Maintenance*' pointed out, every dilemma affords not two but three ways out. You don't have to choose to impale yourself on one of the horns.

In heating the third option that has been overlooked, and one that is looking increasingly interesting, is localised power to heat transfer with thermal storage. Using electricity to provide heat with thermal storage allows low and zero carbon heating and can provide the large amounts of flexibility to the power system that an increasingly renewable power system needs – a double win. Examples include storage technologies from **SunAmp**, and **Pumped Heat** and on a larger scale there are examples in Danish district heating schemes.

These 'cross vector' technologies are starting to enable new services such as Virtual Power Plants and managed energy services for households and businesses of all types. It is very unlikely that the energy system of the (near) future will be an either/or type of system – it is more likely to be a patchwork quilt of local solutions that make economic sense by providing multiple sources of value

When confronted with the horns of a dilemma be sure to look around the bull to see a way out!

2.18 Surprise! You are living in a low energy future (almost). 12 Aug 2013

In 1979, a period dominated by high oil prices and deep concerns about the future supply of energy resources, Gerald Leach and a team from the International Institute for Environment and Development (IIED) wrote an important book called "*A Low Energy Strategy for the UK*". It was controversial at the time as it stated that "the United Kingdom could have 50 years of prosperous growth and yet use less primary energy than it does today". This, the study argued, could be achieved by improving thermal performance of new buildings, implementing energy performance standards for cars and major household appliances, and

improving industrial energy efficiency. Leach's scenario was similar in message to Amory Lovin's more famous "soft energy path" for the USA, published in "Energy Strategy: the Road Not Taken" in 1976. Both advocated a bottom-up approach to energy modelling rather than the prevailing top-down approach and forecast future energy consumptions much lower than the prevailing official forecasts – both turned out to be more accurate than the official forecasts when it came to actual energy consumption.

Leach's conclusion (and that of Lovins in the US) was controversial at the time as official government scenarios were still based on the belief, (perhaps still current in some circles), that there was a rigid link between energy use and GDP – something that was probably true between 1953 and 1973 – a period when affluence was increasing along with the ownership of cars and energy using appliances. The Department of Energy projections for primary energy use were between 32% and 63% higher than the 1976 consumption (460 to 570 million tonnes coal equivalent (mtce) compared to the 1976 consumption of 349 mtce). The Leach analysis was widely considered to be unrealistic by the energy establishment at the time so nearly 35 years later it is interesting to compare the Leach scenarios with what actually happened.

Table 1 summarizes the Leach et.al. scenarios, the official UK Department of Energy scenarios of the late 1970s, and the actual out-turn for UK primary energy consumption. To avoid confusion over energy units (Leach used mtce, now primary energy is reported in mtoe – million tonnes oil equivalent) and different inflators for GDP I have converted everything to indices starting at 100 in 1976.

Table 1. Summary of Leach scenarios, Department of Energy scenarios and actuals.

	1976	1990	2000	2010	2025
Leach GDP scenario (low)	100.0	141.3	172.3	188.5	203.1
Leach GDP scenario (high)	100.0	141.3	191.8	231.4	293.7
Actual GDP	100.0	144.5	189.9	226.1	–
Department of Energy primary energy forecast (low)	100.0	–	132.0	–	–
Department of Energy primary energy forecast (high)	100.0	–	164.0	–	–
Leach primary energy (low)	100.0	102.5	94.5	88.5	84.5
Leach primary energy (high)	100.0	108.8	103.3	102.2	99.9
Actual primary energy use	100.0	103.9	114.2	105.4	–

Interestingly enough the actual GDP out-turn has been squarely in the Low-High scenario range outlined in Leach which were in-line with the official reference forecasts used by the Department of Energy at the time. So the economic forecasts were basically good. Two things really stand out:

- the big difference between the Department's forecast for primary energy use in 2000 and the actual out-turn
- the actual 2010 primary energy use is close to Leach's high scenario.

Looking at energy use per GDP ratios we can see that the official Department of Energy forecast a range between 0.76 and 0.85 for 2000, Leach's scenario was between 0.54 and

0.55, (considered outrageously low and impossible by the establishment), and the actual out-turn was 0.6.

Whatever the causes, we are practically living in what was defined in 1979 as a radical, low energy future.

Now this is a very simple analysis and of course there are a number of factors that turned out to be different to the scenarios and will affect the conclusions including:

- the sectoral breakdown of the economy now looks different to the scenarios of the late 1970s, (industry making up 30% of GDP by 2010 compared to an actual of 24%)
- the sources of primary energy projected also look different to reality. The use of gas was seriously under-estimated, Leach projected 14% of primary energy in 2010 would be gas, in reality the number was more like 35%, as the use of gas for power generation was restricted until the 1980s.

Given the importance of energy forecasts at the current time it is useful to review old future energy scenarios and see what we can learn.

There is an interesting quote in Leach (p.186) in response to the then government's plans to expand generating capacity and nuclear power that has a strange resonance today:

"The enormous investments for new power stations assumed in official forecasts are vastly reduced. The current Department of Energy forecast estimates that 83 GW of new plant must be built in the UK by 2000. Our figures are 26 and 30 GW for the Low and High cases respectively. At an estimated £500 per kilowatt installed capacity for plant only (at 1977 costs) the investment savings on our projections are of the order of £26 – £30,000 million, or well over £1,000 million a year. We should be very surprised if this sum did not amply cover the costs of all the energy conservation measures assumed in this study."

Interestingly, the 83 GW of new plant needed by 2000 referred to here is about the same as the total UK generating capacity today. The Department of Energy's "reference forecast" for 2000 also included 40 GW of nuclear capacity (compared to the actual today of 10 GW).

Maybe we haven't learnt very much about energy forecasting. A lot of the basis of the planning for the current Electricity Market Reform (EMR) was built on DECC scenarios which showed significant increases in electricity demand, up to a doubling of demand by 2050, based partly on assumptions about the electrification of heat and the spread of electric vehicles. Other scenarios, some of which showed demand going down, were discounted. For details see the report, "A corruption of governance" by the Association for the Conservation of Energy (ACE).

https://cdn.ca.emap.com/wp-content/uploads/sites/9/2012/02/ACE-Campaigns-MPs-misled-over-nuclear.pdf

My conclusions from reviewing Leach's "low energy strategy", Lovin's "soft energy path" and other studies are as follows:

1. Government forecasters and indeed most mainstream analysts have trouble seeing outside the perceived wisdom of the time – the prevailing paradigm
2. Official forecasts tend to overstate future energy use
3. Bottom-up, technically based, demand led models may be more reliable than economic top-down models
4. The link between energy and GDP is more complex than we thought – but it is weakening over time
5. We achieved significant improvements in overall energy efficiency consistently over a 35 year period, during which energy efficiency was really only a major concern for about ten years between the mid-1970s and mid-1980s

6. Energy efficiency has effectively delivered more energy services than any other source of energy
7. The Leach book should be required reading for energy analysts and policy makers. Although long out of print copies can be found on Amazon and Abe Books

The final point – if we effectively achieved a "low energy" future without paying attention to increasing the rate of reduction in energy intensity the question is what could we achieve if we actually do pay attention to the energy efficiency resource?

3 The potential for energy efficiency

My PhD in the early 1980s was concerned with the potential for energy efficiency in industry. Many, many studies have been undertaken which identify the potential for improved efficiency in different industries, sectors, regions, countries and globally. I wrote a chapter of my book on defining potentials and summarising some of the studies available at the time. All confirm that there is a very significant potential for cost-effective measures and an even larger potential for technologically possible but not necessarily cost-effective measures. Those of us engaged in the field spend our time trying to exploit that potential. The blogs in this section focus on potential. Exploiting the energy efficiency potential is the same as exploiting the potential for an energy or mineral resource, someone has to believe it is there, and gather the resources and the technology to find it and dig it up.

3.1 Energy efficiency as a resource. 22 June 2015

At the recent EU Sustainable Energy Week, Vice-President Maroš Šefčovič said "we should treat energy efficiency as an energy resource in its own right" and in fact the Commission now talks about energy efficiency first. Efficiency enthusiasts have long advocated this view so it is good to see it beginning to be adopted by the EC.

If efficiency is to be treated as a resource we need to map the language of efficiency onto the language of other energy resources. The energy and finance industry has its own language when taking about resources, a language that is itself often mis-understood by outsiders. In the 1970s there were many reports of oil running out based on the fact that there were only 20 (or 30 or some other number) of years of oil reserves left. This completely mis-understood the meaning of reserves. So let's look at the language of conventional fossil fuel energy resources and how that maps onto energy efficiency.

The methodology for defining and measuring resources and reserves is called the Petroleum Resources Management System (PRMS) and has been developed by the Society of Petroleum Engineers and endorsed by the World Petroleum Council, the American Association of Petroleum Geologists, the Society of Petroleum Engineers and the Society of Exploration Geophysicists. The valuation of oil and gas companies are based on the use of the PRMS and when oil and gas companies come to the public markets the price is related to the PRMS assessment as it provides a standardized way of assessing, and therefore valuing, resources and reserves.

The diagram and the text below explains the PRMS and the definitions.

RESERVES are those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions. Reserves must further satisfy four criteria; they must be discovered, recoverable, commercial, and remaining (as of the evaluation date) based on the development project(s) applied. Reserves are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by development and production status.

CONTINGENT RESOURCES are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations, but the applied project(s) are not yet considered mature enough for commercial development due to one or more contingencies. Contingent Resources may include, for example, projects for which there are currently no viable markets, or where commercial recovery is dependent on technology under development, or where evaluation of the accumulation is insufficient to clearly assess commerciality. Resources are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by their economic status. Note that for resources to be classified as Contingent Resources they must be discovered.

UNDISCOVERED PETROLEUM INITIALLY-IN-PLACE is that quantity of petroleum estimated, as of a given date, to be contained within accumulations yet to be discovered.

PROSPECTIVE RESOURCES are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from undiscovered accumulations by application of future development projects. Prospective resources have both an associated chance of discovery and a chance of development. Prospective resources are further subdivided in accordance with the level of certainty associated with recoverable estimates assuming their discovery and development and may be sub-classified based on project maturity. Prospective Resources can be sub-classified as Prospects, Leads and Plays as follows:

- **Prospect**: A potential accumulation that is sufficiently well defined to represent a viable drilling target
- **Lead**: A potential accumulation that is currently poorly defined and requires more data acquisition and/or evaluation in order to be classified as a prospect
- **Play**: A prospective trend of potential prospects, but which requires more data acquisition and/or evaluation in order to define specific leads or prospects

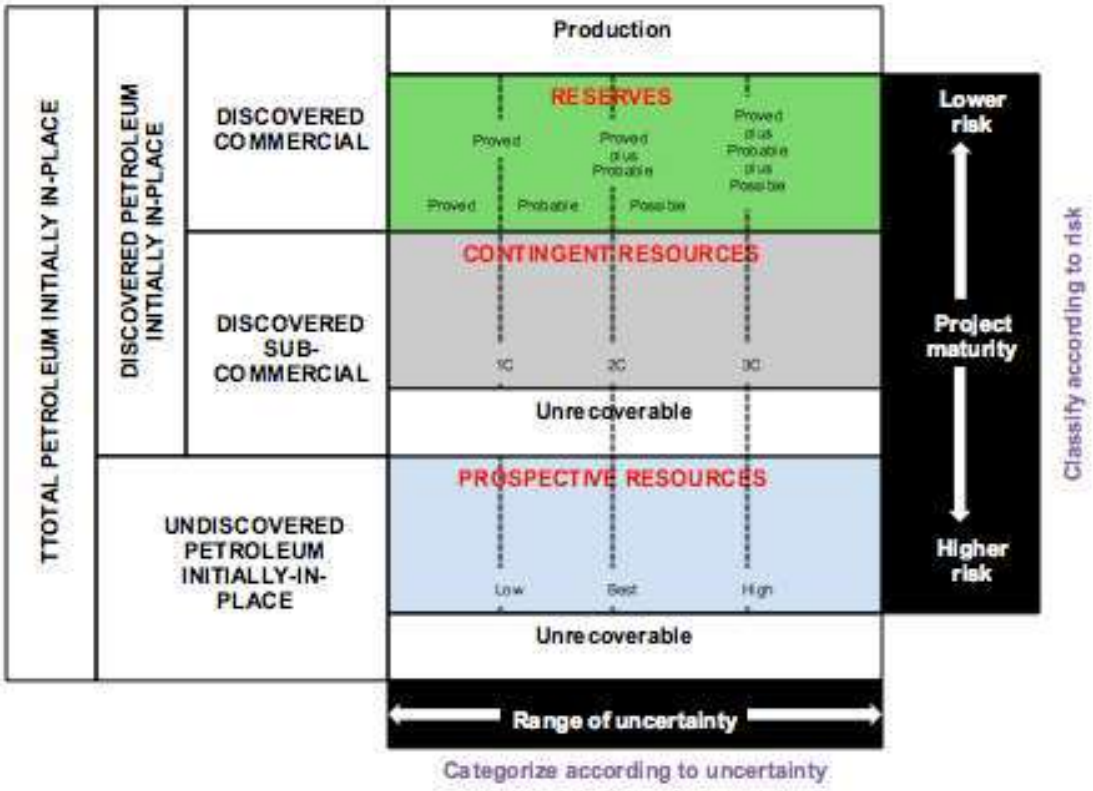
UNRECOVERABLE is that portion of Discovered or Undiscovered Petroleum Initially-in-Place quantities which is estimated, as of a given date, not to be recoverable by future development projects. A portion of these quantities may become recoverable in the future as commercial circumstances change or technological developments occur; the remaining portion may never be recovered due to physical/chemical constraints represented by subsurface interaction of fluids and reservoir rocks.

Determination of Commerciality

Discovered recoverable volumes (Contingent Resources) may be considered commercially producible, and thus Reserves, if the entity claiming commerciality has demonstrated firm intention to proceed with development and such intention is based upon all of the following criteria:

- Evidence to support a reasonable timetable for development
- a reasonable assessment of the future economics of such development projects meeting defined investment and operating criteria.
- A reasonable expectation that there will be a market for all or at least the expected sales quantities of production required to justify development
- Evidence that the necessary production and transportation facilities are available or can be made available
- Evidence that legal, contractual, environmental and other social and economic concerns will allow for the actual implementation of the recovery project being evaluated

To be included in the Reserves class, a project must be sufficiently defined to establish its commercial viability. There must be a reasonable expectation that all required internal and external approvals will be forthcoming, and there is evidence of firm intention to proceed with development within a reasonable timeframe. While 5 years is recommended as a benchmark, a longer time frame could be applied where, for example, development of economic projects are deferred at the option of the producer for, among other things, market-related reasons, or to meet contractual or strategic objectives. In all cases the justification for classification as Reserves should be clearly documents.



After: Petroleum Resources Management System (PRMS), March 2007, prepared by Oil and Gas Reserves Committee of the SPE, sponsored by WPC, AAPG, SPEE

The energy efficiency analogues

So, having explained the PRMS, what are the equivalents in energy efficiency and how do we need to change the language so that we can think of efficiency as a resource?

Clearly assets in Production are efficiency projects that have been implemented and working. Like oil fields actual production (of "negawatt hours") will vary from the initial design estimates, this variation can be down to errors of designs (technical performance) and variations in other factors e.g. occupancy patterns in a building. The economic performance will of course be affected by the price of energy that is being "saved" which will almost certainly vary during the project lifetime, just like the price of oil varies during the production lifetime of an oil field. In both cases the only certainty is that the actual output and actual economic performance will be different to that estimated in the investment case.

Energy efficiency reserves, using the PRMS criteria of being discovered, recoverable, commercial and remaining, are those projects that have been identified in some process (probably involving an energy audit), can be implemented practically, are commercial according to the investor's criteria and are as yet not implemented. The level of uncertainty addressed in the PRMS fits nicely with the difference between a regular energy audit or survey and an Investment Grade Audit (IGA). IGAs typically include fixed prices and a financing plan. (An IGA can be level II or III in ASHRAE or Type 3 under ISO50002.)

Also of course an audit of either type, a simple audit or an IGA, can find projects that are sub-commercial i.e. Contingent Resources. One of the definitions of sub-commercial is projects for which there are "currently no viable markets" – there actually isn't a market for energy efficiency although we can envisage a situation where there could be, similar to the market for demand response. Creating such a market would require the appropriate

regulatory framework. The other criteria is "where commercial recovery is dependent on technology under development", in energy efficiency there are projects that are dependent on emerging technology and assumptions about its timing and/or costs and benefits. The third criteria is "where evaluation of the accumulation is insufficient to clearly assess commerciality", i.e. the level of uncertainty is too high due to a lack of information. This may be a project identified by an audit but where there is still uncertainty over costs and savings, uncertainty that can be reduced by further measurement and analysis or cost determination, or external, contextual uncertainties e.g. uncertainty about the future ownership or occupancy of a building.

Over the last forty years there have been numerous studies of the potential for energy efficiency. One problem with these studies is the definition of economic, what is economic is defined by the investor and will vary from investor to investor. They also often cover the equivalent of Reserves, Contingent Resources, Undiscovered, Prospective Resources and Unrecoverable without breaking the potential down. The size of the Unrecoverable energy efficiency is driven by the technological frontiers with the upper limit set by the laws of thermodynamics.

It is often said that one of the problems with energy efficiency is that it is invisible. This is true but let's not forget that oil and gas resources and reserves are also invisible, it is only the tools of geology and seismic studies – which are increasingly sophisticated – which allows us to "see" those resources. In energy efficiency it is tools like benchmarking and energy audits that allow us to see the resource.

One of the differences between energy supplies and energy efficiency is that once the reserves are identified they don't usually sit around for many years without being developed. Compared to oil and gas the reserves are made up of many (millions of) individual small projects and implementation usually follows evaluation fairly quickly, unlike in oil and gas where projects can cost billions and take many years. On the other hand we know that there have been years of energy audits which identified economic projects which have not been implemented – energy audits are notorious for sitting on the book shelf (or these days on the hard drive). The projects identified in those audits are effectively energy reserves and contingent resources which are not valued. They have a high degree of uncertainty but they are there.

If you are an oil and gas company with control over reserves and even resources, these have a value against which you can raise money. This is how oil and gas E&P (exploration and production) companies raise money on markets like AiM (Alternative Investment Market) or TSX (Toronto Stock Exchange). Given that nearly every building has reserves of energy efficiency potential we need to think about mechanisms that value that potential, just like we value oil and gas fields before they are exploited.

When you look at the world like this the built environment is probably our biggest energy resource.

3.2 Where energy efficiency is really found is in the minds of men and women. 8 May 2018

We know that there is a massive potential for cost effective energy efficiency in nearly all, well all in fact, sectors and situations. Study after study in many countries and many regions have repeatedly shown this as has case study after case study. We know the efficiency resource is available, now we have to turn it into reserves and use it – we need to get it out of the buildings, out of the factories, out of the power systems and out of transportation. To use the oil and gas resource analogy we are in the position of a small exploration company who have found massive reserves of oil but lack the means or the know-how to exploit it.

So what do we need to really scale up utilisation of the efficiency resource, the cheapest, cleanest and fastest to deploy energy resource we have?

Well here are (six) things that we need in any country, situation or sector.

1. First of all we need to see that the resource is there. Wallace Everett Pratt, a pioneer petroleum geologist said; "where oil fields are really found is in the minds of men" and it is the same for efficiency. It is only there when you recognise it as being there. The scale of the resource, as in oil and gas, can also be limited by imagination or technical know-how. Applying integrated design will generally lead to a larger, more economic reserve than using conventional incremental engineering. It opens up bigger reserves in the same way that conceiving of and then implementing horizontal drilling increased oil reserves.
2. Someone, and preferably someone with some authority and power needs to believe that it is a) viable and b) economic to spend the time and money needed to identify and then access the reserves. Viability is in the eyes of the beholder and there is a need for entrepreneurs (in both the private and public sectors) to lead. Such people are often "unreasonable". An example is the Empire State Building renovation that used integrated design and reduced energy use by 38%. Without a forceful, informed client in the shape of Tony Malkin that project would not have happened in the way that it did and at best there would have been smaller, less financially attractive savings, and at worst no efficiency at all.
3. There needs to be a good business case. Traditionally energy efficiency business cases have been of the form, invest £x and save £y on energy costs. The world is more complex than that and it has never really been that attractive because just saving money is rarely strategic. That is why there are so many stories of frustrated energy managers or consultants with dozens of "two-year payback projects" that have been turned down by CFOs. In the last few years we have started to recognise the multiple non-energy benefits that efficiency improvements can bring, including greater productivity, better health, better learning outcomes and many more. These tend to be much more interesting and strategic to decision makers and with strategic investments there is much less focus on the payback. Energy efficiency advocates need to learn to make better business cases that identify and value all the benefits. It is not easy to value them but then again it is not easy to value the effect of advertising and PR spend.
4. There is a need to spend some money developing the opportunity, taking it from an idea to an investable proposition and that is risk money. Development requires some level of engineering work, which can be very simple adaptation work for a simple measure based on a single product like high efficiency motors where you can almost replace like for like, (although that may not be the optimum solution of course) through to complex engineering to modify existing systems or structures and calculate interactions between them. As in oil and gas exploration advanced software tools can be useful here but we have to recognise that there is often still a performance gap between what models say and what actually happens. We need better, and standardised tools. Development of all kinds can be complex and iterative but at the end of the day there is no certainty that a real project will happen as a result of development work. The development process is one that combines engineering, financial work, legal work, and what I call contextual work, looking at how the proposed development interacts with other factors inside and outside the host organisation. It is essentially a process of risk reduction but at the end of the day all development work, whether it is for energy efficiency, a new building, a new product or a new rocket, is high risk, the kind of risk that has to be taken by equity or equity type funding, aided where possible by grants. Equity funding is very different than debt type funding typically used for project implementation. One of the issues in the market is confusion between development and contracting, particularly around Energy Service Companies (ESCOs) and Energy Performance Contracts (EPCs). ESCos are typically contractors and not developers, they respond to Request for Quotations from clients and don't go out and develop pipelines at risk. So called

super-ESCos such as the Etihad Super ESCo do this kind of multiple project development which is essential for scaling up the market.

5. There is a need for project implementation finance. This can come from inside the host organisation or outside. There is much focus on external funding but the reality is for something like 90-95% of energy efficiency projects the funding is internal. There is little point developing a project if there is no project implementation finance available. External finance will usually be some form of debt.
6. The ability to procure, contract and manage the safe, on-time and on-budget implementation of projects. Although there is much focus on Energy Performance Contracts they are only one way of contracting for energy efficiency projects and are best suited to large, high value capital projects involving infrastructure upgrades. Most projects are implemented through industry standard contracts used for all kinds of mechanical, electrical and building works or through standard procurement terms.

That is pretty much it. Other things to note;

- We need developers who can aggregate demand such as Etihad Super ESCo, EESL, the Saudi Super ESCo and the Carbon & Energy Fund. The super ESCos (or super developers as I prefer to call them) contract the work to ESCos
- We do need performance measurement and verification
- We do need project development standardisation as provided by the Investor Confidence Project's Investor Ready Energy Efficiency™
- What legal or organisational form is chosen for the super ESCo / super developer is completely irrelevant – there is no right and wrong here – as long as the activities are taken care of. We see successful examples from the public and private sectors
- Developers seem to perform best when they focus on a sector or segment of the market. A developer of hospital projects is not likely to fare well in the residential sector or even the commercial office sector – the norms, the customers, the experience and the skill sets are too different
- Where you fund the projects from, and how you fund them i.e. what mechanism is used to recover the investment is irrelevant, different situations will demand different solutions such as simple loans, on-bill recovery or property tax supplements
- The hard part of funding is the development piece

That is all for today. More to follow on this – but in the meantime "just do it".

3.3 Depleting Stupidity. 3 Oct 2018

I was glad to see that Amory Lovins returned to the subject of the size of the energy efficiency resource in a recent paper in **Environmental Research Letters**. Amory mentions the oil and gas resource and reserve analogy that I wrote about again in May. The energy efficiency resource, just like other resources, is really found in the minds of people and the scale of the energy efficiency resource, just like oil and gas, is defined by our ways of thinking about them. Amory says in one of his brilliant phrases; "energy efficiency resources are infinitely expandable assemblages of ideas that deplete nothing but stupidity – a very abundant if not expanding resource". My PhD back in the early 1980s, "The Potential for Energy Conserving Capital Equipment in UK Industry", examined the viability of Gerald Leach's 1979 **Low Energy Strategy for the UK** and came to the conclusion that such a future was possible (in industry) even though it involved an improvement in energy efficiency of c.30%. As I have **written about before**, we have practically achieved that future – a future that back then was regarded as impossible by the energy industry, the government and most analysts at the time.

My view is that the potential using proven technology, current economics and "standard thinking" about energy efficiency is always about 30%. Thinking about energy efficiency in a

different way using the integrative design techniques long pushed by Amory and others, but still not widely adopted, increases the size of the economic potential to much higher levels, maybe 60-70%.

As is often the way several ideas or conversations come together at once. I am currently reading "**Zeronauts**" by environmental business guru John Elkington. It highlights the power of the idea of aiming for zero – zero energy, zero emissions, and zero environmental impact and highlights leaders who have worked to turn this idea into reality. Totally zero may not be possible in a particular situation but it is a powerful organising idea that opens up what may be possible. If leaders and decision makers don't set a target and simply accept for instance a building built to building regulations, the potential efficiency resource remains unidentified and unexploited. Setting a target of zero energy may not actually result in zero but it certainly expands the way the design team and others think.

At the AECB's recent conference, which was held in a community centre built to Passive House standards, I visited some Passive Houses and the Passive House technology is another example of how the mind defines the resource. Passive House is a technology, a combination of thinking and physical technologies, that enables the construction of a house that uses much less energy than a house built to building regulations, as well as delivering better comfort. If all new housing was built to Passive House standards the energy saving compared to houses built to code would be immense but most developers don't even consider it, either because they don't know about it or they believe it will cost more, or they don't trust it. It takes leadership, stepping out of the norm, to specify a Passive House design as well as persistence often in the face of opposition.

Many large new developments are now being built with district heating to meet planning regulations. It would be much more cost-effective to simply build the development to Passivhaus standards, thus eliminating the need for district heating with all of its central plant pipes, heat exchangers and control systems, all of which have on-going maintenance requirements. But again, unless leaders and decision makers consider the possibility, as well as the benefits, that potential energy efficiency resource will not be exploited, locking in unnecessary energy use and complexity for many years or even decades.

To make another connection, this week I participated in the first Advisory Council meeting of the Horizon 2020 funded project, **M-Benefits**. This important project is developing tools to help decision makers incorporate multiple non-energy benefits into decision making about energy efficiency projects. As I have said before, these non-energy benefits such as health, well-being, productivity, better learning outcomes etc., are far more strategic and therefore far more interesting to decision makers than simple energy cost savings. We need to focus selling efforts for low energy solutions on those benefits and regard energy (& consequent energy cost savings) almost as a bonus. Doing so will lead to better business cases, higher rates of approval for projects and higher investment into energy efficient solutions.

So for any situation, industry, commerce, domestic, or transport, we can continue to think about the energy efficiency resource in the old way – and we will achieve significant economic and environmental gains, or we can change the way we think about it, aim for zero, insist on integrative design and value non-energy benefits and we will achieve far more, far more than the mainstream views on what is possible.

4 Energy Management

Energy management is a noble profession. I would say that have spent many years in it, initially as an energy management and then as a consultant designing large multi-premise programmes covering hundreds, and even thousands of buildings. Better energy management is the key to improving energy efficiency and we need to encourage better energy management within all organisations.

4.1 How do we make energy efficiency stickier? 4 March 2013

Having just read 'Made to Stick' by Chip and Dan Heath I have been pondering how to make energy efficiency a stickier idea. We all know that efficiency suffers from being very dull as well as being too technical a concept for the person in the street and that 'improving its image' is essential. The term efficiency itself is abstract and as I say in my new book (gratuitous plug – out in October published by Gower – details on their web site) causes confusion even amongst professionals. Chip and Dan, like all good management writers, come up with a check list based around a mnemonic (SUCCES):

- **Simple** – find the core of any idea
- **Unexpected** – grab people's attention by surprising them
- **Concrete** – make sure an idea can be grasped and remembered later
- **Credible** – give an idea believability
- **Emotional** – help people see the importance of an idea
- **Stories** – empower people to use an idea through narrative.

So here is my first pass on making efficiency stickier.

Simple – efficiency is about eliminating energy waste.

Unexpected – despite all of our advanced technology we waste 89% of the total energy that we use.

Concrete – this one is harder as it should really be situation specific, something like:

- 'if we save 20% through improved efficiency (eliminating waste) we will add £x to your profit'
- 'if you save 20% of your energy use you will be able to buy that foreign holiday/new whatever it is you want'
- 'if we save 20% of the country's energy use we could save £20 billion a year, equivalent to the total cost of the war in Afghanistan from beginning to end'. (This one could be improved as £20 billion is still totally abstract and the Afghan war comparison is still hard to grasp).

Credible – this is all about who says it.

Emotional – it should be straight forward to find emotional stories about the effects of fuel poverty (unnecessary illness or death), the effects of going without electricity in a developing country, or the number of deaths a year caused by atmospheric pollution. To be really emotional, however, they should focus on individuals rather than macro numbers.

Stories – leaders tell stories rather than spout facts in order to inspire, lead and educate.

I am sure other people can do better so let's hear any ideas about how to make the importance and imperative of improving energy efficiency a stickier idea.

4.2 A brief history of energy management. 15 May 2016

In 2001 I wrote a brief history of energy management with a UK focus which Vilnis Vesma published on his website. I thought I would try to bring it up to date.

Introduction

The management of energy and improving energy efficiency has long been important for industry and commerce. In the 1790s Boulton and Watt's steam engines produced competitive advantage because they were more fuel efficient – and indeed they charged a share of the fuel cost savings in a way similar to today's energy performance contracts. In World War 2 fuel efficiency became vital to the war effort and the National Industrial Fuel Efficiency Service was set up to provide advice to industry on energy saving measures as fuel shortages continued in the post-war years. Energy management as a separate discipline, however, began to evolve after the first oil crisis of 1973 and really came into effect after the second oil crisis of 1979 when real energy prices rose dramatically.

After more than forty years it seems appropriate to look back at the evolution of modern energy management and energy efficiency. In looking back four distinct phases can be identified:

- Phase 1: 1973 – 1981 – "energy conservation phase"
- Phase 2: 1981 – 1993 – "energy management phase"
- Phase 3: 1993 – 2000 – "energy procurement phase"
- Phase 4: 2000 – 2010 – "carbon reduction phase"

In looking at the present time and projecting forward two additional phases are identifiable or foreseen.

- Phase 5: 2010 –2020 – "energy efficiency phase"
- Phase 6: 2020 – 2030 – "efficiency as a resource phase"

Each of these will be described in turn. All dates are approximate and of course there has been a natural evolution of techniques and approaches, rather than a sudden transition between phases.

Phase 1: Energy conservation focus – 1973–1981

Phase 1, between 1973 and 1981, was characterised by the "save it" mentality and a crisis response to sudden increases in energy prices and problems with energy supplies caused by the oil shocks, a result of geopolitical drivers. Energy conservation was the usual description of the activity. In this phase there was usually a shallow approach with wide variation in approach between practitioners and few common techniques. Much effort was put into exhorting staff to "switch off" through the use of stickers over light switches and posters – probably with limited effect. Many companies appointed Energy Managers who typically were engineers, often an engineering manager took on the energy role in addition to their normal job. A few organizations appointed accountants or purchasing staff as energy managers but this was unusual.

Few organizations had any form of energy Monitoring and Targeting and when they did there was no commonality of approach. Most systems were manual and did not take into account variances due to factors such as weather, production output or product mix.

Engineering based energy managers started to invest in energy saving technologies but with little in the way of investment analysis beyond simple payback period. There was generally a gulf of understanding between energy mangers seeking investment funds and financial managers in charge of capital budgeting and many seminars and courses sought to fill the gap. On the technical front new technologies emerged and were often adopted before they were fully developed e.g. industrial heat pumps – leading to sub-optimal investment and many failures. There was also a number of "black boxes" introduced that purported to save energy but which were of dubious value (some of which resurface every now and again).

Energy supplies were almost totally from the nationalised utilities, British Gas, British Coal and the Electricity Supply Industry in the form of the CEGB and the twelve regional distribution companies. There was little or no scope to negotiate prices even for large users. A few large,

sophisticated users, generated their own electricity in Combined Heat and Power schemes with no export of power.

Government activity in this phase concentrated on "propaganda" and exhortation in the form of TV advertisements, posters, and "Switch off" stickers, and subsidising energy surveys which led to the rise of energy consultancy, much of it carried out by people with little or no experience. Towards the end of the period the UK Government started the Energy Conservation Demonstration Projects Scheme which subsidised early adopters of new technologies in return for the right to disseminate information about the results. In an early work the author observed that the scheme was not market orientated and ignored the fundamentals of successful innovation and diffusion.

1973 – 1981: Major energy events and headlines:

- 1973: OPEC quadruples price of oil
- 1979: Iranian revolution leads to second oil price rise

Phase 2: Energy management focus – 1981-1993

This period saw the development of energy management as a separate recognised discipline and the rise of full time Energy Managers. The UK Government through the Department of Energy supported regional Energy Managers groups which were an excellent way of spreading information, sharing resources and improving standards. The term energy management started to replace energy conservation. Models of effective energy management were developed and widely implemented. A consensus on what energy management was started to emerge.

In this period Monitoring and Targeting (M&T) began to be used much more widely. This was aided by the introduction of personal computers (then called "micro-computers") in the early 1980s and the beginnings of the PC or IT as we know it today, (albeit with floppy disks, state of the art 10Mb hard drives and very noisy dot matrix printers). Monitoring and Targeting software was introduced and linked to bill analysis software derived from the discipline of utility bill analysis. Computerised M&T systems could take into account relevant factors such as Degree Days for space heating and production levels. M&T was subsidised and promoted by the Government with good effect through sector Trade Associations.

Another approach that emerged in this period was the use of Performance Indicators for focusing management attention. This was particularly effective in local authorities in the form of Normalised Performance Indicators (NPIs) developed by the Audit Commission and implemented as a national system, as well as being replicated in Scotland by the Accounts Commission.

In this period a key technology that emerged was Building Energy Management Systems (BEMS now more often called BMS). These were widely adopted by owners of large portfolios such as local authorities and undoubtedly bought benefits in terms of central alarm handling and control of building services. There is considerable evidence that the cost effectiveness of these investments was not always as expected. Early systems used mini computers as central stations and were extremely expensive to install but costs fell as PCs were introduced and more "intelligence" was added to outstations, thus reducing field wiring costs.

This period saw the peak of the energy management consultancy market with many large organizations bringing in consultancy teams to establish M&T systems, carry out audits, implement projects and deliver communication and awareness schemes. The latter became more sophisticated with greater user involvement and in some cases incentive payments (for local establishments or individual user groups).

Another major development in this period was the introduction of Contract Energy Management (CEM) which initially went under various names including "third party financing", "performance contracting" and "Energy Service contracting". Early schemes were extremely difficult and expensive to negotiate and implement, particularly in the public sector where external finance was most needed and where arcane Treasury guidelines on

local authority expenditure meant that even capital expended by a CEM company counted against the authority's capital budget, thus introducing a no-win situation. These rules were finally changed in 1986 following a concerted effort from the nascent CEM industry and potential customers (including the author).

1981 – 1993: Major energy events and headlines:

- 1981: first micro-CHP technology introduced
- 1984/85: Coal miners' strike
- 1984: launch of EMSTAR, Shell's energy efficiency subsidiary
- 1986: Energy Efficiency Year led by Secretary of State Peter Walker
- 1986: privatisation of British Gas
- 1990: privatisation of electricity supply industry, competition for > 1 MW users
- 1992: competition for > 2,500 therm gas users

Phase 3: Energy procurement focus – 1993 – 2000

In this period energy management as a discipline entered a decline which came about as a result of two factors, the reduction in real prices bought about by privatisation of the utilities, and general corporate downsizing. As energy prices declined in real terms, and opportunities for effective purchasing strategies were opened up by market liberalisation, most of the attention on energy shifted purely to purchasing. Greater savings with less risk could be made through more effective purchasing than through implementing energy efficiency projects. Many energy managers were made redundant or transferred into other jobs and many large organizations which had been pioneers of energy management started to lose ground.

In this period the energy consultancy market declined dramatically except in the area of purchasing. In Government activity there was a shift away from subsidies and towards encouraging management approaches through voluntary agreements and management tools such as the Making A Corporate Commitment and the energy management matrix.

The environment started to emerge as an issue in this period and many companies incorporated energy management into wider environmental initiatives. This did not, however, do as much for energy efficiency as some enthusiasts had hoped. Investments still had to meet the required Internal Rates of Return and often corporate downsizing meant that organizations did not have the staff to identify, evaluate and implement viable energy efficiency opportunities. Even at the reduced energy prices bought about by more effective purchasing much potential for improved efficiency remained untapped (and still does).

1993 – 2000: Major energy events and headlines:

- 1994: competition for < 100kW electricity market
- 1998: domestic gas liberalisation and competition for < 100 kW electricity market

Phase 4: Carbon reduction focus – 2000 – 2010

In this period in the UK the climate change agenda became a major focus for individuals and organizations. In the UK the Climate Change Levy (CCL) and the various Negotiated Agreements came into effect. CCL made energy a high level issue again as energy prices rose and many companies make clear commitments to reduce consumption, and faced penalties for failure to do so

Government activity in energy efficiency was outsourced (or some would say given away) to programmes run by the Carbon Trust. The UK government introduced feed-in tariffs for renewable energy sources. In 2008, before the full effects of the financial crisis became clear and amidst a rash of concern about oil peaking and resource pressures, the oil price hit a record $147/barrel.

2000 – 2010: Major energy events and headlines:

- 2001: Climate Change Levy introduced
- 2001: New Electricity Trading Arrangements introduced
- 2001: Carbon Trust founded
- 2005: EU Emissions Trading Scheme introduced
- 2008: Department of Energy and Climate Change created
- 2008: Feed-in tariffs introduced
- 2008: Oil price exceeds $147/barrel

Phase 5: Energy efficiency focus – 2010 – 2020

From about 2010 policy interest in energy efficiency started to grow globally. There was increasing recognition of the role that energy efficiency could play in meeting climate targets as well as the scale of the economic opportunity efficiency presents. The IEA said that efficiency is the first fuel, whereas back in the 1980s it was the fifth fuel.

In the last couple of years the value of non-energy benefits such as increased sales, increased health and well-being, as well as macro-benefits such as job creation have been recognized but have only just started to be valued. The value and importance of non-energy benefits need to be further recognized by energy efficiency professionals, as well as the added value they can bring to an investment things like increased sales or increased health and well being of employees and customers are far more strategic to organizations than just energy saving – and therefore far more likely to get a project approved than the payback on energy savings alone.

In the last few years interest in financing energy efficiency has been growing, and particularly the use of private finance. The market is still nascent in most countries but the signs are positive. There is increasing commitment to energy efficiency from institutional investors, even though most of the commitments have not yet been put into action. The necessary infrastructure of standardization through the Investor Confidence Project has been built. Projects are underway to build capacity within banks and financial institutions. The first attempts to put all the pieces of the energy efficiency financing jigsaw together rather than just establish specialized funds or use public funds are now being established.

In the UK, contrary to much of the rest of the world, government commitment to energy efficiency waned with changes to the ECO scheme and subsequent further budget cuts, along with cuts to feed-in tariffs for renewables.

2010 – 2020: Major energy events and headlines:

- 2012: Green Deal on bill financing scheme launched in the UK
- 2013: Regulatory Assistance Project in the US launches "Recognizing the full value of energy efficiency" report
- 2013: UK government makes changes to ECO in response to Labour leader's promise to freeze energy prices
- 2014: Environmental Defense Fund launches the Investor Confidence Project in the US
- 2014: The International Energy Agency labels energy efficiency "first fuel"
- 2014: The IEA launches "Capturing the multiple benefits of energy efficiency"
- 2015: Energy Efficiency Financial Institutions Group report published
- 2015: First Buildings Day at a COP – focusing on energy efficiency in buildings
- 2015: End of the Green Deal
- 2016: Investor Confidence Project rolls out Investor Ready Energy Efficiency

Phase 6: Efficiency as a resource and energy productivity – 2020 – 2030

In this period efficiency will be seen increasingly as a reliable resource that can be both accessed by utilities and others, as well as valued and traded. This will be based on an increased acceptance of the idea of metered energy efficiency, as pioneered in California.

It will also be a period where we learn to scale up energy efficiency activity and investment by putting together four elements; development and project finance, developing a robust pipeline of projects, building capacity amongst the energy efficiency community, building owners and the financial world, and standardization of project development, documentation, contracting and measurement and verification. The value of non-energy benefits of energy efficiency will be increasingly recognized and valued, both for their financial value but also their strategic value.

On the policy level there will be a switch more towards focusing on energy productivity, getting the most economic value out of each unit of energy, rather than "energy efficiency". Productivity is hard to argue against and is the basis of a much more positive policy narrative. It is possible that this period will be a period of energy abundance globally, with oil, gas, renewables and efficiency all being available, rather than the 1970s dystopian view of energy shortage. Even if we move into energy abundance the advantages of improved efficiency in terms of costs, speed to deliver and lack of environmental impact, will help to make it the first choice rather than the last.

Forecasting is dangerous, especially about the future, but in this period there may well be major technological advances that change energy markets even more than we expect at the moment. There will undoubtedly be more intelligence applied to the energy system which will bring energy savings and greater flexibility. We may see storage becoming really cost-effective and a mass market, and we will see greater use of electric vehicles.

Conclusions

Our current ways of thinking about energy started to emerge in the 1970s in response to the oil crises. It is interesting to look at energy scenarios from back then and compare them to how the world really turned out. Almost all scenarios back then, apart from Amory Lovins' "Soft energy paths" and Gerald Leach's "A Low Energy Scenario for the UK", assumed greatly increased energy demand – demand that has not materialized. Our current energy consumption in the UK and the US is at the low end of a range considered crazy by official energy forecasters in the 1970s – energy efficiency delivered and decoupling of energy use and GDP has happened and will continue to happen. Official forecasts back then also assumed:

- increasing centralization of power generation
- increased use of coal in power generation
- use of coal through synthetic fuel conversion technologies
- renewables would not be economically viable
- nuclear power would grow and we would utilize fast breeder rector technology, and even fusion by now
- "running out" of fossil fuels and ever increasing real prices.

Obviously the future turned out differently to the forecasts and scenarios, in the words of Arthur C Clarke – "*the future isn't what it used to be*". Geo-political or technological wild cards could radically change the energy scene at any time but what seems certain, however, is that there will be a continuing trend towards improved energy efficiency and the use of cleaner technologies.

4.3 Doughnut energy management in the 21st century. 14 Feb 2018

My eye was recently drawn to an interesting headline; "***How to do business with doughnuts***", which was the title of a thought provoking article by Kate Raworth of the Environmental Change Institute at Oxford University. Kate's work on "doughnut economics", which I had not found before, is really worth exploring. Soon after I saw a piece about Brian Chesky's, the Co-founder and CEO of AirBnB, letter to stakeholders about what a 21st century company should look like. There seemed to be a connection but let's deal with the doughnuts first.

In Kate Raworth's model the doughnut is a ring that sets out to define boundaries set by ecology and by social conditions. In many areas such as climate change and biodiversity we are clearly exceeding the ecological limits. On the social factors we have massive deficits as billions of people still fall short on even basic essentials. The challenge is how to meet the social needs without exceeding the ecological limits i.e. how to live within the doughnut.

Kate Raworth lists five reactions to the diagram she has had when talking to a range of corporates about this idea over the last six years. They are characterised as:

- Do nothing
- Do what pays
- Do your fair share
- Do mission zero
- Be generative

Brian Chesky's letter to stakeholders talks about building a company for the 21st century and even the 22nd century ie a long-term focus rather than a focus on short-term results. For AirBnB this means:

- we will have an infinite time horizon
- we will serve all of our stakeholders

Both Kate Raworth's work and Brian Chesky's letter address some fundamental questions we should all to be concerned with – what are businesses for, (both on an individual enterprise level and a social level), and how should they be organized and operate to best serve their purpose?

This caused me to consider what does this kind of thinking mean in an energy context, specifically for energy consuming (i.e. all?) businesses? Using Kate Raworth's five responses as a guide:

Do nothing means simply that – don't bother about energy consumption and costs at all. In the corporate world this is unusual, at least in larger companies in the developed world. In other markets and SMEs it is still common.

Do what pays means reduce energy costs by investing in cost-effective projects. This could be characterised as "standard energy management" which most corporates have. Even where there is energy management many very cost-effective projects are not implemented for a number of reasons including; uncertainty about the outcomes and competing and more strategic demands on capital. A lot of work on energy management, including my own, has been about improving the do what pays model to maximize the uptake of the huge economic potential that we know exists, and maximizing the returns.

Do your fair share means committing to science based targets for reducing emissions. Adopting science based targets appears to be growing, at least amongst large corporates. A recent example is TH Real Estate, one of the largest real estate investment managers in the world, with equity investments in nearly 900 office, retail, industrial and residential assets globally.

Do mission zero means committing to a goal like net zero energy or net zero emissions. A net zero energy building or facility would put back as much energy as it uses into the system or grid. Of course there are deeper questions here, generating on-site energy in a way that has higher emissions per kWh than the grid may be net zero energy but not net zero emissions. IKEA has committed to use 100% renewables by 2020.

Be generative means going beyond zero energy or zero emissions and building a business that is net positive in energy and emissions. This may include supporting energy production in excess of usage, something that Unilever is targeting for 2030, or a business that removes carbon dioxide from the environment, either through a production process making

something, such as cement production that absorbs CO_2, or whose main revenue generating activity is removing CO_2 from the atmosphere, (which of course would require a value to be ascribed to a tonne of CO_2).

To build a 21st century enterprise (or for that matter a 22nd century enterprise), we need to consider many factors – both technical, financial, social and human. It seems, however, that such an enterprise would at least be working to improve its position on the doughnut in relation to energy and the environment. That means moving energy management beyond the "do what pays" model – what we may call a 20th century model – into at the very least a "do your fair share" model, and ultimately into a "mission zero" and "generative" model. The doughnut gives us a new model for categorising the response of companies to energy problems.

4.4 21st century energy management. 27 Feb 2018

Growing up I loved anything to do with the future – particularly the 21st century. TV21 was the comic to read and it was full of stories about life in the 21st century, Thunderbirds, space travel etc. In some respects reality has not lived up to those dreams, although Elon Musk is doing his best to make them come true, but in other ways we already live in a world long described by science fiction – universal communicators for all (mobile phones), and a giant computer that can answer any question (the internet).

When I started to really think about and practice energy management, it was back in the 20th century and it seems as if some of the ways of thinking about energy management remain stuck in the 20th century. Now we are nearly 20% of the way through the 21st century, (hard to believe I know), we need to refresh our thinking and bring energy management into the 21st century.

Let's consider some aspects of energy management and efficiency and compare 20th century thinking and 21st century thinking.

Aspect	20th century thinking	21st century thinking
Energy audits	Energy audits lead to projects being implemented. Energy audits should be mandatory.	Energy audits on their own don't lead to anything – there needs to be top level commitment & energy audits are just a tool to use when you are committed to addressing energy efficiency. Energy audits need to feed into better business cases that identify, value and risk appraise all sources of value, i.e. all the energy and non-energy benefits.
The benefits of improving energy efficiency	The benefits are energy cost savings. The direct environmental benefits e.g. tonnes of CO_2 avoided may be a social benefit for CSR reporting.	There are multiple non-energy benefits – many of which are far more strategic and interesting to decision makers than mere energy cost reduction. Energy savings may be the least attractive benefit of a project that improves energy efficiency and should be sold last – as a co-

Aspect	20th century thinking	21st century thinking
		benefit to the non-energy benefits.
Monitoring and Targeting (M&T) and Measurement and Verification (M&V)	There should be enterprise level M&T with some project specific M&V on large projects. Anything else beyond that, sub-metering etc., is expensive.	M&T, M&V, data collection and analysis is cheap. The advent of big data analytics can identify savings opportunities even in systems that are believed to be close to optimum. Monitoring is a part of ISO 50001's Plan, Do, Check, Act cycle and is embedded into every Energy Management System.
Energy Service Companies (ESCOs) & Energy Performance Contracts (EPCs)	ESCOs and EPCs are the answer to all our problems.	ESCOs and EPCs are applicable in some limited circumstances, mainly in the public sector. They are not the only answer and they definitely don't work at all in most sectors. ESCOs and EPCs are only one of many ways to bring finance to energy efficiency projects.
Measurement of energy saving	It is hard to measure because it is a counter-factual and is invisible. It can't be metered.	Units of energy saved can be metered and calculated just like units of energy delivered.
Energy efficiency is somehow special	It is a stand alone activity. It is a "crusade". It should have a higher priority than everything else.	Energy efficiency is part of an integrated energy (& resource) solution including self-generation, demand response etc. Good energy management is one aspect of good management.
Project development	Project development is non-standardized and every project is developed and documented in a different way. Every project developer has some "secret sauce" in developing projects even when the technologies are well known and standard.	Project development and documentation can be standardised using systems such as Investor Confidence Project's Investor Ready Energy Efficiency™. Standardization of project development and documentation is essential for aggregation and growing the finance market. Project developers don't really have "secret sauce".

Aspect	20th century thinking	21st century thinking
Making the business case	The business case is purely about capital expenditure versus the value of the energy savings over the life of the project.	The business case is about the capex versus the value of multiple energy and non-energy benefits over the life of the project, of which energy savings is just one. The non-energy benefits may be more strategic and attractive to decision makers than just energy savings.
Risk and uncertainty	Energy efficiency projects have low, or even "zero risk". This was often stated even though we had no data and in fact outcomes were uncertain.	Recognition that energy efficiency projects do have risk although we often can't quantify the risk at the moment. Risk is generally low across portfolios of projects & becoming better known and understood but for individual projects actual risks are less well known.
Energy management	A practice that is hard to systematise and is highly dependent on individuals.	A practice that can be systematised and embedded into the operation of an enterprise through the application of ISO 50001.
The value of a kWh saved	Is the same at all times and in all locations.	Is highly time and location specific.
Project development	Optimise the components.	Optimise systems e.g. integrated design (which is still not very common at all).
Energy prices	Always go up.	Go up and down.
The availability of investment	There is no money for energy efficiency.	There is a lot of money for energy efficiency – just a shortage of well-developed, bankable projects
Chief Financial Officers (CFOs) and Finance Directors	Chief Financial Officers are stupid for not investing in these "no brainer" projects with very rapid payback periods.	CFOs may be rational in not investing i.e. they may have more strategic things to invest in, or they may consider the benefits uncertain because they have not seen the evidence or they don't believe the assessment.

Aspect	20th century thinking	21st century thinking
Low hanging fruit	There are a lot of no-cost and low-cost projects that can be implemented easily – "low hanging fruit".	There still are many no-cost and low-cost measures that could be implemented through better energy management (EnMS) and applying ISO 50001. We should however ban the phrase as even no-cost and low-cost measures require effort.
Energy efficiency	Comes about through specific retro-fit projects with the aim of reducing energy costs.	Comes about through retro-fit investments, investment into plant and building refurbishments carried out for other, non-energy, reasons, and through investment in new plant and buildings that improve the average efficiency of the sector.
Renewables	One day they may be viable.	They are cost effective in many situations.
Energy storage	"Electricity cannot be stored". Only viable in massive hydro-electric schemes. The holy grail of energy studies.	Available in several forms. Rapidly becoming cheaper. Economically viable in many situations behind the meter and in the grid.

As they say in 'Thunderbirds', FAB.

5 ESCOs, EPCs and alternative contracts

Energy Service Companies, or ESCOs, are a source of endless conversation within energy efficiency circles. They are often re-discovered by new entrants to the field and regarded as 'the answer' to all our problems. Over the years, and based on a lot of experience working with, and inside, ESCOs I came to the conclusion that are widely mis-understood. I have returned to the theme of explaining them and alternative contract forms several times and some of those blogs are contained in this section. They remain a focus of ours, ep group has created the 'ESCO-in-a-box' business model which is now being rolled out in the UK, Kenya, the USA and elsewhere and is deisgned to address some of the problems with ESCOs.

5.1 Isn't it time to ditch the term ESCo? 11 March 2013

The term ESCo, or Energy Service Company is widely used to describe companies that develop energy efficiency projects in clients facilities and then either invest themselves, less and less common by the way as balance sheets are constrained, or bring a third party source of finance to fund the projects. In a classic Energy Performance Contract, EPC, the ESCo provides a guarantee that savings will exceed a certain level and the savings should exceed the repayments such that the client is cash flow positive from day one.

The ESCO EPC concept grew out of work in the US public sector, and even today 75 to 80 % of the total market in the US is in the MUSH, Municipal, Universities, Schools and Hospitals market. The US government did a great job of exporting the idea around the world with USAID and other agencies promoting it widely. The concept was enthusiastically picked up throughout the world but the truth is it has never taken off to the extent that people expected. Why?

Fundamentally the US only exported half of the idea, the contract form. They didn't export the low cost municipal bond market or central budgets that most users of ESCo EPCs in the USA take advantage of. Secondly a major problem is that the real incentive for the ESCo is not the shared savings they use to promote the idea, rather the real incentive is on the ESCo to maximise capex. They make their margin on capex not the savings. Interestingly there seems to be growing dissatisfaction with the EPC model even in the US public sector. When ESCOs have tried to expand into the private sector they have met resistance due to the complexities of contracts, the split incentive, lack of transparency and perceived excessive margins.

The ESCo term is widely used but there are many different understandings of the word. Is it a company that developers EPC contracts, or does it deliver energy services in the form of heat and power, or does it deliver warmth, light and motive power directly? Even at the recent ESCO Europe conference there were many different definitions.

It may sound radical but the time is right to ditch the term ESCo altogether and just talk about project developers, project delivery companies, financiers and underwriters. Project developers, just like in renewable or conventional energy can be a variety of types of organisations from small, independent entrepreneurial companies, to large multi-national energy companies or equipment vendors. They can also be, and increasingly are, community groups., This is no different to the renewable industry. Being brave enough to ditch the term ESCo and adopting the standard language of energy projects would be a sign of maturity of the energy efficiency industry and be a useful step towards scaling the energy efficiency markets.

5.2 ESCO obsessions. 25 June 2013

The ESCO (Energy Service Company) industry appears to have a number of obsessions that result from its history and don't help to advance the cause of energy efficiency and third

party financing, something that the industry actually does – or should – want to advance. Here are some thoughts that may cause controversy.

The ESCO/EPC industry grew out of good work in the US public sector and even to this day **85% of EPC deals in the USA** are in the Municipal, Universities, Schools and Hospitals ('MUSH') market and the Federal government. Most of these deals have been funded by the clients issuing bonds or some form of municipal lease, which in the US have tax advantages which make them a cheap source of finance – for more details see **here**.

Back in the 1980s and 1990s the US government, through agencies such as USAID, and the US ESCO industry did a great job of selling the ESCO/EPC model around the world. As communism collapsed in Central & Eastern Europe (C&EE) and the Former Soviet Union (FSU), many missions were organized to promote the concept and they were very successful. I saw them first hand when I was working in Romania in the mid- to late-1990s. As well as in C&EE and the FSU the concept was promoted in China, Asia, Africa and Latin America. In Western Europe the EPC concept was promoted as a solution to improving energy efficiency. Unfortunately the model was exported without the access to the long-term low cost finance provided by muni bonds.

Now, in many markets we seem to have a situation where the ESCO industry, and its supporters are confused. Typically there are two refrains; one – 'why don't customers buy EPCs when it is a no brainer' and two – 'we need to bolster the balance sheets of ESCOs'. This is then overlaid by government or IFI support schemes trying to address these 'market failures'. (I should say that there has been some great work going on, particularly by the EBRD, who really do understand these issues, in providing debt through local banks and building capacity in local banks to understand and evaluate energy efficiency investments). In all markets the ESCO/EPC market has not achieved its perceived potential.

Maybe the 'market failures' referred to by the ESCO industry are not market failures at all – but rather poor marketing (and I mean marketing in its true sense – really understanding the market and providing what it needs – not advertising and communications).

To be fair the ESCO industry in the MUSH market has consistently delivered, and over-delivered, on savings but it has also made large margins on front-end capital. For all the talk of 'shared savings' the traditional ESCO/EPC deal is designed to produce maximum capex (on which the ESCO makes a healthy margin), and a small stream of net savings after financing to the client. So we have a situation where the client:

- may not be confident about the savings (despite an ESCO guarantee)
- is being asked to sign a long-term, complex deal (10-15 years plus in many cases)
- is paying a high price for capex and development
- receives a small stream of savings relative to energy bills
- has high transaction costs.

Just maybe EPC is not such a good deal as the ESCO industry presents. It maximizes the return to the ESCO but not the host – incentives are not truly aligned. At the same time most ESCOs design and develop projects in a very traditional way – there is much talk but little delivery of holistic, integrated design which has been proven to increase energy savings and reduce capex requirements time and time again.

When the ESCO industry has tried to move into the commercial sector it has hit a number of barriers including the fact that commercial organisations are better at procurement than the public sector and typically demand a high level of transparency – something that the public sector has not done. The level of margins made by ESCOs in the MUSH market has not been acceptable. This is in addition to other well-known issues such as the split incentive.

Some other obsessions of the ESCO industry and IFIs and government departments interested in the sector which I have heard recently include the following.

ESCO balance sheets and how to strengthen them

ESCOs are developers of projects, they could be two men and a dog as long as they are good. They don't need balance sheets to develop projects – consultants can do it as well as ESCOs and may ESCOs use consultants anyway. Implementers of projects, i.e. contractors, do need balance sheets but they don't have to be an ESCO – all an ESCO usually does is sub-contract the implementation piece to 'ordinary' contractors. In the renewables industry, or even the conventional power sector, project developers do not need balance sheets. Typically they are either consultants working for a site owner or are parlaying time and expertise spent on development, along with option agreements, into a small proportion of the project equity on financial close. The ESCO industry seems to think it is different – as I have said before, the very term ESCO adds to the confusion and it is time to drop it. We don't talk about 'Wind Energy Service Companies' – we talk about:

- developers who pull together the technical and commercial aspects of the project
- contractors who build things
- investors who fund the construction and benefit from the uplift of value by funding construction risk
- O&M companies
- and long-term owners who like long-term stable income streams without construction risks
- and of course there are specialist insurance companies, which will under-write different aspects of performance.

What is the difference between wind/solar/conventional power and energy and energy efficiency? We need to un-bundle the ESCO proposition.

Given this there is no need to bolster the balance sheets of ESCOs, this seems to be based on the belief that ESCOs will fund projects off their own balance sheets. Even the big guys don't want to do this.

Project financing and asset financing

At first glance energy efficiency financing has similarities to both project financing and asset financing. However, typical projects are far too small for project finance and project finance departments in most banks rightly won't get out of bed to look at them. Asset financing has been done for energy efficiency but it is best applied to single, stand-alone assets such as Combined Heat and Power (CHP) plants which can be taken away if the client stops paying for any reason. It is very difficult to take away most energy efficiency projects such as low energy lighting, Building Energy Management Systems (BEMS), software or insulation, all of which are embedded in the building and have little or no value if removed.

Energy efficiency financing is all about cash flow financing – not project finance and not asset financing.

Payback period

We often hear about the fact that most organisations have a two or three year payback period on energy efficiency investments and this is inhibiting ESCO/EPC deals. It is true that for self-funded projects a two or three year payback criteria is normal (as well as understandable). Self-funded projects have to compete in the capex budget with projects that are central to the organisations core purpose – making widgets, selling tins of beans or developing new software. We can, and should, argue that CEOs and CFOs can profitably increase the level of self-funded projects, as well as improve energy management generally, but the same payback period can't be applied to a third party financed energy efficiency project as it is being funded by a different investor with different criteria. The only important thing for the project host is, how much does this deal reduce their cash operating expenses (quantified as NPV)? The payback is important to the third party investor but much of the point of third party finance is to be able to fund longer-term projects by accessing the kind of money that likes long-term, low-risk income at lower rates of return.

On/off balance-sheet. Traditional EPC contracts were usually on balance sheet but a number of structures and regulations could affect that, depending on geography and sub-sector even within the public sector. The accounting standards bodies, the IASB and the FASB, are now harmonising a position on leasing and off-balance sheet financing which will affect energy efficiency financing. Off-balance sheet leasing is likely to be stopped by 2016/17 and all structures will be subject to more scrutiny. The ESCO industry does need to worry about this and evolve new, service-based structures as has happened in the US with Metrus and the Efficiency Services Agreement (ESA).

The global ESCO/EPC industry and its boosters need to recognize the realities of the situation and develop new models – continuing to push a model that isn't very attractive to potential customers will be frustrating and un-productive. There needs to be innovation.

A historical note

It is often thought that the ESCO 'shared savings' concept originated in the US in the 1970s. I was recently reminded that it was in fact introduced by Boulton and Watt when they joined forces in 1775 to commercialise Watt's steam engine which was far more efficient than the prevailing technology. The application was pumping water out of mines and Boulton and Watt sold the engine on the basis of taking a share of savings. Interestingly enough they often had Measurement and Verification problems due to the variability of coal quality and got into disputes with the project hosts. So, shared savings, another British invention commercialised by others! If you can find one the current Bank of England £50 note commemorates Boulton and Watt.

5.3 What do we really mean by EPCs and ESCOs? 5 May 2015

I have written before about ESCO (Energy Service Company) obsessions (read **here**) and how the Energy Performance Contract (EPC) may be part of the problem and not the catch-all solution that some people seem to think it is.

At a recent meeting organized by EASME (the Executive Agency for Small and Medium Enterprises[1] of the European Commission) on the topic of energy efficiency financing, I was reminded once again about the difficulties of communication, both in general and specifically on the subject of EPCs and ESCOs. At the meeting there were representatives from several projects receiving both EC and European Investment Bank support, and many of these are involved in EPCs in some way, either in buildings or street lighting. It seems as if there are many different interpretations of EPC across Europe (and the rest of the world).

Energy Performance Contracts

Personally I tend to use EPC to mean the classical North American model which developed in the 1980s and was successfully exported around the world by USAID funded trade missions in the 1990s. In this the contractor (normally called an ESCO but we will come onto that term) provides a guarantee of energy savings. EPCs are most often talked about, and most often implemented, using external financing and in the US most of the market (80% plus) is public sector and is financed by municipal bonds or federal funds. We should not forget of course that the client can fund an EPC themselves – the best example being the Empire State Building retrofit in which the energy efficiency components were carried out under an EPC but financed by the owners of the building. To my mind the classical EPC has a number of problems including the fact that the contractor is motivated to maximize capex, the contract is complex and it is often a black box to the customer.

ESCOs

The term ESCO is also a minefield of confusion. I am on record as saying we should abolish the term. It is generally taken to mean a developer of energy efficiency projects which

[1] Now absorbed into the European Climate, Infrastructure and Environment Executive Agency (CINEA)

provides some form of guarantee of their performance. It is also often used to denote a company that both develops projects and provides, or more likely facilitates, financing for the projects from a third party.

We need to be more precise in our language – in **my book "Energy Efficiency"** I argued for distinguishing between the concept of shared saving, the entity and the contract form.

The concept – shared savings

The concept of shared savings is straightforward. It is what it says on the tin. Financial savings resulting from some form of energy efficiency improvement are shared over a period of time between the host and the party responsible for producing the savings. The energy efficiency improvement itself could be an investment in technology such as high efficiency lighting, new boilers and controls or a behavioral programme with no investment (less common). However, the implementation of this simple concept is fraught with difficulties in practice and can be affected by a range of different business models, contract forms and financial arrangements. This has led to the confusion around the ESCO and EPC/ESPC concept amongst policy makers, suppliers and customers.

The entity

The entity developing the projects is called a developer in any other field, and could be an ESCO, a Facilities Management (FM) company, a construction company, a consultant or a community group. The term ESCO is usually reserved for companies offering some kind of performance guarantee.

The contract form

The contract form can be one of several variants such as EPC, Energy Savings Performance Contract (ESPC), Managed Energy Services Agreement (MESA), Efficiency Services Agreement (ESA), or some other variant. All these types of contract encapsulate some form of energy services. In addition there is the form traditionally used in France and other parts of Europe, called 'chauffage' which involves the sale of heat at an all-in price which covers the capital costs of the boiler and distribution system, operations and maintenance costs, and fuel costs. Chauffage contracts, in their original form at least, do not inherently produce energy savings and in fact during the length of the contract the supplier is actually incentivized to sell the customer more heat, not less. It is true of course that the upfront installation of new heat generating plant, either a boiler or Combined Heat and Power (CHP), can result in an energy saving when it replaces an old inefficient boiler plant and distribution system. In this case the contracts can be said to be shared savings (in some cases) because the total outgoings including repayment of the capital costs during the contract were less than the total outgoings on energy and maintenance prior to the investment. In some cases however, total costs go up in order to pay for the capital expenditure, but these costs are transferred to operational expenditure. Much of the EPC business being done in the public sector such as the UK's National Health Service involve this kind of infrastructure upgrade and catching up with maintenance backlogs.

Large providers of chauffage contracts in their home markets such as EDF and GDF-Suez in France traditionally used their large cash flows and balance sheets to finance projects, as well as start or acquire operations in new markets, although this is becoming more difficult for them. In the UK these operators entered the energy service market in the 1980s and dominated the market for many years, predominantly selling outsourced operations and maintenance of boiler houses and making savings mainly through automation and de-manning. In the 1980s in the UK uniquely, this became known as Contract Energy Management (CEM).

As well as chauffage, selling heat, some energy service companies also expanded into the provision of multiple utilities including cooling, compressed air, treated water, effluent treatment and industrial gases. A leading example of this contract form is the series of Utility Alliance Agreements (UUAs) signed between Diageo and RWE Solutions UK (latter RWE npower) between 2002 and 2003 which were 15 year multi-utility agreements. Like some

chauffage contracts, these multi-utility contracts produced large upfront energy and maintenance savings, which were split between the client and the contractor, with the contractor recovering all costs including capital expenditure over the lifetime of the contract. These UAAs are yet another contractual variation of the shared savings concept.

Increased confidence in performance will reduce the need for EPCs

The **Investor Confidence Project** is working to improve confidence in the performance of energy efficiency by standardizing the development process and documentation. As confidence in the performance of energy efficiency increases, the need for an ESCO to offer a guarantee is reduced – there is no point in a client paying for a guarantee – and they always pay for the guarantee somewhere – if they have confidence in the outcome. The advent of energy efficiency project insurance as offered by companies like Huber Dixon also reduces the need for performance guarantees and the Energy Performance Contract. In time we should move to a more "normal" market where developers develop projects, insurance companies underwrite them, delivery companies implement them and finance companies finance them – just like in the rest of the energy or construction sector.

Anyway in summary we all need to be careful when discussing EPCs and ESCOs. We always need to "mind our language" as it shapes our thinking. Also, never forget communication is hard – in any language.

As an aside on ESCOs we should not forget of course that as in many things the UK was the pioneer in sharing energy services – although not necessarily the best at exploiting the early lead. Boulton and Watt, using the more efficient Watt steam engine, made a lot of money from the 1770s by replacing the inefficient engines in tin mines and taking one third of the savings in fuel over a period of 25 years. For that they truly deserve their place on the £50 note. Although the "no cure, no pay" option offered by Boulton and Watt was successful even they encountered problems we would recognize today – specifically those of Measurement and Verification and baselining.

"There was some local resistance in Cornwall, where the new engines were certain to save costs in pumping out water from the tin mines, ….., the 'no cure, no pay' terms offered by Boulton and Watt – based on one third of the savings in fuel over a period of twenty-five years – saved the day."

Thomas Crump, *The Age of Steam*, p58,

London, Constable and Robinson, 2007

5.4 Is it an ESCO, is it a framework? No it is a super-developer. 13 Nov 2017

At the recent Green Bonds conference at which I chaired a panel, Sean Kidney of the Climate Bonds Initiative challenged the audience in his inimitable way with the questions – "how do we scale-up all this (meaning investment into green infrastructure) rapidly?"

It won't be a surprise but my response starts with the absolute need to focus on the massive economic potential offered by energy efficiency. Improving energy efficiency will bring cheaper, cleaner, faster reductions in emissions, and greater economic impact than investing in generation options – and it has been proven many times there is massive potential that is economic right now.

It also won't surprise anyone when I say scaling-up requires standardization in the way that projects are developed and documented and for energy efficiency this means through systems such as the Investor Confidence Project (ICP). Failure to require standards like ICP will lead to a lot of under-performance, both financially and environmentally. If green bond investors only rely on ex ante assessments of energy saving, or rely on inaccurate indicators like Energy Performance Certificates, and don't require standardized projects with independent Quality Assurance and enforced Measurement and Verification of results we

may end up with a gross misallocation of investment into "green" energy saving projects that really are not performing, financially or environmentally.

The really big problem is that there is not a culture or eco-system for developing large, multi-premise investment programmes. Project developers and owners tend to work on one project at a time, developers like ESCOs are passive and only respond to RFQs, they don't go out there and create demand at a portfolio level. We need a new type of developer – let's call them a "super developer", that only develops large scale projects, aggregating smaller projects and acts like an infrastructure or property developer. Developing anything is high risk and there is a need for risk equity capital to drive the development of project investment opportunities at scale. Super developers could be private sector or public sector. Governments have huge portfolios of property and vehicles and should provide a ready channel to aggregate demand through super developers but they are not really doing it.

To learn how to scale-up investment into energy efficiency we need to look around the world to places where efficiency investment is actually happening at scale and I see four case studies of super developers in action that have global significance and everyone needs to examine:

- PACE in the US which was discussed earlier in the conference
- The Carbon & Energy Fund (CEF) that is a framework for procuring Energy Performance Contracts in the UK's National Health Service (NHS)
- The Etihad Super ESCo
- Energy Efficiency Services Ltd (EESL) in India

At the green bond conference we heard from David Gabrielson of PACE Nation and Craig Brown of Renovate America about how PACE has really started to scale in the US. In Europe the good news is that the EuroPACE Project has been awarded €2.4 million of Horizon 2020 funding to introduce PACE type models to Europe. I am pleased that we at EnergyPro Ltd are advisers to that important project. In the PACE eco-system there are large players like Renovate America and Renew Financial who aggregate demand, ensure contractors meet appropriate standards and access large pools of capital through bond issues.

The Carbon & Energy Fund, which is not actually a fund but rather a procurement framework, engages with NHS hospitals to develop and deliver EPCs. Hospitals join the framework and commit to implement an EPC which CEF develops in conjunction with an ESCO selected by a competitive process between the ESCOs on the CEF framework. CEF sources finance and charges a fee based on capital expenditure and an on-going fee for contract management and measurement and verification. CEF has developed about 40 EPCs.

The Dubai Super ESCo – the Etihad Energy Services Company is doing great work in the UAE and it only works with portfolios of buildings. I wrote about it **here** and since then they have announced new deals including; retrofitting controls and installing PV in 243 buildings owned by a leading property company, and 650 facilities, (mosques, offices and residences), under the jurisdiction of the Islamic Affairs and Charitable Activities Department (IACAD).

EESL in India has done and is continuing to do amazing things, operating a commercial model that has aggregation of demand at its heart. They have deployed 270 million LEDS and through aggregation of demand reduced the price of an LED by a factor of ten. The approach is now being applied to other technologies like high efficiency motors, pumps and fans and smart meters. EESL also recently procured 10,000 EVs for government departments in the largest ever procurement for EVs and reduced the price of EVs significantly. The 10,000 EVs are seen as a pilot and next year EV procurement will be ramped up many-fold.

Whatever the choice of structure, whether it is a framework, a super-ESCO, a corporate aggregating demand and accessing finance, or some other form we haven't seen yet, it is clear that we need more super developers.

6 How to accelerate investment into energy efficiency

Most of my work since 2012 has been focused on this question; 'how do we accelerate investment into energy efficiency?'. Naturally it became the subject of many blogs, some of which are included here. There is inevitably some repetition and overlaps. We need to keep repeating some basics to put in place effective solutions to the problems of investing in energy efficiency, and we have to start by addressing the situation as it is now, not how it should be or how we would like it to be. That includes confronting the truth, that for most people most of the time, energy efficiency is the most boring subject out there.

6.1 Massively scaling up energy efficiency: Where are we? What do we need? 4 Dec 2013

I come back to my theme of how to massively scale up energy efficiency with the perspective of thirty years involvement in the field – during which I have worked at the operational level designing and deploying multi-premise programmes, the strategic level developing innovative energy outsourcing and financing deals, the policy level advising UK and other governments. First of all the good news – I am positive that energy efficiency is finally being recognised for what it is, the cheapest, cleanest and fastest energy resource we have for providing essential services. This is true in the UK and many countries around the world – in North America, Europe, Asia, Africa and the Middle East the importance of efficiency is now being recognised. The problem is however, to use the language of fossil fuels, recognising a resource, turning it into a usable reserve and then exploiting that reserve profitably are all very different things.

It is not widely recognised that over the last thirty to forty years, improved efficiency has provided more energy services than all other energy resources put together and we did that without really trying except for a period between roughly 1975 and 1985. The rest of the time we forgot about energy efficiency and yet it still provided more energy services than any other resource. Just imagine what we can do if we really put our mind to it. We live in a global society which only manages to turn eleven per cent of all the primary energy resources we use, the coal, the oil, the gas, the nuclear, the solar, the hydro, the wind and the biomass, into usable energy services that we need and want, the warmth, the process heat, the cold, the motive power, the light and the sound. Eight nine per cent is wasted. Even allowing for the fundamental limits set by thermodynamics this is pretty pathetic for a so-called advanced technological society.

Everywhere we look we are seeing concerted efforts to improve energy efficiency in new products, in industry, in the home, in electrical devices, in cars, in IT, in lighting, in ships and in aeroplanes – as well as to develop retrofit solutions. Whereas energy efficiency has never been a design criteria in the past it is increasingly so and all the millions of improvements in efficiency that come from devices as diverse as mobile phone chargers to giant ship engines will have an increasing effect on overall efficiency levels as they become adopted, normalised and regulated in to the economy. I am sure that most long-run energy forecasts don't take sufficient account of these developments which for the first time, in developed countries at least, are starting to decouple growth in income (GDP) and growth in energy use.

However, even now senior managements in many organisations (and most governments and political parties) are still not taking energy efficiency seriously enough and we are not making enough progress in the short-term. The message needs to go out that investing in energy efficiency is a low risk, high return deal that brings with it numerous quantifiable benefits over and above just cost saving. On a national level it could bring huge benefits in terms of increased security of supply – helping to reduce the UK's £24 billion (and growing) trade deficit in energy. The strategic importance of energy, and the risks associated with it in a world facing increasing supply constraints as demand rises from a larger and wealthier global population, need to be recognised and acted upon at board level in all

organisations, big and small, whatever their energy intensity or energy spend as a proportion of total costs. We know from decades of experience amongst the global leading organisations that when top management lead on this issue, and appropriate management systems are set up, the energy efficiency reserves can be profitably mined for year after year, decade after decade. We know how to do this.

We are seeing increased interest and investment in energy efficiency but what we are not doing at the moment is making large-scale investments in energy efficiency across large portfolios of existing buildings and facilities – despite the fact that are massive economic opportunities. Many organisations with hundreds or even thousands of sites and large energy bills are making pilot investments, saving twenty to twenty five per cent or more on their energy spend, rolling out the technologies to ten or twenty sites and then stopping. This is down to several factors on the demand side including the fact that we don't have enough senior leaders (private sector, public sector and national politicians) who are demanding – and I do mean demanding – large-scale programmes. We need more informed leaders who understand the opportunity and can "bang the table" to demand mass roll-out, large scale programmes using integrated design techniques and state-of-the-art technologies to maximize savings. To get there we need more and better communication and capacity building at the top level. Energy – despite its strategic importance – is still often dealt with at an operational level and constrained by capital budgets which of course favour offensive spending on new products, processes or markets. On the supply side there is a shortage of project developers that use state-of-the-art technologies and integrated design and perhaps more importantly, can develop large-scale multi-site, and even multi-customer projects. There is both a skills gap and a serious equity gap in the project development stage of the process.

The financing of energy services, energy performance contracts (EPC) and shared savings is often seen as the holy grail of energy efficiency. This area is witnessing a boom but it is more a boom of interest rather than deals. As a speaker said at an energy efficiency financing conference, the ratio of conferences to deals is getting better but it is too high. Many new entrants to the energy efficiency arena have suddenly discovered "shared savings" as a panacea without really understanding the issues. Why should this apparent win-win proposition be so hard to make happen? Firstly there is a lack of demand which is caused by a combination of ignorance, fear that savings won't be produced, very high transaction costs and the fundamental truth that the traditional EPC is not that good a deal, and not even viable in much of the private sector. A lot of complexity, a long-term deal and a small slice of savings over many years is not that attractive. Furthermore EPCs don't really work in the private sector – particularly commercial offices. Secondly there are supply issues, many project developers (Energy Service Companies – ESCOs) are still developing projects in the old way with relatively small savings instead of holistic, high savings projects. We need more innovation on the supply side.

On the supply of money, most of the money trying to finance these deals at the moment is high cost money seeking almost private equity returns. Massively scaling up energy efficiency investment won't be done by the kind of funding that is currently available. We need to get the right structures to provide customers with real up-front benefits and secure cash flow streams that can provide sufficient scale and be attractive to the debt capital markets. Traditional EPCs are not the answer to every problem. Appropriate investors are keen to move into energy efficiency but their confidence in the processes and savings need to be built, something that is being helped by the wider adoption of Measurement and Verification (M&V) through the International Performance Measurement and Verification Protocol (IPMVP), standards such as ISO50001, and standardized protocols through the Investor Confidence Project (ICP) in the United States. All of these need to be encouraged in the UK and indeed in all markets.

At the policy level energy efficiency is still the poor cousin, the Cinderella of energy policy. This is true in the UK despite sterling efforts from some individual ministers. In February we had David Cameron launching the "energy efficiency mission" and extolling the virtues

of improved efficiency (in a speech that in an Orwellian manoeuvre never made it to the Number 10 or DECC websites) and in December we have seen the ECO programme disrupted – effectively at the behest of the energy suppliers – and most of this short-term, politically driven change is occurring because another politician made an undeliverable, economically illiterate promise for his short-term gain. Energy is an industry that demands long-term vision and leadership to find its way through the massive, structural changes it is facing. In all the noise about energy prices the real potential of the energy efficiency resource, and how we move it from a resource to a reserve to exploitation, has scarcely been mentioned. The furore over prices was (and still is) an opportunity to reform the energy supply market, make it more transparent, recognise the huge impacts of distributed generation, and once and for all put efficiency at the centre of policy.

We need a regulatory regime that fosters innovation in the energy supply and services models rather than just encourages more investment in energy supply, both in generation and distribution. We also need to move energy efficiency out of the regulation, compliance mentality where it has always sat. We need to radically overhaul the plethora of programmes such as CRC, EU ETS, DECs, EPCs and the forthcoming ESOS (Energy Savings Opportunity Scheme – a.k.a. mandatory surveys) to ensure that energy managers can spend their time really developing and implementing projects and not just reporting on their energy use in several different formats. We need to make energy efficiency a market commodity just like coal, oil or gas by standardising procedures, measurement of savings and financing structures. Again, we know how to do this through programmes like ISO50001, IPMVP and the Investor Confidence Project. We just need to apply them and this needs leadership.

If we can develop and finance the large scale energy efficiency programmes we know are possible, and sort out the policy mess, we can move efficiency from being a resource – the equivalent of the resources of the North Sea of the early 1960s – into an energy reserve that can be exploited to provide massive economic benefits on the scale of the North Sea and larger – only unlike the North Sea the benefits from massive investment in energy efficiency will be permanent.

6.2 Meter and pay or deem and pray. 12th Nov 2015

California has long been regarded as a leader in energy efficiency – although as in many things in California and in life – the grass often looks greener on the other side and not everything in the Golden State on efficiency that glitters is real gold. However now it seems as if California is making changes that once implemented will truly lead the world in energy efficiency and probably transform the state and ultimately global market. Everyone with an interest in energy should be watching these changes.

Like most things in US politics the changes are wrapped up in acronyms, in this case the laws AB 802 and SB 350. SB 350 will increase building energy efficiency targets in the state by 50 percent by 2030. It will also boost the amount of renewable energy utilities are mandated to buy to 50 percent by 2030. According to the California Public Utilities Commission's fourth quarter 2014 report the three investor owned utilities in the state are well on their way to meeting the current 2020 goal of 33% renewables so SB 350 will keep up the pressure. AB 802 mandates state-wide energy benchmarking and access to building performance data for commercial buildings. Benchmarking and open data are critical tools in driving action in commercial real estate.

The real game changer in SB 350 lies is the way that energy efficiency will be counted in future. Up until now the state incentive schemes run by the utilities have only been able to reward energy savings over and above Title 24 – the rigorous building code. What this means is that you can only get an incentive to improve your existing building to a level over and above the high level of efficiency required for new buildings. Given that it is often impossible to do this, lesser but still valuable improvements were not being rewarded by incentives and what is more, the code is heading to net zero buildings leading to an existential problem. Furthermore incentives were paid out in advance either based on

deemed savings, or the results of engineering models (which we know don't work very well). SB 350 turns this system around completely – it requires measurement of savings and actually defines savings as "reducing the quantity of baseline energy services demanded" and includes both the adoption of efficiency measures and practices such as behavioral change – another important innovation. The law says that savings "shall be measured taking into consideration the overall reduction in normalized metered electricity and natural gas consumption".

The model will switch to something we have never had in energy efficiency – pay for performance. The system won't care what measures are implemented – leave that up to the market, it will just pay for actual savings delivered. We will move from deeming savings and hoping or praying the result will be OK to measuring actual results and paying for performance.

Watch this space – but the switch from deemed savings to metered savings enables all kinds of new business models. We are actively developing these in Europe and will be happy to discuss them with interested parties.

NB Thanks to Terry Egnor for the title.

6.3 Assembling the jigsaw of energy efficiency. 26 Jan 2015

On the 15th January I chaired the 3rd annual Energy Institute conference "*Accelerating energy efficiency*". I believe that we have now got to the point where the huge economic potential for improved energy efficiency is broadly recognized although the true value of the multiple co-benefits is only just being identified. What we haven't yet achieved is the "main streaming" of improving energy efficiency. To resolve our energy cost, energy security and environmental problems we need to, and should, work to accelerate the rate of improvement of energy efficiency – hence the title of the event.

To accelerate energy efficiency we need to increase the demand for energy efficiency, increase the supply of energy efficiency products and services, and increase the flow of finance into energy efficiency investment, both internal and external investment. To do this requires a systematic approach and this year the Energy Institute conference covered more parts of the jigsaw than ever before. Lord Deben kicked off the event with a brilliant keynote in which he stressed four words; vulgarity, centrality, urgency and difference. I understood vulgarity to mean moving energy efficiency away from the deeply technical language only understood by experts to a more commonly understood language – a theme I have pushed for a while having come to the realization that energy efficiency is deeply boring and uncool (**see the energy efficiency cool wall**). Centrality meant central to the energy and environmental issues, urgency meant in relation to climate change but I would also add urgency in terms of economic and geo-political energy security issues such as dependence on imported gas and oil. By difference I think Lord Deben meant diversity of solutions.

Following Lord Deben's keynote there were presentations covering an update on ESOS from David Purdy of DECC and presentations on the different routes to ESOS compliance, ISO50001 and energy surveys. Bert Lunenborg, Production Manager at major energy user British Gypsum made the point that ISO50001 was powerful as it produced a system that is not dependent on individuals, and has a life beyond surveys. This cemented (no pun intended) my belief that government and other stakeholders concerned with improving energy efficiency should be promoting and adopting ISO50001. Wider adoption will better embed effective energy management into organizations which should improve the rate of improvement in energy efficiency and investment into energy efficiency measures. I would like to see a more positive commitment to ISO50001 from government, large organizations and industry associations alike to build capacity and capabilities. The public sector could accelerate its behavior by insisting on suppliers having it, just as they often do with quality and environmental ISOs.

A welcome addition to the programme compared to previous years, was the focus on behavior with several presentations on the theme including "Applying behavioral science to improve energy efficiency" by Phillipa Coan and "Energy management through people: the missing ingredient?" by James Brittain. James reported on an effective approach using low cost real time sensors and employee engagement to reduce energy use. The results from the Heathrow Terminal 2 building project where James' company worked with restaurants and retail units to reduce installed capacity and energy use were particularly impressive.

In the afternoon the themes were finance and data. I introduced the Investor Confidence Project Europe (http://goo.gl/glbj5S) and then Nick Paget from Energy Works plc described the fully financed lighting as a service model Energy Works is providing to the SME market. Rajvant Nijjhar of i-VEES gave a great practical demonstration of the issues of measurement by getting six volunteers on stage to measure a piece of string. The range of answers was amazing. It was a great reminder of the fundamentals of measurement and the reality that every single measurement or data point concerning any parameter has a range of error attached to it – something we often forget in the digital age. Luke Nicholson of Carbon Culture described his work based on big data and open collaboration.

In conclusion, if we are to accelerate energy efficiency we need to work on all the pieces of the jigsaw simultaneously – not just the technology. Some of the pieces are well-developed and understood such as Measurement and Verification (although they all need to be applied more), in others – particularly in the behavior and financial spaces – we are only just learning what to do. We need to continue to build the jigsaw and gather, maintain, improve and spread best practice in all these areas.

6.4 My talk at the Berlin Energy Transition. 30 March 2016

I was honoured to speak on a panel at the Berlin Energy Transition 2016 on the 18th March 2016.

Here is an edited and improved version of my speaking notes from the event. It is what I would have said given more time and more eloquence. The event made me think of an additional law of energy efficiency (see my others here) – "while Amory Lovins shows that energy efficiency has produced 30x as much energy services as renewables over the last forty years, energy conference organizers only give energy efficiency 1/30th of the time they give to renewables". Seriously though, a big thank you to the German Federal Foreign Office and Federal Ministry of Economic Affairs and Energy for the invitation to speak at such a prestigious and well attended event, and thank you to my fellow panelists, the panel chair Sylvia Kreibiehl and of course the audience.

I am very pleased and honoured to be invited to speak to you today about energy efficiency financing. This is a very interesting time for energy efficiency and energy efficiency financing around the world and we are starting to see real understanding and progress emerge – slowly but surely.

It is good to start by putting some scale on the problem and the opportunity. The IEA estimate that investment in energy efficiency must multiply by a factor of 3x by 2035 to achieve the 450ppm scenario. The EU estimate that investment in building retrofits need to increase by a factor of 5x to achieve climate goals. Various estimates of the potential market exist but a round trillion dollars is a good number to use – big enough to excite even institutional investors.

Today I will give a overview of where we are on developing the energy efficiency financing market and my own views on what we need to do to grow that market to the levels that we know are needed to achieve our medium term energy goals around energy security and the environment. So I am going to talk about the current status, some of the problems, some of the solutions and then a brief look to the future.

I want to start with a status report on energy efficiency financing:

- The massive economic potential for energy efficiency has now been largely recognized. Those of us like Amory Lovins and myself who have been working on energy efficiency and talking about the potential for energy efficiency for decades it is surprising how long it has taken but it is a step forward. Recognizing the potential is the first step
- Following some good work from the IEA and others the non-energy benefits of energy efficiency – and by that I mean all the other benefits that come with energy efficiency other than just energy and cost savings – are now increasingly recognized and starting to be valued. We still have a way to go on this important issue but things are improving
- We now have strong and growing interest in investing in energy efficiency from institutional investors. This is a new development over the last few years
- However, despite these positive developments the growth of the energy efficiency financing market has been slower than we would like and slower than we need. Not just in Europe, but in North America and Asia there is a sense of frustration that things are not happening as fast as they need to. As one of the US bankers involved in energy efficiency financing said: "the trouble with this energy efficiency business is that the ratio of conferences to deals is too high"

If we dream for a minute about what a healthy, growing and dynamic energy efficiency finance market would look like, it would have:

- strong demand from building owners and investors
- highly skilled and accredited workforce
- a mix of financing products at different rates
- standardized tools for tracking and quantifying savings
- and finally a secondary market that the primary investor can sell onto – ultimately the debt capital markets.

In fact it would look like the markets for financing conventional energy infrastructure, and by conventional I mean oil and gas and solar and wind power. In fact it would like any other financial market. At the moment it does not look like that anywhere – it is nascent, very niche and very hard to invest in. Only the real enthusiasts – the pioneers, the early adopters – are investing at the moment.

To sum up, when I look at the whole area of energy financing this is what I see. For oil and gas projects, if you happen to own an oil field, the ways of developing, documenting and valuing the project are standardized, and there is a large volume of money available for such projects from a wide range of sources across the value chain.

25 years ago when I did some early wind farm projects in the UK the same was not true for wind power, we made it up as we went along and there was only one bank in London we could go to who I suspect were also making it up as they went along. Nowadays of course funding renewables is fairly standardized, and almost as mainstream as oil and gas and you can go to multiple sources for money across the value chain.

However, when we look at energy efficiency projects, we see something completely different. Processes and documentation are not standardized, it is not mainstream, there is only a small amount of lending/investing going on and there are only a few sources you can go to. Investing in energy efficiency is hard, even when you want to.

So how do we make the vitally important energy efficiency financing market grow and look more like other financial markets? Looking at this problem I see a jigsaw and it has four main pieces:

- Product offerings
- Bridging the development gap
- Capacity building

- Standardization

We need to put all the pieces together if we want to grow this market – and not just make perfectly formed single pieces. I want to say something about each of these pieces in turn.

Product offerings

Let's talk briefly about product offerings from the energy efficiency industry. Whenever energy efficiency financing is brought up people say "Energy Performance Contracts" – usually followed by some cliché about how they are the solution.

Let me only say that Energy Performance Contracts (EPCs) are not the answer that some people seem to think they are. It is a model that evolved to meet the needs of a particular market segment (the US public sector) and was exported around the world but has always been a source of frustration for its boosters and others. The EPC model has never grown to the extent that people think it should for a number of reasons:

- debt is on the balance sheet of the host
- debt is constrained by mortgage covenants or finance structure
- the guarantee is not a credit enhancement
- transaction costs are high
- they don't address the split incentive.

For too long the energy efficiency industry, and some policy makers have pushed EPCs as if they are the answer to everything – they are not.

We are now seeing innovation in contract forms and business models appearing around the world, these include acronyms such as ESA (Efficiency Services Agreement), MESA (Managed Energy Services Agreement) and MEETS (Measured Energy Efficiency Transaction Structure). We need, and I am sure will see, much more innovation in different sectors. By the way, one of the problems with the energy efficiency industry is that like the space industry it likes acronyms too much.

Bridging the development gap

The development gap is the gap between what we know is a massive potential for viable projects and actual, bankable, actionable projects.

To overcome the development gap requires:

- vision and knowledge about what is possible
- technical and financial skills
- finance – developing projects, especially big projects, costs money and this is risk money like all development whether it be energy efficiency, energy projects or property development
- standards – we need to develop multi-building projects in portfolios using the same standards and document sets.

We need to learn how to finance the development process at scale. We have an established way of doing that in energy supply projects but not for large-scale, multi-building energy efficiency projects – although there are a few good examples out there like the Etihad Super ESCO in Dubai.

Capacity building

Now let's look at capacity building which has to happen on the demand side, the supply side and the in the financial sector. On the demand side we have to acknowledge that lack of demand for energy efficiency projects is a problem that we have to address.

We also have to acknowledge something that is hard for those of us who have spent our lives in energy efficiency to accept. Energy efficiency is just simply boring – for most people most of the time it is extremely dull. Only when we recognize that can we move forward.

One the most promising ways of making energy efficiency a lot less boring is to talk about the non-energy benefits that come from energy efficiency. Those benefits occur at different levels; in the energy supply system, in the participant or host, and in society at large. Here I am only concerned with the benefits to the host, the project owner.

These benefits include amongst others: improved productivity, increased retail sales, increased quality and reduction in hours lost at work. These are increasingly being recognized and they are starting to be measured. Often the value of these benefits will be much larger than the value of the energy savings alone – the IEA estimate 4x more valuable in some industrial cases. Also they are much more strategic and the more strategic an investment proposition the more likely a management decision to invest. For example, if a retailer recognizes that LED lighting retrofits, or better still natural lighting, leads to an increase in sales (as some have done) and starts to value that benefit, you can be sure that energy efficiency becomes strategic and rises up the management agenda.

Capacity building on the demand side – that is the customer side – should also include tools like ISO50001 and integrated design as well as knowledge of outsourced energy services that bring with them expertise and finance. Companies frequently finance or outsource assets of all types, particularly those that are non-core business, but rarely energy assets or efficiency.

On the supply side we need to build capacity in different ways. The energy efficiency industry needs to learn to work with the finance industry right at the start of a project, not just at the end. We need to learn how to develop projects at scale, understand financial markets better and sell non-energy benefits and not just energy savings. Traditionally the energy efficiency industry has been very bad at understanding its markets and tended to assume that because a project has a two or three year payback on energy grounds alone it is "no brainer". Often when you look at other factors it is not.

Within financial institutions we need to build capacity around:

- non-energy benefits
- the risks of energy efficiency investment – and there are definitely risks – it is not the "no risk" investment some have described in the past
- the proven energy efficiency technologies
- the various contract types
- tools for standardization
- available support for development and project work.

The EIB and others are doing good work in this area but we are starting from a low base.

Standardization

Finally the last piece of the jigsaw – and what I and many others think is the key piece – standardization.

We all know that standardization is essential if you are making cars in a factory or in fact any other manufactured product. Standardization was the key to the industrial revolution.

Of course people forget that banks and financial institutions are also factories – they cannot operate at scale without standardization. Every financial market, whether it be mortgages, car loans, commodity trading, stock exchanges, bonds or credit cards, is based on standardization. Lack of standardization is the major barrier to growing the energy efficiency financing market.

It is not just me saying this. Various institutions, groups, banks and individuals have said it. The Energy Efficiency Financial Institutions Group, a group of 100 banks and financial institutions set up by the European Commission and the UNEP Finance Initiative, concluded that lack of standardization was a key factor in impeding both the demand and supply of energy efficiency financing.

The Joint Research Committee of the European Commission also came to similar conclusions.

Michael Eckhart, the head of Finance & Sustainability at Citi said it well when he said:

- "energy efficiency projects do not yet meet the requirements of capital markets
- no two projects or contracts are alike."

He also highlighted the high transaction costs that come with lack of standardization.

And finally the IEA concluded that standardization was important and that the Investor Confidence Project, which I will talk about now, could "facilitate a global market for financing by institutional markets that look to rely on standardized products".

The current lack of standardization in the way that energy efficiency projects are developed and documented has several consequences:

- greater performance risk
- higher transaction costs
- financial institutions cannot build capacity even if they want to invest in this area
- institutions cannot aggregate projects – which is essential because we know that energy efficiency projects are small compared to the needs of the institutional investors.

So let's consider an important and significant response to the lack of standardization – the Investor Confidence Project. This was a US project that I brought over to Europe and secured Horizon 2020 funding for. I want to give you a flavour of the Investor Confidence Project, what it is and what has been achieved in the US and Europe and where we are going.

Working with the finance and energy efficiency industries the Investor Confidence Project has developed open source Protocols that organize the process of developing and documenting a project and for each stage of a project define the standard or combination of standards and best practices that should be used – as well as the format of the output. It is not about writing new standards but rather about standardizing the process.

In both the US and Europe six Protocols – each matched to local needs – have been launched and are now being applied in real projects and programmes. They cover different types of projects in commercial and residential buildings. As well as Protocols the Investor Confidence Project has also developed accreditation for project developers and software.

The Protocols and the accreditation come together in a label; "Investor Ready Energy Efficiency". When we talk to investors, including some of Europe's largest real estate investors and lenders they say that is what they want – a label that gives them confidence that best practice process has been followed. Underneath the label the process reduces transaction costs, facilitates aggregation and ensures on-going measurement of savings, something that will become more important as secondary markets such as green bonds emerge.

The Investor Confidence Project is supported by some 200 Allies in the US and Europe – anyone who supports the ideal can sign up on the website: **eeperformance.org** (for the US) or **europe.eeperformance.org** (for Europe).

So having created the tools – the Protocols and the Investor Ready Energy Efficiency label – to standardize the development and documentation of energy efficiency projects in buildings the Investor Confidence Project is now applying those tools to a wide range of projects and programmes across Europe and the US, working with leading property companies, energy efficiency developers, financial institutions and frameworks. We have a network of the most active investors and work to link them to projects, as well as with developers to make projects more bankable.

So that is my jigsaw of energy efficiency financing.

What would it look like if we finished the jigsaw? We would have a dynamic and rapidly growing energy efficiency financing industry with the characteristics I described at the start:

- strong demand from building owners and investors

- highly skilled and accredited workforce
- a mix of financing products at different rates
- standardized tools for tracking and quantifying savings
- and finally a secondary market that the primary investor can sell onto – ultimately the debt capital markets.

I think we have identified the jigsaw pieces and in few cases we have put them together, now we need to replicate those cases widely. If we do that I believe we will be surprised by how big the energy efficiency financing market becomes and just how much demand we can take out of the system through economically and financially attractive efficiency investments.

That is the future the Investor Confidence Project is helping to build and we would welcome working with anyone else who shares that vision.

6.5 Growing the energy efficiency financing market. 27 June 2016[2]

On the 22nd June I was asked to speak at a high level meeting in Brussels on energy efficiency on the topic of growing the energy efficiency financing market and two specific projects I am heavily involved with, the Energy Efficiency Financial Institutions Group (EEFIG) de-risking project and the Investor Confidence Project (ICP). Here is a cleaned-up version of my speaking notes. Of course my shopping list for EU policy measures has been made somewhat redundant by recent events but they apply equally to the UK and elsewhere.

Before talking about growing the efficiency financing market and the two specific projects I am going to cover I would like to start with a status report on the energy efficiency financing market.

There is some good news:

- After many years the potential for investment into energy efficiency has been recognized. Different analysts have different numbers but there is general agreement that circa €70 to €100 billion a year could be profitably invested into energy efficiency in Europe. For comparison in 2015 $58 billion was invested into renewables, down sharply from $132 billion in 2011 and so we are dealing with a manageable amount here
- The many non-energy benefits that come from improved energy efficiency – everything from increased sales and productivity through to health and well-being effects – have been recognized and are starting to be valued. This is really important because these non-energy benefits are much more strategic and attractive to decision makers than "mere" energy savings
- Many institutional investors and banks are now really interested in energy efficiency – this is a major change over the last 3 to 5 years. Efficiency has real economic benefits, it has impact and it is not reliant on subsidies – some of us have known that for years but now the bankers have caught up. Because of this the efficiency industry can no longer rely on that old excuse……there is no money. There is plenty of money but a lack of investable deals

The not-so-good news is that in Europe, and elsewhere, there is deep frustration that the energy efficiency finance market is going very slowly. As one banker said; "the problem with energy efficiency finance is that the ratio of conferences to deals is too high". It is getting better but it is still a niche activity and far from being the dynamic, well-developed market we need it to be.

[2] **https://bit.ly/3nooSBm**

So, given that we want to, and in fact need to, accelerate the rate of investment into energy efficiency what are the barriers and what should we be doing to overcome them? Firstly, we need to recognize that there are many barriers including:

- very small project sizes – especially compared to institutional investors' typical deal size and the needs of the debt capital markets
- efficiency is invisible
- it is hard to measure – or at least it has been – that is starting to change with advanced metering, measurement and verification technologies
- and one really important point is that efficiency is definitely not cool, not sexy or even photogenic.

We have to acknowledge that there is a fundamental lack of demand – because hardly anyone wakes up in the morning and says; "I want to buy some energy efficiency".

Another major barrier identified by the Energy Efficiency Financial Institutions Group (EEFIG) and others is the lack of standardization in the way that projects are developed, documented and presented – this leads to higher risks, or perceived risks, and high transaction costs for financial institutions. So, how do we overcome these barriers and make the energy efficiency financing market rock?

I think there are four key elements which need to be brought together in what I call the jigsaw of energy efficiency finance:

- Finance – and by that I mean both project finance and development finance i.e. the risk capital to develop projects
- Real demand and a robust project pipeline which requires several things – a new ecosystem of project developers, better development skills, but also better selling skills built around a focus on non-energy benefits which are much more strategic and attractive than "just" energy cost savings
- Capacity building in financial institutions, the energy efficiency industry and project owners
- De-risking through the standardization of processes, contracts and reporting of results

I want to talk about two projects that are addressing some of the key elements of the de-risking piece; the EEFIG De-risking project and the Investor Confidence Project.

The EEFIG De-risking project is funded by DG ENER and is being steered by the circa 100 members of EEFIG. It has two linked parts:

1. Building a database of project performance so that owners and investors can see how projects actually perform and over time we can build an actuarial database of actual performance – both energy and financial performance
2. Developing standardized underwriting procedures such that banks and financial institutions can better assess both the value and the risks of energy efficiency projects which will lead to better pricing and help to build capacity

We are currently building the database, which is called DEEP (De-risking Energy Efficiency Platform) and we are collecting data on several hundred projects. Individual projects will be anonymous and if anyone in the audience is able to provide project data the Commission, myself and the team will be very happy to talk to you in detail. The more projects of all sorts, across buildings and industry we can have in DEEP the more useful it will become, for investors, lenders, project developers and project owners.

We also welcome any input from financial institutions into developing the standardized underwriting framework that we believe can become a useful tool for those investors and banks keen to increase capital deployment into energy efficiency. It will help them to fully assess risks and value – from all sources –leading to better pricing, build capacity around standard processes, and better manage overall risk in portfolios of projects.

The second important project is the Investor Confidence Project (ICP) Europe. I brought the idea over from the USA and in Europe the ICP is supported by Horizon 2020. The ICP addresses the lack of standardization at a technical level by bringing together financiers and the energy efficiency industry to agree common Protocols for developing and documenting projects. We now have >150 Allies across Europe and have published six protocols which are now being used in a growing number of building renovation projects across the EU. The ICP has also introduced a project developer and quality assurance accreditation scheme that is called Investor Ready Energy Efficiency. Our investor network has over €1 billion they would like to deploy into energy efficiency and many of them offer lower fees or interest rates for standardized ICP accredited projects. We are now looking at expanding the suite of protocols to include industry and infrastructure.

When I think about what else do we need, particularly from Brussels, I have the following shopping list:

- Ensure all EU funded projects have to provide performance data into the DEEP database and encourage all project developers, vendors and financiers to support DEEP and similar evidence platforms. It would be foolish to establish DEEP and then not require funded projects to contribute to it
- Ensure EU funded projects adopt standardization of the development and documentation of projects using the Investor Confidence Project protocols
- Focus on the project development piece and building demand. This needs to be done by:
  - providing more technical assistance but very tightly focused assistance, don't just give money out to municipalities who want to do "investment grade audits" and assume banks will lend on the back of those audits
  - focus on selling non-energy benefits – I now say let's not even mention the energy savings, sell the comfort, the health and welfare, the employment or whatever is most likely to push the buttons of the decision maker – and then say "by the way, it also produces some energy cost reduction"
  - selling the benefits of financed energy solutions. This has to be done at local and regional level.
- Use EU funds like Structural Funds to further de-risk private capital – don't crowd out private capital by lending to projects but rather create mechanisms like first loss loan reserves – you get much more bang for the euro that way
- Start working on enabling collection mechanisms such as On Bill Recovery (OBR) and Property Assessed Clean Energy (PACE) which is based on local property tax. In the US PACE funded retrofits have really started to accelerate and there has been more than $1 billion of securitization of PACE loans in the last 12 months. There is now a real secondary market which allows recycling of capital and proper risk allocation. I know that property tax systems are different across Europe but we need to work out how to use them in a mechanism like PACE in each member state
- Insist on open energy data. US cities like New York and Chicago have pioneered the open publishing of normalized energy consumption data for commercial buildings above a certain floor area. If you can't yet do it for commercial buildings (even though there is no reason not to other than a lack of leadership), then insist upon it for all EU buildings and member state government estates
- Finally, really take a long hard look at what is happening in California where the latest regulations are moving towards requiring metered efficiency and pay for performance. We need to move out of the old energy efficiency paradigm which is mandate and public sector led into a market led paradigm where we pay for what we actually want – negawatt hours. Using this approach we can create a real market where efficiency is just as reliable and just as financeable as energy production. Let's start actually paying for real performance i.e. energy savings rather than for stuff, boilers, insulation etc and praying for results

So, on the day before the historic referendum on UK membership of the EU, that is my small shopping list for today.

I just want to say that I am more optimistic than ever that we are building the foundations of a vibrant energy efficiency financing market by bringing the four pieces; de-risking. finance, demand and capacity building, together, but we still have a long way to go. If we build that market I think everyone will be surprised by how much efficiency is actually delivered.

Again, making reference to the referendum which is hard to avoid doing, I want to finish by saying that I think EC policy in this particular area is joined up, it is helping to build the jigsaw and is moving in the right direction – if anyone wants to tell the BREXIT campaign that is fine by me.

Thank you for listening!

6.6 Financing energy and resource efficiency in the built environment. 6 Feb 2017

On 1st February I made a keynote address at COWI, the Danish engineering company, at an event to launch their new tool to help value the multiple benefits of energy efficiency and other projects.

Good afternoon. I am going to start by saying we are in the midst of a revolution – and I don't mean the revolution going on in Washington DC. The revolution I am talking about is an energy revolution. The old model was the large centralised energy plant sending energy out over a network to consumers. The new model is one which has two chief characteristics. Firstly there is a diversity of technologies including renewables, distributed generation, energy efficiency technologies, storage, and smart controls. Secondly there is a multi-directional model in which there are no longer producers and consumers but rather prosumers.

This revolution has already had a major impact on traditional utilities. In 2013 the Economist had a story headline on utilities, "How to lose half a trillion euros". The number has gotten bigger since then. The good news is that there is big money in energy efficiency. The World Business Council on Sustainable Development estimated that the energy efficiency in buildings opportunity is worth $0.9 to $1.3 trillion – yes trillion. So this is a massive opportunity. However, everywhere I go in the world I find a sense of frustration, frustration that the market for energy efficiency investment is not growing fast enough. Why is that?

There is a massive gap between on the one hand the huge potential for cost-effective projects to improve efficiency, a potential that only needs proven technologies, and the massive amount of capital that is looking for profitable investments, especially investments with a green aspect. This is the gap we have to bridge. Just in case anyone is unconvinced about the availability of capital, a report from PIMCO stated that there is $12 trillion of institutional capital in global investment grade bonds trading with negative yields and that 15% of bonds within the Barclays Global Aggregate, (a widely used benchmark), was trading with negative yields to maturity. This huge amount of capital could be usefully deployed into energy efficiency and other green projects. The demand for green investments is growing rapidly as witnessed by the rise of green bonds.

So how do we start to deploy more capital into energy efficiency? My view is that there is a jigsaw of energy efficiency financing with four pieces; finance, building pipeline, standardisation and building capacity. Any project or programme, whether it is funded by public or private funds, needs to address all four parts of the jigsaw.

Let me start with standardization. Many studies and market observers have highlighted the lack of standardisation in energy efficiency to be a major barrier to scaling up investment. The Energy Efficiency Financial Institutions Group (EEFIG) identified this and Michael Eckhart of Citibank has identified it by saying "energy efficiency does not yet meet the needs of the capital markets. No two projects or contracts are alike". The importance

of standardisation was brought home to me by a quote from D.E. Purcell who said: "Standards are like DNA. They are the basic building blocks for all technology and economic systems." We could not have had the industrial revolution without standardisation and we could not have any financial market without it.

So why do we need to standardise?

Lack of standardisation introduces a number of problems:

- it increases performance risk
- it introduces uncertainty which in itself reduces demand
- it increases transaction costs as investors and lenders have to spend more money on due diligence
- it makes it difficult for financial institutions to build human capacity – you can't build teams around ad hoc processes
- it makes it difficult to aggregate projects – and aggregation is vital in energy efficiency because individual projects are small compared to the need of institutional investors.

And what do we need to standardise?

Firstly we need to standardise project development and documentation. This is the province of the Investor Confidence Project and its Investor Ready Energy Efficiency™ system.

Secondly we need to standardise the understanding of risks and value. This is the subject of the EEFIG "Value and Risk Appraisal Framework for Energy Efficiency Finance and Investments" which we have written with COWI for DG ENERGY and will be published in the summer.

Thirdly we need to standardise contracts. There have been several European and UK projects to standardise contracts for Energy Performance Contracting but they are still not widely used and different project developers use their own contracts.

Finally we need to standardise performance measurement and reporting. This is the area of Measurement and Verification (M&V) but it goes beyond M&V and the International Performance Measurement and Verification Protocol (IPMVP). We need to collect and make available information on project and investment performance. Several initiatives are working on this including EEFIG's De-risking Energy Efficiency Platform (DEEP) developed by COWI for DG ENERGY, the Investor Confidence Project's Building Button, and the Curve. None of these to date have much in the way of actual performance data – one of the problems with time-series data is that it takes time to collect.

To develop sizable pipelines of projects, which are necessary to attract lower cost institutional capital, two things are needed. Firstly it is necessary to have a proposition that sells – you have to sell something that is compelling to customers and many existing energy efficiency projects and contracts are simply not compelling. Secondly there is no point taking a building-by-building approach – you have to take a portfolio approach whether that portfolio be owned by a single owner like a company or a city, or whether it is a portfolio made up of buildings with different owners.

One aspect of solving this problem is building better business cases based on selling benefits that are strategic to decision makers. Energy efficiency projects have multiple non-energy benefits which are increasingly recognised such as; increased asset value, improved health and well-being, reduced staff turn-over or higher productivity. These benefits are much more strategic, and hence attractive to decision makers, than simple boring old energy savings. With strategic decisions people don't question the payback so much.

So to sell energy efficiency better, sell the non-energy benefits that are most likely to be strategic for your organisation – and then when you have the attention of the board, add the fact that this project will save x amount of energy and carbon with a payback period

of y. Don't start with energy savings and payback – that is a good way to get a "no" when we all want a "yes".

We also need to understand and be honest about the risks of energy efficiency. It used to be said that energy efficiency was low risk or even no risk. This simply is not true. Energy efficiency investments have all kinds of risk, especially performance risk which results from the performance gap – the difference between how much energy the project is designed to save and how much it actually saves. The limited amount of data on this is pretty worrying if you are an investor. Then there are other risks like weather risk, change of use risk etc. as well of course the normal credit and counterparty risks.

To better understand risks we need data. In many areas of investing and lending there are decades of data. In energy efficiency there is very little data but new data platforms are emerging such as the De-risking Energy Efficiency Platform (DEEP) developed for EEFIG, Building Button developed by the Investor Confidence Project, and the Curve developed by The Crowd. These data platforms are new and to date have very little actual performance data. Accessing data is hard, the lack of a common language with which to compare projects is a barrier, and of course collecting time series data takes time.

So to really scale up investment into energy efficiency to the levels we need to – we require new structures and organisations that put together the four pieces of the energy efficiency financing jigsaw: finance, building pipelines, standardisation and building capacity. A few examples of these organisations exist but we need more models and more innovation. Good examples include: The Etihad Super ESCO in Dubai, the Carbon & Energy Fund in the UK, and Retrofit Accelerators in the US.

So what of the future? The real future that is just starting to emerge is about moving from paying for stuff to paying for performance. All energy efficiency programmes rely on predictive models (many of which don't work very well), incentives or mandates with no accountability for savings, and high-level performance measurement based on samples. In Pay for Performance models actual savings would be quantified and paid for on a per unit basis. This would align risks, innovation and project finance and allow energy efficiency to become a truly scalable, and reliable, resource. Pay for Performance models are now being used in California which is putting much store on them working and are being used in pilots in Germany too.

One interesting thought is to take Pay for Performance beyond just energy efficiency. What do we really want from a building for instance? Clearly we want a pleasant environment but we also want good indoor air quality (IAQ), and the link between IAQ and productivity and well-being is increasingly being proven. Why not pay a building provider on a pay for performance contract for maintaining a set level of IAQ?

To sum up:

- we need to standardise
  - project development and documentation
  - understanding of value and risk
  - contracts
  - performance measurement and reporting
- we need to work on building large pipelines of viable projects which will require both developing new, more compelling business models, and taking a portfolio approach
- we need to consider pay for performance models and using new data and analysis techniques to measure energy efficiency and make it a reliable resource that can truly compete with energy supply options .

6.7 The key to scaling up energy efficiency – new business models and structures. 14 March 2017

The level of investment in energy efficiency required to meet climate and energy security targets is significantly higher than both the current levels, and the levels that can be financed by public capital. In order to scale up energy efficiency to the levels that we know are possible, and we know are needed, we need to change the game and make energy efficiency into something that people want to buy, and something that can be easily financed by institutional capital at scale.

The barriers to scaling up investment into energy efficiency are now well documented. To name just a few: projects are small, the methods of developing and documenting project development are not standardised, capacity within the financial sector to understand value and risks of energy efficiency is limited, and traditional business models such as Energy Performance Contracts are not attractive in many segments of the market. As Michael Eckhart of Citi said; "energy efficiency does not meet the needs of the capital markets".

There are signs, however, that the foundations of a functioning energy efficiency financing market are now being put in place. The Investor Confidence Project is rolling out its Investor Ready Energy Efficiency™ project certification system in the US and Europe, with growing interest from India, China and Australia and New Zealand. The EU's Energy Efficiency Financial Institutions Group (EEGIG) is soon to launch its "Value and risk appraisal framework for energy efficiency finance and investments", a guide to under-writing energy efficiency projects in buildings and industry. Investors and lenders are expressing more interest in developing energy efficiency related products. In the US Property Assessed Clean Energy (PACE) continues to grow and PACE loans are now regularly being securitised.

To build upon these foundations we need to ensure that four components are brought together in the same place at the same time by entrepreneurial individuals and organisations.

The four components are; finance (for projects and development), standardisation, large-scale pipelines, and capacity building on the demand side, the supply side and within the financial sector. Project finance is abundantly available and much of it is seeking environmentally conscious or green homes – the issue right now is a lack of projects. Many failed energy efficiency finance schemes prove that project finance alone is not enough.

There is a need to finance the development of projects, that risky stage between "here is a good project idea" and "here is a fully developed bankable project". Development capital is always high risk and there is an argument for using public capital to support this stage, although of course this does not generally happen in other sectors like property or power generation so it is questionable why it should in energy efficiency. The efficiency sector generally lacks a development mentality and eco-system and so public capital could be used to kick-start the development market using low cost convertible loans or grants such as the EU's Project Development Assistance.

Standardisation in the development and documentation of projects is now available through the Investor Confidence Project. Currently available for buildings in the US, Canada and across all countries of Europe, the Investor Ready Energy Efficiency™ project certification system is there to be used. As it brings reduced due diligence costs and greater certainty of outcome, project developers, clients and financiers will increasingly require its use.

There is a lack of large-scale pipelines that can attract institutional capital. Energy efficiency projects tend to be developed on a building by building or site by site basis rather than across portfolios. In the 1980s and early 1990s large scale energy management programmes were implemented across many public and private sector portfolios but that skill and activity seems to have been lost. We are still in the pilot project mentality all too often. To develop large pipelines requires several things. Firstly it needs entrepreneurial efforts to acquire and build pipelines. Secondly, it needs attractive and simple business models that really make sense for clients. Existing models such as Energy Performance Contracts do not make sense

for large parts of the market. Emerging models such as Efficiency Services Agreements, metered efficiency and Pay for Performance are more attractive and need to be developed and deployed. Finally, it needs strong leadership from client organisations and those that convene portfolio holders such as central, city and local governments to demand effective action at scale.

Capacity building amongst clients – the demand side – needs to focus on the energy and non-energy benefits of improved energy efficiency and the availability of financed solutions. Non-energy benefits such as increased asset value or improved health and well-being need to be stressed above just energy costs savings as they are usually much more interesting and strategic to most organisations. On the supply side capacity building needs to focus on developing standardised and bankable projects with consistent results. Within the financial industry capacity building needs to be focused on understanding the nature of efficiency, understanding the sources of value and the risks, as well as on the different ways that energy efficiency can be made into a financeable asset – all subjects covered in the EEFIG under-writing guide.

Pulling these four components together requires entrepreneurial effort – effort that can come from the public and/or private sectors – and can manifest itself in different organisational forms. Successful organisational forms include, but are not limited to, procurement frameworks, super ESCOs and retrofit accelerators. Successful procurement frameworks that can be used as models include the UK's Carbon and Energy Fund which develops and helps finance large scale projects within the National Health Service. Through its framework it delivers finance, the pipeline, capacity building and standardisation (based on the Investor Confidence Project's system). In the US there are several retrofit accelerators which bring together the different elements. In Dubai and India there are Super-ESCos, Etihad in Dubai and EESL in India. Both have successfully brought the four components together to deliver large-scale energy efficiency programmes and are good models for Europe and the US.

Massively scaling up investment into energy efficiency remains one of the biggest financial opportunities on the planet as well as the best opportunity to improve environmental conditions and reduce the threat from climate change. Even at current low energy prices the world spends some USD 5-6 trillion a year on energy. Entrepreneurs need to work to deliver new localised and national organisational forms that bring together the four components and deliver investment projects that significantly reduce energy spend and bring multiple other benefits.

6.8 Four reasons why financial institutions should be active in energy efficiency. 8 Aug 2017

This is the first in a series of blogs based on and picking up key elements in the EEFIG Underwriting Toolkit which was published in June. The Toolkit aims to equip financing institutions to better value and assess the risks of energy efficiency projects.

There are four reasons why financial institutions should consider deploying capital into energy efficiency:

- Energy efficiency represents a large potential market. The IEA estimates that in 2015 global investment in energy efficiency was USD 221 billion with approximately USD 32 billion being financed through explicit energy efficiency mechanisms such as Energy Performance Contracts or green bonds. To achieve our climate goals this level of investment needs to grow to circa USD 1 trillion per annum by 2050 and the provision of finance can help overcome some of the barriers to energy efficiency investment
- Reducing risks in two ways. Firstly, increasing energy efficiency improves the cash flow of clients, thus reducing their risk. Secondly there is the risk of financing assets that become stranded as energy efficiency regulations are tightened. For example, in England & Wales it will become unlawful to lease a commercial building with an

Energy Performance Certificate rating below E on 1st April 2018. This puts owners of low performing buildings, and their lenders, at risk

- Improving energy efficiency has a direct impact on reducing emissions of carbon dioxide and other environmental impacts such as local air pollution and therefore should be a key part of Corporate Social Responsibility (CSR) programmes. Energy efficiency is regarded as one of the key pathways to reducing greenhouse gas emissions
- Bank regulators are increasingly looking at climate related risks. Actions include asking banks to disclose the climate-related risks of their loan portfolios. In France disclosing climate-related risks is already required by law. This will allow financial institutions to be better informed about loan performance and thus the cost of risk and carry out better risk appraisal. Possible future actions may include reducing capital reserve requirements for "green" financing

Each of these four factors are considered in more detail below.

A large potential market

The IEA estimate that that in 2015 total global investment into demand-side energy efficiency was USD 221 billion, USD 118 billion in buildings, USD 39 billion in industry and USD 64 billion in transport. Investment into energy efficiency was less than 14% of total energy sector investment but increased by 6% in 2015 whereas investment into energy supply fell. The US, EU and China represent nearly 70% of the total investment into efficiency. Total investment into efficiency can be split into "core" investments, where the motivation is specifically to achieve energy savings, and "integrated" investments which are the regular transactions in which energy efficiency is not the motivation but which improve efficiency because the new product is more efficient than the one it replaces.

To date about 85%, of all energy efficiency investment has been financed with existing sources of finance or self-financing rather than specific energy efficiency products or programmes. The global market for Energy Performance Contracts, which are most often associated with external financing, was USD 24 billion in 2015 and of this USD 2.7 billion was in Europe. In addition, about USD 8.2 billion of green bonds were used to finance energy efficiency.

In order to achieve climate targets the level of investment in energy efficiency, and the level of energy efficiency financing, will need to increase substantially. The IEA and IRENA estimate that to achieve their "66% 2°C" scenario cumulative, global investment in energy efficiency between 2016 and 2050 will need to reach USD 39 trillion of which USD 30 trillion would be in the G20 economies, implying a global level of c.USD 1 trillion a year compared to the current level of USD 221 billion – a five-fold increase.

The business opportunity for financial institutions falls into two categories:

- creating new business lines for specific energy efficiency projects e.g. specific energy efficiency loans, mortgages or funds
- ensuring normal lending and investing which is being used to finance projects where energy efficiency is not the primary objective, e.g. building refurbishments or production facility upgrades, is leveraged to ensure funded projects achieve the optimum cost-effective levels of energy efficiency which are usually higher than "business as usual" levels.

Energy efficiency projects often have rapid paybacks. In EEFIG's DEEP (De-risking Energy Efficiency Platform) database, which includes over 7,500 projects, the average reported paybacks are 5 years for buildings and 2 years for industrial projects. Despite this economic attractiveness many potential projects do not proceed because of other priorities of the other project host, lack of internal capacity to develop projects, or shortage of investment capital. Furthermore, normal investments in building refurbishments and industrial facilities or new buildings and facilities often do not utilise all of the cost-effective potential for energy efficiency. The provision of third party finance through business models that reduce the

overall cost to the host is an important way of overcoming some of the barriers to improving energy efficiency and represents a major business opportunity for financial institutions.

Reducing risk

Energy efficiency investments can reduce risks for financial institutions in two ways:

- assisting individual clients, whether they be businesses or individuals, to reduce their energy costs improves their cash flow and profitability, as well as increasing their resilience to energy price rises. Reduced expenditure on energy translates directly to improved cash flow which improves the affordability of loans or mortgages, thus lowering risks to the lender
- tightening regulations around energy efficiency, particularly buildings such as Minimum Energy Efficiency Standards, mean that it will become impossible to rent or sell energy inefficient buildings. This is a stranded asset risk for the owner and lender.

Increasing levels of energy efficiency, essentially reducing the amount of energy used for any activity, is a central part of European policy to address concerns about energy security and climate change. European policy is driving tighter energy efficiency regulations for buildings, equipment and appliances as well as vehicles. The main EU policies are the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD) and in November 2016 the European Commission, in its Winter Package, "***Clean Energy for all Europeans***", proposed further tightening of energy efficiency regulations.

Some member states have implemented Minimum Energy Efficiency Standards (MEES) (also known as Minimum Energy Performance Standards (MEPS)) which mean that after a certain date, buildings with an energy efficiency below a set level cannot be sold or rented. These regulations mean that significant proportions of existing real estate portfolios could lose their income and asset value if they are not upgraded to a higher level of energy efficiency. For owners of large property portfolios, or banks lending to property owners, this represents a significant risk which needs to be addressed.

The environmental impacts of energy efficiency

For many years advocates of energy efficiency have argued that it is the lowest cost source of energy services and a low-cost route to achieving significant reductions in greenhouse gas emissions. This has now been recognised both by policy makers and by many financial institutions. The projects in EEFIG's DEEP (De-risking Energy Efficiency Platform) database suggest that the median avoided cost of energy is 2.5 Eurocents/kWh for buildings and 1.2 Eurocents/kWh for industry, which is lower than generation costs. Energy efficiency has been described as "the linchpin that can keep the door open to a 2°C future". The IEA estimates that in achieving a 2°C scenario energy efficiency must account for 38% of the total cumulative emission reduction through 2050, while renewable energy only needs to account for 32%. For financial institutions looking to make a positive impact on resolving environmental problems as part of Corporate Social Responsibility programmes supporting energy efficiency should be a high priority. As well as reducing emissions of carbon dioxide that drive global climate change, reducing energy consumption can also have a positive effect on local air pollution.

Energy efficiency and financial regulators

Financial regulators are taking an increased interest in systemic risks including climate change. There is also a growing interest from regulators and governments in encouraging the growth of "green finance". The European Systemic Risk Board in its Scientific Advisory Committee report of February 2016, "***Too little, too sudden***", warned of the risks of "contagion" and stranded assets if moves to a low carbon economy happened too late or too abruptly. The report's policy recommendations including increased reporting and disclosure of climate related risks and incorporating climate related prudential risks into stress testing.

In December 2016, the Financial Stability Board (FSB) Task Force on Climate-related Financial Disclosures (TCFD) published its recommendations which included disclosure of organisations' forward looking climate related risks.

In July 2015, France strengthened mandatory climate disclosure requirements for listed companies and introduced the first mandatory requirements for institutional investors as part of Article 173 of the ***Law for the Energy Transition and Green Growth***. These provisions require listed companies to disclose in the annual report "***the financial risks related to the effects of climate change and the measures adopted by the company to reduce them, by implementing a low-carbon strategy in every component of its activities***." Institutional investors will also be required to "***mention in their annual report, and make available to their beneficiaries, information on how their investment decision-making process takes social, environmental and governance criteria into consideration, and the means implemented to contribute to the energy and ecological transition."*** The law also requires the government to implement stress testing reflecting the risks associated with climate change.

This trend towards greater disclosure and open assessment of climate-related risks is likely to continue across Europe.

These four reasons suggest that energy efficiency should be on the board room agenda of financial institutions. Whatever the markets they operate in there are growth opportunities as well as opportunities to reduce risks.

6.9 Moving capital from energy supply to energy efficiency. 28 Sept 2018

On the 14th September I was very pleased to be able to present to the Association of Environment Conscious Building (AECB) Convention. It was a great event, based in a Passivhaus standard community centre and it was excellent to meet some old friends, as well as make new interesting contacts. It was also an excellent opportunity to visit two amazing passive houses.

The following is based on my slides and presentation:

Thank you for the opportunity to speak today. I have a long-standing interest in low energy housing and in fact helped build some low energy self-build houses in the 1980s including a house at Energy World in Milton Keynes. I am here to talk today about how to shift capital away from energy supply to energy efficiency, and this is the topic I spend much of my time working on. I am going to try to paint the big picture, tell you about some things that are going on in this area, and hopefully leave you with some grounds for optimism.

I always start with this picture of the £50 and say "there is big money in energy efficiency". I really hope they don't withdraw the £50 note because I think it is the only bank note in the world that celebrates energy efficiency. If you travel around the world you see bank notes that celebrate oil and gas and even electricity but this one of course shows Matthew Boulton and James Watt. Contrary to what you may have learnt in school James Watt did not invent the steam engine but he did invent a more efficient steam engine, and Matthew Boulton was the entrepreneur who teamed up with him and turned that invention into a successful business. They did that by offering shared savings energy contracts, taking a share of the savings in coal that the new engine produced when pumping water out of mines. This is perhaps another example of a UK innovation that we have never really exploited properly, and even 250 years after this we still don't really know how to exploit the massive potential for economic, cost-effective energy efficiency which is all around us.

So just how big is this potential? Over the decades there have been many, many studies of potential across many, many geographies and sectors. All of them show that there is massive potential that is not being exploited. Just to give one example, in 2012 the IEA published several scenarios including its Efficient Worlds Scenario. This estimated the potential for energy efficiency as 40% in buildings, 23% in industry and 21% in transport. Implementing this scenario would halve the rate of growth of energy demand and result in emissions

peaking in 2020. Significantly the economic impact would be $18 trillion, which is more than the combined GDP of the USA, Canada, Mexico and Chile in 2011. That is a lot of money.

If we are going to shift investment from energy supply to energy efficiency we need to consider the starting point so that we can measure progress. It is not easy to measure the global investment into energy efficiency but the IEA now does this on an annual basis. The IEA estimate that total global investment into energy efficiency in 2016 was $231 billion and the good news is that this is increasing. That is the good news. The bad news is that the IEA and IRENA estimate that to achieve their "66% 2°C" scenario would need to ramp up to almost $3 trillion a year in the 2040s, more than a factor of ten higher than the current level.

It is worth putting these big numbers into context. Total investment into the energy system was estimated at $1.8 trillion in 2017. A few highlights:

- Investment in coal was $79 billion which was 13% down – and nothing Donald Trump does will stop that going down
- Investment in electrical networks was $303 billion and this is expected to grow in the next few years as it includes storage
- Investment in fossil fuel generation was $132 billion, down 9%
- Investment in renewable generation was $298 billion which was down 7%. It is important to note, however, that the capacity installed in the year actually went up due to the falling costs of wind and solar generation.
- Oil and gas investment went up – probably in line with the oil price and because of the growth of investment in fracking. I will say, however, that the other day I was talking to a very experienced oil and gas investment banker and he said that it was now really difficult to raise money for new oil exploration and production companies in London, which traditionally has been one of the global centres for oil and gas funding.

Next it is important to be very clear that there is not a shortage of capital. Traditional energy efficiency people have tended to say "there is no money for our projects" but there is no absolute shortage of capital. Fitch Ratings reported that there is approximately $9 trillion of global government debt that trades at negative interest rates, i.e. the investors are paying to hold that debt. There is a wall of capital looking for good investments and an increasing share of that capital wants to invest in green projects. As there is an over-supply of funds the yield a project needs to generate to attract investment has come down.

So how to tip the balance of investment more in favour of energy efficiency? I am going to talk about two areas; changing the way we think about energy efficiency and making it more investable.

Changing the way we think about efficiency starts with thinking about it as an energy resource in exactly the same we think about other energy resources. Wallace Everett Pratt, a famous petroleum geologist said that "where oil fields are really found is in the minds of men". When you think about it is true. When Edwin L. Drake first drilled for oil in Pennsylvania in 1859 people thought he was mad. The physical material was there all the time, in fact oil seeped to the surface and was collected, but sub-surface oil became realisable when someone thought it was there and assembled the technology and the resources to prove it. It is the same in energy efficiency. If you think about it there is an energy efficiency resource in every building, industrial plant and transport facility (except of course this passive building) but the resource is only there when you think about it, if you look at a building in a certain way you can see energy (and money) flying out through the roof, the walls, the doors and the windows.

In the oil and gas industry there is something called the Petroleum Resources Management System which sets out the different types of oil and gas resources and reserves. This has been standardised by the industry and is the basis of fund raising. If you have a prospective resource you can raise money on the back of it, it will be high risk money because you still have to drill holes and test it and even if oil is there you still need to work out a viable,

financeable way of getting the oil out to market. We need to think about efficiency in these terms. A potential study is like a prospective resource. The output of an energy audit moves that resource into a contingent resource. Then some of the projects identified will be developed and ultimately move into production, that is production of savings of negawatt hours. Imagine if we could get the market to think about efficiency in this way. Building owners could lease their buildings open to efficiency exploration and production companies in exactly the same way that the owner of a field in Pennsylvania or Texas may choose to lease it to an oil and gas company. Owners of buildings could even hold auctions based on selling the right to explore the building for efficiency resources.

Energy efficiency has many barriers. There is a whole genre of research on barriers to energy efficiency. All of that is important work but there is one fundamental problem that energy efficiency has that the books don't mention…….it is really, really boring. For most people, nearly everyone, it is tedious beyond belief. People just don't care about it. Unless we recognise this we are kidding ourselves. So how do we overcome this?

The answer I believe is non-energy benefits. We only really started thinking about the multiple non-energy benefits of energy efficiency a few years back. Non-energy benefits include, amongst many others:

- better comfort
- better health outcomes
- better employee productivity / reduced absenteeism
- better plant productivity
- increased asset value
- reduced need for capex in energy supply
- poverty alleviation
- improved local air quality
- and many more.

We need to consider the impact of non-energy benefits and how people make decisions. Even in the corporate and investment world, where economics are critical, it has been found that profitability is not the main driver of investment decisions and that financial evaluation tools only play a secondary role in decision making. The strategic nature of a project or investment carries a heavier weight than just the economics. If an action is considered strategic there is much less consideration of the investment return. Therefore we need to make energy efficiency more strategic. Non-energy benefits such as comfort, productivity, increased resilience etc. are the way to do this as they are much more strategic and therefore much more interesting than simple energy cost savings. Nowadays I always say to people developing efficiency projects, work out what is strategic to the decision maker and stress those strategic benefits, only as an addition say "by the way you will also save some energy costs".

There is an increasing amount of work going on around the world to value these non-energy benefits including several projects funded by the European Commission. Some are difficult to value but many have real and measurable value. Studies by the World Green Building Council and Rocky Mountain Institute have shown the value of benefits such as a reduction in sick days, higher asset values and reduced capex and build times.

To build better business cases we need to assess the value of energy savings, as we have always done, assess the financial value of non-energy benefits, and assess the strategic effect of the proposed investment. Putting these three elements together will make better business cases and better business cases help more capital will flow.

Of course I have been talking about capital investment in organisations. Individuals choosing houses exhibit some of the same characteristics. Evidence shows that people, and here we are talking about "ordinary" customers, not energy geeks or specialists, are sold on passive

houses because they increase the overall quality of life by providing a quieter environment, better air quality, greater comfort and longevity.

Now I am going to turn to making efficiency more investable. Energy efficiency is hard to invest in for lots of reasons including:

- there is a lack of standardisation
- the outcomes rarely measured
- there is uncertainty i.e. the risks are unknown
- projects are small compared to needs of institutional investors
- there is a lack of capacity in financial institutions and CFOs – but also in the supply chain and amongst decision makers
- traditional contracting models like Energy Performance Contracts don't actually work well – especially in the real estate, industry and residential sectors.

Several groups and analysts including the Energy Efficiency Financial Institutions Group identified that lack of standardisation in the way that energy efficiency retrofit projects are developed and documented is a barrier to investment. Michael Eckhart of Citi, one of the world's top "green bankers" said:

"Energy efficiency projects do not yet meet the requirements of capital markets. No two projects or contracts are alike."

Lack of standardisation creates several problems for investors. It:

- increases performance risk
- increases transaction costs
- makes it hard to aggregate projects – aggregation is essential because energy efficiency projects are so small compared to the "cheque size" of financial institutions
- makes it difficult for a financial institution to build capacity – if a bank wants to deploy capital into energy efficiency it is hard to build human capacity and scale without standardisation.

An important response to the lack of standardisation is the Investor Confidence Project (ICP) which has a project certification system, Investor Ready Energy Efficiency™ (IREE™), which is based on best practice, is transparent and has independent certification by quality assurance professionals. We introduced ICP and IREE™ to Europe from the US a few years back with the assistance of the European Commission's Horizon 2020 programme. The system is now up and running across Europe for energy efficiency projects in buildings, industry, street lighting and district energy. Its impact has been confirmed by Munich Re HSB who offer energy efficiency performance insurance. If you take them an IREE™ certified project they will offer a lower insurance premium and not require an independent engineering analysis (which the customer pays for), thus proving the thesis that IREE™ reduces risk and transaction costs.

I want to turn now to the role of banks and investors. There are four reasons why financial institutions should consider deploying capital into energy efficiency:

- it is a large potential market
- it can reduce risks in two ways:
  - improving the cash flow of clients
  - avoiding financing stranded assets
- it helps Corporate Social Responsibility
- banking regulations are increasingly looking at climate risks through bodies such as the Financial Stability Board Task Force on Climate-related Financial Disclosures (FSB TCFD).

The impact of risk reduction and the banking regulations will become more significant. If as seems likely banks will need to measure and declare their climate related risks it will drive banking behavior. Having a mortgage portfolio dominated by high energy consuming houses will be higher risk than having a portfolio dominated by low energy houses and that could affect regulatory capital and the stress testing that you hear about nowadays.

Banks and investors are paying attention to this. The International Investors Group on Climate Change, which represents investors with more than €21 trillion of assets under management supports energy efficiency. In Europe, as well as the work of the Energy Efficiency Financial Institutions Group we have a number of financial institutions that are leading the way. ING Real Estate, which has c.€50 billion lending to commercial real estate, has developed an app to help its borrowers assess the potential for improvement and offers higher Loan to Values for high efficiency portfolios as well as cheaper money for efficiency improvements. They see this as a) good business and b) reducing the risk of stranded assets as the Minimum Energy Efficiency Standards in the Netherlands progressively tighten.

Another important European initiative is the European Energy Efficient Mortgages Plan which is backed by the European Mortgage Federation, the European Covered Bonds Council and Horizon 2020. It is developing a standard energy efficiency mortgage for Europe. This is a challenge but will enable scaling which ultimately will allow refinancing through issuing green bonds, an asset class that is much in demand by institutional investors.

Finally I want to talk about creating a level playing field and a real market for energy efficiency. The market for energy is clear and functional, like all markets it is based on standard units, known risks, standardised contracts and liquidity. We often talk about the market for energy efficiency but I can tell you categorically there isn't one – there are only markets for stuff like boilers or insulation. I can call an energy broker or sit at a Bloomberg terminal and buy some energy in the energy market but I can't buy energy efficiency. That is a major barrier.

Now, with the advent of smart meters, cloud computing and big data we are starting to see the emergence of tools and regulatory systems that can create a real market for energy efficiency. In California now, and increasingly in other states, utility regulators are introducing metered efficiency and 'pay for performance' models where payments are based on actual metered results and not just on the basis of installing a piece of kit. We are now working with OpenEE, the pioneer of this approach, to bring it to the UK and Europe. We believe that it has the potential to transform the energy efficiency world by making efficiency a reliable, contractable, distributed energy resource that utilities can rely upon and easily invest in.

So, finally, looking to the future, I see that we are moving:

- from justifying energy efficiency on cost savings alone to justifying energy efficiency on the basis of its strategic non-energy benefits
- from a world where energy efficiency was considered to be "no risk" to a world where we understand the real risks of efficiency projects
- from a situation where basically efficiency is a pain to utilities to one in which it is a reliable, contractable distributed energy resource
- from a world where it is hard to invest in energy efficiency to one where it is easy to invest in
- from a global annual investment in energy efficiency of c.$250 billion to more than $1 trillion a year.

6.10 Financing energy efficiency. 14 March 2019

The beginning of a new year is always a good time to take stock of where we are in achieving our objectives in life and what we need to change to make greater progress. The same is true for energy efficiency and building renovation so let's begin by looking at where we are.

The good news from the **International Energy Agency's 2018 Energy Efficiency Market Report** is that global investment in energy efficiency grew by 3% to reach USD 236 billion in 2017, although the rate of investment growth slowed in all sectors which is a concern. Europe remained the largest source of investment, rising by 1%. Buildings accounted for 59% of total investment.

The challenge is that we have to do much better and greatly increase the investment into efficiency. To realise the IEA's Efficient World Scenario (EWS), one in which carbon emissions fall, we need to double the average rate of investment between 2017 and 2025 to USD 584 billion a year, and then double the average rate again between 2025 and 2040 to USD 1,284 billion a year. The cumulative investment between now and 2040 in the EWS is USD 24,514 billion. Table 1 summarizes the investment levels required in the EWS.

Table 1. Investment into energy efficiency required in the IEA Efficient World Scenario

Annual average 2017-2025 (USD billions)	Annual average 2025-2040 (USD billions)	Cumulative 2017-2040 (USD billions)
584	1,284	24,514

According to the IEA 30% of the total investment will have to go into buildings and 30% of that will be in the EU, suggesting some USD 2.2 trillion would need to be invested in EU buildings between 2017 and 2040. Various EU studies show the size of the potential and the problem in Europe. With 35% of the EU's buildings over 50 years old and the slow replacement rates, the renovation potential in the EU is huge, some **110 million buildings could be in need of renovation**. The total costs could be in excess of EUR 1 trillion. So we know what the target is but current levels of investment are much lower than where we need to get to.

Another positive development in recent years is that financial institutions are beginning to recognise the value and potential of energy efficiency. For many years it was ignored but the pioneering 2015 report of the Energy Efficiency Financial Institutions Group (EEFIG), convened by the EC and the UNEP Financial Initiative, as well as work by the G20 and others have increased interest – over 100 banks and financial institutions from more than 40 countries signed up to a statement that they acknowledged the unaddressed financing opportunities, would contribute to scaling up energy efficiency financing, and further embed energy efficiency principles into the way they engage with clients.

In more good news green banks around the world have increased their annual allocations for energy efficiency. In the expanding green bond market, worth USD 161 billion in 2017, energy efficiency's share of the disclosed uses of funds increased from 18% to 29%. In the US the use of Property Assessed Clean Energy (PACE) financing is also growing and by mid-2018 nearly USD 5.9 billion in energy efficiency measures had been financed by PACE programmes in the US, covering both residential and commercial buildings (C-PACE) but with 90% in the residential sector. PACE is being introduced to Europe by the **Euro-PACE project**.

As energy efficiency specialists and advocates we must pull all the levers we can to increase the levels of investment to those in the Efficient World Scenario as it is clear that the outcome will be a much better world, with falling carbon emissions, reduced air pollution, less fuel poverty, improved health and many other benefits. Increasing the levels of investment into energy efficiency on this scale is undoubtedly a challenge, but I believe that we are now beginning to understand the barriers and the levers that we can pull to achieve it. We need to really acknowledge the problems with efficiency as an investment and address them.

Those of us who advocate for improved levels of energy efficiency regard it as special for several reasons; it is the cleanest and often cheapest way of providing energy services, it offers high return, rapid payback projects which are often not implemented for a variety of organisational and structural reasons. However, we need to recognize a fundamental truth and that is for the rest of the world energy efficiency is not special at all – in fact it is boring. Energy is usually a small cost line for most building owners and operators. Also for senior managers making investment decisions there are many other more pressing decisions

which are linked to the organisation's core business, energy efficiency will always be lower priority than basic maintenance, production or marketing.

We do know that there are massive opportunities to improve energy efficiency in all areas especially buildings. Many, many examples from Europe and the rest of the world show that buildings can be retrofitted in ways that can reduce energy use by 30%, 50% or even 80%. Net zero energy use is the ultimate goal and is achievable but at significant cost. The European Buildings Performance Directive requires all new building to be Near Zero Energy Buildings (NZEB) by 2020. For existing buildings we need to recognise that the energy savings alone will not pay for the investment needed to get to anywhere near NZEB performance. We also need to recognize that building refurbishments happen at certain points in the building life-cycle, refurbishing on energy grounds other than as part of a major refurbishment is not likely to be optimal or even viable. We also need to learn how to build and present better business cases to decision makers.

For a financial institutions looking to invest in energy efficiency projects there are a number of barriers including:

- the fact that the economic benefit is a saving – a counter-factual compared to what would have happened without the investment
- energy savings are hard to measure – unlike energy production projects where you can meter output and charge a client accordingly
- a lack of data on the outcomes of projects
- projects are usually very small and need to be aggregated
- balance sheet treatment of assets which are integrated into buildings can be an issue
- there is a lack of standardization in the way that projects are developed and documented – financial institutions require standardization
- financial institutions lack capacity to assess energy efficiency projects – despite the high level commitments from many financial institutions at the operational level there is a lack of understanding and knowledge about energy efficiency.

These barriers within organisations and within financial institutions help explain why there is such a big gap between the potential and what we are achieving. These problems are beginning to be addressed in a number of ways.

Standardization is addressed by the **Investor Confidence Project** with its project Protocols and independent quality assurance system which certifies projects as Investor Ready Energy Efficiency™. Standardization also helps aggregate projects.

The lack of data on projects is being addressed by the **EEFIG database DEEP** which contains data on over 10,000 projects across Europe. Financial institutions can now review projects by sector, type and geography and hence build their confidence in the sector.

The lack of capacity in the financial sector is addressed by the **EEFIG Underwriting Toolkit** which provides a common approach to assess the value and risk of energy efficiency projects. It also provides a common language that project owners, project developers and financial institutions can use, something that has been sorely lacking. The newly reconvened EEFIG will be doing more work to spread the use of the Toolkit and build upon it as a training tool.

Better business cases need to be built but they need to go far beyond just energy savings. We now know that energy efficiency projects bring multiple non-energy benefits including things like increased productivity, increased occupant satisfaction, improved health outcomes and increased asset values. We need to recognise that all of these are much more interesting to decision makers than some energy cost savings and value them in our investment decisions. Valuing multiple benefits is the focus of **Horizon 2020 funded project Multiple Benefits**.

The **ABRACADBRA** project is a specific case of utilising multiple benefits to build better business cases. It is focused on utilising volumetric additions such as façade additions or

rooftop extensions which can add value to tenants and building owners and help finance near zero energy refurbishments. Having more space and amenities such as sun rooms is a real benefit to tenants and owners that is highly attractive, and the added real value they bring to the property can be used for financing improvements.

Although we have only recently started on the journey of increasing investment into energy efficiency we are already seeing the pieces of the jigsaw emerge. To reach the investment levels in the Efficient World Scenario and reap all the economic, environmental and social benefits that would bring, we need to put all the jigsaw pieces together into platforms that develop and implement projects that meet the needs of financial institutions and enable investment at scale i.e. in the billions rather than the millions. There are grounds to be optimistic.

6.11 Emerging models for energy efficiency finance. 2 Sept 2013

In previous blogs we have discussed the pros and cons of Energy Performance Contracting (EPC) as a mechanism to enable financing of energy efficiency investments and seen that EPCs have a number of issues and may not be suitable in all situations. In the EU the main focus of attention is still on fostering growth of the EPC market, (which to be clear is a worthwhile objective), but in the USA we are seeing a flowering of innovation in contract forms and financial structures. Some of these innovations have the potential to unlock a huge market and transform energy efficiency financing into a mainstream market, rather than the rather small niche market it is today. Here we take a look at the emerging contract structures.

PACE

Property Assessed Clean Energy financing (PACE) is a modification of an old approach to funding public goods. Benjamin Franklin invented the original concept in the 1700s to finance investment in sewers. PACE is a senior obligation which is on an equal footing with other taxes on the house and the system is still commonly used to finance sewers and projects to put utility wires underground. It is tied to the house and not the owner or tenant. PACE was first used in California and the first schemes were operated in two very different Californian markets, Berkeley – which has a mild wet climate and liberal politics – and Palm City which has hot dry climate and conservative politics – and it was a success in both markets.

Despite its subsequent adoption in 28 states and Washington DC and rapid growth, PACE in the residential market has been stopped by a controversial decision by the Federal Housing Finance Agency (FHFA) to limit its use in housing. Since then several states have started to implement PACE schemes in the commercial sector and these hold great promise. The potential for commercial PACE is estimated at $2.5 to $7.5 billion annually in 2015 with a total opportunity of $88 to $180 billion in large commercial buildings alone. The largest project to date, recently announced, is a $3.16 million retrofit to a four building, 250,000 square feet, office park in Sacramento California. The retrofit was financed through Clean Energy Sacramento, a city-wide programme backed by up to $100 million of financing from Ygrene Energy Fund.

Efficiency Services Agreement (ESA)

In the ESA structure, pioneered by Metrus, the agreement leads to the contractor being paid purely for savings on a price per MWh basis. This makes the client – contractor agreement much more of a services agreement than a traditional EPC and therefore can help in getting the project off the client's balance sheet. Metrus contract with service providers (ESCOs) who guarantee a level of savings to Metrus. Metrus have applied this structure to a number of sites including four sites belonging to BAE Systems and invested $8 million. It is now rolling it to other BAE Systems' sites in the US.

Managed Energy Services Agreement (MESA)

The MESA™ has been pioneered by SciEnergy. It involves the contractor taking over responsibility for the clients energy bill and the relationship with the utility provider(s). The building owner then pays the contractor the historical energy bills corrected for weather and other factors i.e. what they would have paid. SciEnergy invests in energy efficiency upgrades.

On-bill repayment (OBR)

On-bill repayment, where the repayment of capital is added to utility bills, is also growing but this is more of a collection mechanism than a type of financing, as it can be tied to various contract forms. Investment funds for many OBRs came originally from stimulus money or utilities mandated to invest in efficiency but there is a move towards attracting private investment. Work is typically carried out by a certified contractor who often introduces the client to the financing scheme. OBR has been mainly used in the residential sector but is now attracting attention in the commercial sector. In 2011 New York was the first state to enact state-wide OBR and offers finance at 3.49%. The New York State Energy Research and Development Authority (NYSERDA) is currently issuing $24.3 million of AAA rated bonds backed by residential energy efficiency loans – 35% of which were on-bill loans and the rest being direct with the householder. The UK Green Deal is a form of OBR with external financing provided through the Green Deal Finance Company and faces many of the same difficulties as OBR schemes in the US such as generating sufficient demand and the accuracy (or otherwise) of building energy models that are used to predict savings.

Measured Energy Efficiency Transaction Structure (MEETS)

MEETS is the latest structure to emerge and was developed by EnergyRM and applied to the Bullitt Foundation's "Living Building" in Seattle. It uses EnergyRM's "DeltaMeter™ dynamic baseline metering system" which is a system for measuring savings that has been approved by the utility industry in the Pacific North West. The client pays the agreed price per unit of energy as per normal and an agreed price per unit saved (negawatt hour) on a 20-year agreement similar to a Power Purchase Agreement. The advantage is that the repayment is linked to the building rather than the occupier and this allows a longer time-frame to be considered when looking at retro-fit options – allowing deeper retrofits to be financed. The system is well suited to US markets where the utilities are mandated to make energy efficiency improvements (which of course includes EU countries after the implementation of the Energy Efficiency Directive).

Conclusions

The US is seeing significant innovation in energy efficiency financing, prompted by the falling away of stimulus money over the last few years. Although currently small, these new contract forms have the potential to grow the energy efficiency financing market from its (2010) level of c.$14 billion (some $3 billion of which was stimulus money) to more like the $100 to $200 billion market some analysts predict it could become. Commercial PACE shows particular promise. With the exception of the Green Deal, which is an on-bill repayment scheme, we have yet to see these kinds of innovation in Europe, and some structures such as PACE are constrained by existing property taxation systems. To grow the market for energy efficiency financing to the level we know it could achieve, and the level we need to hit environmental targets, we need to recognise that EPCs are not the be-all and end-all and foster greater innovation in contract form and financial structure.

6.12 An inflection point for energy efficiency financing? 26 Feb 2014

There is a tangible sense of frustration at the slow progress being made in scaling up the European energy efficiency market. But traditional players need to learn from the more dynamic markets in the US or risk being overtaken by rivals with new business models.

The science fiction writer Arthur C Clarke once said: "New ideas pass through three periods: 1) It can't be done; 2) It probably can be done, but it's not worth doing; 3) I knew it was a good idea all along!"

Only Eleven Percent

The idea that energy efficiency can be a major factor in addressing environmental and economic problems, and benefit from its own major financing market seems to be somewhere in stage two – at least for those outside the space.

Now efficiency is rising up the policy agenda as practical cost and technical problems with low-carbon energy sources, both renewables and nuclear, become more obvious. There has also been increasing commitment from financial institutions to find ways to deploy money into energy efficiency. But at the same time the market remains small and the early participants report problems finding good projects, even in the US.

Right at the centre of this problem/opportunity is the ESCO industry which met in January for the 10th annual ESCO Europe conference, in Barcelona.

One of the problems with energy efficiency is the plethora of acronyms, and the first one to address is 'ESCO', the definition of which remains a mystery to many, including many in the industry. Different definitions abound but fundamentally an ESCO (energy service company) offers EPCs – energy performance contracts. EPCs guarantee a set level of energy savings, sufficient for the client to pay back any finance taken out to fund the capital cost of the energy efficiency projects, which are still often called ECMs – energy conservation measures.

The ESCO/EPC combination grew up in the US in the 1980s, and in Europe and elsewhere is often seen as a model to be replicated. Yet the EPC model in the US has largely been in the MUSH (Municipal, University, Schools and Hospital) and Federal government markets. Although it is growing, it is only worth $5 billion a year, with most financing being through municipal bonds and direct from federal budgets.

Attempts to transfer the ESCO/EPC model to the commercial sector have not been successful due to its complexity and high transaction costs as well as problems such as the split incentive. The current level of activity needs to be compared with a potential investment opportunity of $100 billion in the US MUSH market, (as estimated by the Lawrence Berkeley Laboratory) and what Deutsche Bank estimates to be a $280 billion investment opportunity across all real estate in the US. According to the International Energy Agency's first Energy Efficiency Market Report there was £300 billion of energy efficiency investment in 2011 and, given the potential still to be exploited ('the efficiency gap'), this could grow significantly. The World Business Council for Sustainable Development estimates that energy efficiency could become a trillion dollar market.

So, we have increasing policy attention on energy efficiency everywhere, we have more money being committed to energy efficiency, we know the potential is huge, and more deals are slowly being done. But there is an overwhelming sense of frustration that not enough is happening, and in the European ESCO industry that frustration is palpable.

Several sessions at ESCO Europe focused on how to transform the ESCO market, with presentations from across Europe. From these, and experiences in North America and Asia, it is clear that the issues are the same everywhere: small project size, insufficient volume to access the bond market, high project development costs, lack of capacity in both the customer base and financial institutions, and insufficient confidence in energy savings.

Measurement of savings has always been an issue for many, but we have had the solution for years in the shape of the IPMVP (International Performance Measurement and Verification Protocol), which is in use globally. A good ESCO contract will have a Measurement & Verification (M&V) plan audited by an independent M&V professional. The availability of near real-time measurement enabled by reduced cost of sensors and IT is reducing M&V costs. Organisations with good energy efficiency programmes should be measuring the results of their own efforts anyway.

The traditional ESCO/EPC model can work well in specific segments of the market and above a certain project size, notably the public sector, and it can bring many advantages other than energy efficiency, including infrastructure upgrades, catching up with maintenance backlogs, and reduced operations costs. In other market segments, such as

multi-tenant commercial offices it does not work, and the ESCO industry and finance industry need to acknowledge this and innovate new models.

There are signs that a wave of innovation and growth in efficiency financing is starting to build, mainly in the US where the use of financing models such as PACE (a charge on property tax), Efficiency Services Agreements (ESAs) and Measured Energy Efficiency Transaction Structure (Meets) are growing. The European ESCO industry and finance industry needs to learn from this rather than just focusing on the traditional ESCO/EPC model. If the incumbents don't recognise this they will be overtaken by new entrants with new business models.

One of the problems of energy efficiency financing is that the efficiency industry does not speak the same language as the finance industry. It was good that ESCO Europe brought in more sources of finance than ever before. From the public sector there was the EIB – which has made a big commitment to efficiency – the EBRD, which has always pushed the agenda in its area of operation, and the EU, which is supporting efficiency financing through its Horizon 2020 programme.

From the private sector it was good to hear from SUSI, a Swiss efficiency fund that recently closed a €65 million fund aimed at large building projects, and Joule Assets, a US company with a different model of financing residential retrofits, which **recently announced a $100 million fund**. We need to make more effort to bring together the efficiency and finance industries and evolve a common language, and that requires "mashing" them together.

Markets cannot operate without standardisation. A presentation by Matt Golden of the Investor Confidence Project (ICP), which is supported in the US by NGO the Environmental Defense Fund, explained how the ICP is developing protocols for different building types that set out standards for developing and documenting efficiency projects. It does not set out to design new technical standards – that task lies with the technical standards organisations – but rather to provide a common approach that investors can recognise and have confidence in. It reduces transaction costs, facilitates a portfolio approach, and allows different actors, project developers, insurance companies, investors, M&V specialists, to do what they do best rather than trying to address the whole problem. The Environmental Defense Fund is working with European partners to develop an ICP equivalent in Europe – a common approach would facilitate a global market and enable global investors to address efficiency.

It is clear from ESCO Europe that activity in efficiency financing is gearing up but many barriers remain. It is also clear that much of the energy efficiency and financing discussion focuses on what the public sector can do and implies that increasing efficiency requires increased regulation and complex centralised programmes. We need to move the focus to be much more about creating real markets that reward exploiting the efficiency resource by actually delivering megawatt-hours saved, rather than programmes in which governments specify expensive processes. This is the real problem with programmes such as the Green Deal and, its equivalent in California which was recently reported as costing $15,000 per customer who then made an average investment of $18,000 – such high costs are clearly uneconomic and unsustainable.

Financial markets are made by buyers and sellers coming together and agreeing standards and protocols. This happened in the energy supply industry many decades ago, in renewables from the 1990s, but is yet to happen in efficiency. If we can do that over the next few years we will create a trillion dollar market and have a major impact on environmental problems.

This piece was originally published in Environmental Finance *on 30th January.*

6.13 Too much money chasing too few projects? Thoughts from ACEEE FF. 25 May 2014

Some thoughts from ACEEE Finance Forum in Washington DC, 12th-13th May 2014.

For the third year running I attended the American Council for an Energy Efficient Economy's Finance Forum (ACEEE FF) which is the leading conference on financing energy efficiency. It is a great place to get up to speed on the latest developments in the rapidly changing US market for efficiency finance and this year I chaired an international panel to bring a wider global perspective. The following are some thoughts inspired by the event.

Firstly it is clear that 2014 is an inflection point in energy efficiency finance and as Marshall Salant of Citi said in the opening session the ratio of deals to conferences is finally getting better. This year we have seen several landmark transactions including the securitisation of WHEEL (Warehouse for Energy Efficiency Loans) residential energy efficiency loans and $100 m funds for Joule Assets and Kilowatt Financial. It now seems that until recently the challenge was bringing finance to the market but now it seems that the real problem may be creating sufficient demand to utilise the available finance. I have been saying for a long while that to massively expand the energy efficiency market and start to take up the massive potential we know exists, we need to scale up demand for energy efficiency goods and services, expand the supply of energy efficient goods and services, and expand the supply of finance flowing into energy efficiency from all sources, both internal money (I.e. Internal to the host organisation with the efficiency opportunity) and third party money. The provision of finance alone is insufficient to solve the problem. The analogy is that the fact that car manufacturers offer easy to arrange and often very cheap finance does not make people want to buy a car, we want to buy a car because we need a car to go work or whatever, or we lust after a particular car because we like the brand or in some hard to define way it meets some basic desire we have. The fact that finance does not mean people want to buy energy efficiency is reflected by the fact that several specialised funds that have been established in the UK and elsewhere are having trouble deploying money.

So an important issue is how to increase demand for energy efficiency. This requires a real understanding of markets and market segments. As one speaker at ACEEE FF said, the energy efficiency industry has always been woefully bad at marketing i.e. really understanding market segments and how purchase decisions are made. To build energy efficiency demand we need to really understand market segments, and that means segments way below the normal, residential, commercial, public sector split that most energy efficiency presentations talk about. Within each segment we need to really understand decision points and when interventions can be made. For instance there is little or no point trying to sell a major commercial building retrofit at any other point in the building life cycle than the point of major refurbishment. Property owners are extremely unlikely to undertake energy efficiency retrofits at any other point and so we need to focus on making sure these opportunities are maximised which requires capacity building in clients as well as property managers and architects and engineers. These critical decision points can also be influenced of course by regulation, if major refurbishments have to meet certain energy performance standards it will help drive demand but alongside regulation capacity building is needed. Likewise in the domestic/residential sector we need to understand and influence moments of intervention such as re-roofing or boiler/HVAC replacements in order to maximise the uptake of opportunities for improving energy efficiency.

Anyone contemplating design of energy efficiency finance programmes has to address demand and not just the supply of finance.

For several years people have talked about the bond market and securitisation for energy efficiency loans. With the first WHEEL deal we have now moved from theory to initial practice. There is, however, an awful long way to go before securitisation of energy efficiency loans is normal. Jack Bernard of Renewable Finance, who has had a long career in securitisation, forcefully made the point that the industry has to recognise the requirements of the securitisation industry and make products that look like products that serve other markets like

auto loans or credit cards. An interesting emerging securitisation market, worth some $5 billion in 2014, is the single family home rental market. This is now growing but faces some of the same data issues as energy efficiency, the market just does not have the years of loan performance data that other markets have. In the US market there is some 150 years of loan performance data and auto loans have been offered for nearly 100 years and so there is a lot of data covering the full range of economic cycles.

Securitisation clearly needs standardisation and that is where initiatives such as the Investor Confidence Project (www.eeperformance.org) come in. The Investor Confidence Project is a US initiative of the Environmental Defense Fund and we are now close to launching a European version. It has developed a number of protocols which cover the development and documentation of energy efficiency projects in different types of buildings. Standardising processes and documentation will improve investor confidence in the performance of projects and reduce transaction costs. The ICP is increasingly being specified by large energy efficiency programmes such as the Texas PACE programme and a growing number of investors and insurers.

So, we now seem to be at the initial stages of solving the finance problems. The shortage now seems to be the ability to develop large scale, multi-premise, energy efficiency programmes that are standardised and designed to take advantage of the available finance.

6.14 Making a market for energy efficiency. 25 March 2015

On the 17th March I was on a panel at a meeting of PRAESEG (Parliamentary Renewable and Sustainable Energy Group). The question being addressed was "Ahead of the Election in May, what should incoming government's priorities be for energy efficiency?". The other speakers were Dr. Nick Eyre, Dr. Joanne Wade, Simon Roberts and Catrin Maby, all of whom made great contributions with a lot of cross-over. Here are the notes for my remarks – which of course probably ended up somewhat different in practice.

First of all I should start by saying that we should never say or believe that energy efficiency is not working – the evidence is now firmly in and what it shows is that we have decoupled energy use from GDP and that over the last 30 years improved energy efficiency has provided more energy services than any other source of energy. We need to say that loudly and often so that decision makers really get it and move away from the near total domination of the energy debate by the energy supply network. The thing is, however, is that we have achieved all that without really trying and now we need to start trying harder.

What we need to talk about now is how to accelerate the improvement in energy efficiency – at the risk of using an inappropriate analogy it is like we are still in 2nd gear doing 10 mph on a B road and now we need to get into top gear and get moving on the motorway. The end result we want is an acceleration in the reduction in energy intensity (energy/GDP) as we all want a growing economy – having that growing economy with falling energy use is starting to happen and accelerating that decoupling of energy and GDP would help us achieve our energy goals of increased security, reducing environmental impact and having lower energy costs. And as we now know – but has not yet been widely recognized – improving energy efficiency brings with it many valuable co-benefits such as improved health, productivity or customer satisfaction. In fact the co-benefits are often worth more than the energy benefits – they just don't get recognized, measured or recorded. As well as standing up and shouting that energy efficiency is working we should always talk about co-benefits whenever anyone mentions energy efficiency. Indeed, in many situations the co-benefits will be more attractive to the decision maker than the energy and cost savings.

Governments over the past 40 years have been conducting a grand experiment with the energy efficiency industry in the belief that energy efficiency is something special that needs government action and that it can only be helped by public expenditure, some kind of grant or some kind of government designed programme. We have had government exhortation campaigns, additional taxes, cumbersome reporting schemes, energy company obligations

and clumsily government designed programmes like the Green Deal. These approaches smack of 1970s – or even 1950s – state intervention and just impose a cost – they don't create a real market for energy efficiency. They are all top down approaches and they will always be limited in their effectiveness.

At this point, we can say that the programme-centric approach to energy efficiency does not appear to be working fast enough, nor can it scale sufficiently. Furthermore, it is highly vulnerable to cyclical political changes, as we saw with the knee-jerk changes to ECO in response to Ed Milliband's announcement on freezing energy prices and the "green crap" comment. Even if the top down approach worked effectively it can never scale to the level needed given limits on public expenditure and sensitivity to energy price supplements. Even moderately successful scenarios will require an investment in energy efficiency that that vastly exceeds even the most optimistic assessment of available public funds but is easily within the bounds of the debt capital markets. The BPIE estimate that for Europe the required capital just to renovate buildings is €3.5 trillion across Europe, €90 billion per year. We have to design things to mobilize private capital. It is time to move away from the top down programme approach and try something different.

Energy efficiency is a resource just like any other energy resource. It delivers clear public benefits (in addition to enormous private benefits such as improved comfort and lower bills). It creates local jobs, reduces the need for new power plants, improves health, and moves us closer to meeting our emissions goals. We need to think about efficiency just like any resource. Getting paid for the value that efficiency resource creates is not charity; instead, monetizing these unrealized benefits simply aligns interests and pays for this distributed negawatt power plant by rewarding the homeowners and companies making the actual investments energy efficiency — just as if they were building new generation capacity.

Energy efficiency is the cheapest way of meeting energy services but in most cases – if not all cases – there is not a market for energy efficiency in the way that there is a market for energy. Energy generators can forward sell their projected output to get project finance – we need to make a market for efficiency that works like the market for energy. By creating a more transparent marketplace for energy efficiency, we can increase private funding, increase flexibility in delivery, and truly add efficiency to the pool of resources that will make up the future more dynamic energy system.

We have the elements now in terms of smart metering, low cost communications, low cost sensors and M&V protocols, to have energy efficiency meters. Energy efficiency meters are in development and we need to get these regulated just like energy meters and turn them into fiscal meters.

An essential part of building the market for energy efficiency is to standardize the process of developing and documenting energy efficiency projects – at the moment every developer does it differently – this is the aim of the Investor Confidence Project Europe which I chair. As well as project development we need to develop tools for measuring performance of efficiency projects – we have the basics – we need to measure the performance of projects in a standardized way and keep open data so that investors can see the results. At the moment there is an act of faith that it works.

We must engage private capital to invest in this emerging new market that will value energy efficiency as a reliable resource, and we must pay for these investments in the same way we finance power plants — through project finance that monetizes cash flows from savings, rather than the balance sheets of the building owner.

It is also important to talk about demand generation – we hear all the time about "low hanging fruit" – it is time to drop that analogy. A better analogy used by my colleague Matt Golden in the Investor Confidence Project is that the potential is more like wild strawberries, or perhaps in the UK case blackberries – it takes lots of people on their hands and knees a long time to fill a basket. Just relying on the inherent cost-effectiveness of EE is not sufficient – it is not working – there is very low demand despite the fact that energy efficiency is cost-effective. Just relying on programmes does not work either.

To help drive demand we need to reward people for what we want – reduction in energy use and increase in comfort in fuel poverty and not reward people for creating bureaucratic processes. These processes in top down programmes have to be defined centrally and end up imposing huge costs. In California for example the house retrofit business used to have a customer acquisition cost of a few hundred dollars, then when they introduced a Green Deal type of programme the average acquisition cost went to $14,000 while the average project capital expenditure was $14,000 – which is totally crazy.

The coming paradigm shift would not the eliminate the need for public and funding – particularly in the early days – and regulations to ensure a fair and transparent market, but it will require a different, simplified regulatory role – a role that looks essentially like the public sector involvement in every established market.

- ***Is the Government at risk of missing the full potential that energy efficiency can play in helping achieve its energy policy goals?*** There is a real danger around energy security at the moment. The UK's (and Europe's) energy dependency is getting worse which has geopolitical as well as economic costs. The UK government has been complacent on this issue, citing the fact that we don't buy any gas from Russia while ignoring the Russian coal imports and Gazprom's strategic investments in gas suppliers and pipelines. Energy security is another area where the use of traditional language limits our thinking on the subject. We don't actually need energy security, security over the physical flow of energy, but we definitely do need security of energy services. Thinking about the subject in this language expands the options and helps to bring energy efficiency into the equation.
- ***Does Government need to set out a more ambitious, coherent strategy to make the UK more energy efficient?*** Yes – we need to put energy efficiency truly at the heart of energy policy and make sure efficiency is truly considered as an alternative. One issue here is the historical reality that DECC (and all equivalents like the US Department of Energy) have a very strong historical link to nuclear power (50% plus of DECC budget spent on nuclear issues) and of course are subject to very strong continuous lobbying from the energy supply industry. It was only last year that the demand-side industry managed to get one person seconded into DECC for the first time. Maybe the demand side and energy planning should be entirely separated from DECC or its equivalent in order that modeling and decision making can be made entirely based on demand side modeling rather than supply side modeling.
- ***Are sectoral energy efficiency targets needed?*** Yes – we need to have an overall energy per GDP target broken down into sectors, then bring in the sectors to ensure they own the targets and develop sector specific and appropriate plans. The overall targets should be driven by reducing energy dependency.
- ***Is there a need to link energy efficiency policy with other demand side action, such as decentralised energy, demand side response, smart grids etc?*** A few years ago, with the CHPA (now the ADE) we coined the term D3 which stood for Demand Management (EE), Demand Response (DR) and Distributed Generation (DG). They are all demand side resources which need to be encouraged. Smart grid is a widely mis-used term – smart distribution systems and end use are tools to enable demand side resources but unless D3 is encouraged then smart grid is just a piece of technology, or lots of technologies, without much application and therefore once public money disappears the initiatives will disappear.
- ***Does the Government need to set in place longer term energy efficiency strategies for the business and public sectors?*** Long term stable strategies are always good for investors and industry players. We need a five and ten year target and frequent reporting against the target. Given the energy security situation in relation to Russia and the Middle East we may not have five to ten years but we need to get on with it. Importing >50% of our energy limits our degrees of freedom and is building in problems down the track. We need to use this period of low oil prices to increase

investment in energy efficiency. Relying on government programmes or supplier obligations means that they can't be stable.

- ***What might a revamped Green Deal and supplier obligation look like?*** Just pay for what we want which is a) reduction in energy use b) reduction in fuel poverty c) whole house approach – let the market innovate and decide. Don't favour any particular technology. On the supplier obligation just get rid of it altogether and replace it with payments for results. Charge a tax on energy suppliers, ring fence it and spend it on buying efficiency. Or require every supplier to always review demand side options ahead of supply side options.

These remarks were significantly based on a series of articles by Matt Golden.
Let's Get Real: The Energy Efficiency Industry Can Do Better
Why Top-Down Efficiency Programs Are So Expensive and What We Can Do About it

6.15 Assembling the jigsaw of energy efficiency. 8 April 2015

On 25th March I made the keynote address at DENEFF's (the German energy efficiency trade association) event launching the report on energy efficiency financing resulting from their EFFIN project. Here are the notes of my presentation – the slides can be found here.

Introduction and status report

I am very pleased and honoured to be invited to speak to you all at this critical time for energy efficiency and energy efficiency financing in Germany and in fact across Europe and the rest of the world.

Today I want to give a wide-ranging view of where we are on developing the energy efficiency financing market – globally -and my own views on what we need to do to grow that market to the levels that we know are needed to achieve our medium term energy goals around energy security and the environment.

As I will be speaking about the Investor Confidence Project Europe, which is supported by a €1.9m grant from the Horizon 2020 programme I am obliged to show this disclaimer slide – I will take it that you have all read it.

I want to start with a status report on energy efficiency financing:

- Those of us who have been working on energy efficiency for a long time have known that the potential for energy efficiency is huge. It is a massive untapped energy resource. Those of us on the inside have known that for decades but it is true to say that the scale of the potential has now been generally recognized. That is a step forward
- The co-benefits of energy efficiency – and by that I mean all the other benefits that come with energy efficiency other than just energy and cost savings – are now increasingly recognized. There was some great work by the IEA on multiple or co-benefits last year which I highly recommend. We still have a way to go on recognizing and valuing co-benefits but things are improving in that respect
- We have growing interest in investing in energy efficiency from institutional investors. This is good news
- However, despite these positive developments the growth of the energy efficiency financing market has been slow. Not just in Europe, but in North America, Asia and everywhere else that I go I encounter the same sense of frustration that things are not happening as fast as they need to

As one of the bankers in the USA trying to do stuff in this market said: "the trouble with this energy efficiency business is that the ratio of conferences to deals is too high".

If we think for a minute about what a healthy European energy efficiency market would look like – if everything was rosy – it would have the following characteristics:

- strong demand from building owners and investors for energy efficiency retrofits
- a highly skilled and accredited workforce
- a mix of financing products at different rates
- standardized tools for tracking and quantifying savings
- and finally a secondary market that the primary investor can sell onto – ultimately the debt capital markets.

Right now we don't have those characteristics – and in fact I don't think we have them in any market anywhere in the world.

The jigsaw of energy efficiency financing

Now, this is not one of my holiday photos that slipped into my presentation. Last year I went to Neuschwanstein Castle for the first time ever and I really enjoyed it – although on the day I visited there was so much cloud that we could not see the Castle from the ground.

My mother who is 82 likes doing jigsaws and so when I was at Neuschwanstein I bought her a jigsaw puzzle and this is as far as she has got (up until last Sunday at least).

Looking at the energy efficiency market makes me think of a jigsaw and it has at least six pieces – it is just as well it does not have 1,000 pieces:

- product offerings from the energy efficiency industry
- standardization
- the development gap
- supply side capacity building
- demand side capacity building
- and capacity building in the financial institutions.

I want to say something about each of these but I will start with standardization because that is the area that the Investor Confidence Project is active in.

Now we all know that standardization is essential if you are making cars in a factory or washing machines or in fact any other manufactured product.

Of course people forget that banks are also factories – banks and other financial institutions cannot operate at scale without standardization. Every financial market, whether it be mortgages, car loans or credit cards, needs standardization.

It is not just me saying this. I know that some of you are very familiar with the EEFIG report and indeed some of you contributed to it.

The EEFIG report concluded that standardization was a key factor affecting both the demand and supply of energy efficiency financing.

The Joint Research Centre of the Commission also came to similar conclusions and also highlighted:

- high transaction costs
- the difficulty of predicting savings
- the lack of standardization.

Michael Eckhart, the head of Finance & Sustainability at Citi said it very well when he said:

- "energy efficiency projects do not yet meet the requirements of capital markets"
- "no two projects or contracts are alike"
- "say you have 1,000 energy efficiency projects, Standard & Poor's would have to read 1,000 documents to assess the risk. Fees won't pay for that level of review."

And finally the IEA concluded that standardization was important and that the Investor Confidence Project could "facilitate a global market for financing by institutional markets that look to rely on standardized products".

Energy efficiency financing compared to energy financing

To sum up let's look at the whole area of energy financing – and I mean energy financing not just energy efficiency. This is what I see.

For oil and gas projects, if you happen to own an oil or gas field, the ways of developing and documenting the project are standardized. You have to hire a Competent Person who will be a geologist and who will follow strict guidelines set down by groups like the Society of Petroleum Engineers and if you have an oil and gas company floated on a stock exchange then the use of certain standards is required by the exchange itself. Oil and gas financing is entirely mainstream. There is a large volume of money available for oil and gas projects from a wide range of sources – although of course this may reduce with the divestment movement.

Now let's look at renewables, solar and wind. 25 years ago when I did some early wind farm projects in the UK the same was not true of renewables, we made it up as we went along and there was only one bank in London we could go to – and they pretty much made it up as they went along. Nowadays of course funding renewables is as standardized, and almost as mainstream as oil and gas and you can go to multiple sources for money.

However, when we look at energy efficiency projects, here represented by the Empire State Building retrofit project, we see something completely different. Processes and documentation are NOT standardized, it is NOT mainstream, there is only a small amount of lending/investing going on and there are only a few sources you can go to.

The Investor Confidence Project

So let's consider the Investor Confidence Project which is a direct response to the lack of standardization. I want to give you a flavour of the Investor Confidence Project, what it is and what has been achieved in the US, and then talk about the Investor Confidence Project Europe project. Our German representative, Dr. Frederic Brodach of Plus Ultra, is here today and he will be able to talk to you about the project in German and give you more details today or in future.

As we have seen there is currently a lack of standardization on the way that energy efficiency projects are developed and documented. Here we see three different projects that use three different routes through what we call the alphabet soup of different standards and practices.

The lack of standardization imposes several negative things:

- greater performance risk
- higher transaction costs
- financial institutions cannot build capacity around ad hoc processes even if they do want to invest in this area
- financial institutions cannot aggregate projects, aggregation is essential because we know that energy efficiency projects are small compared to the needs of the institutional investors. To get to the debt capital markets and access cheap money we need to aggregate projects.

The Investor Confidence Project Energy Performance Protocols organize the process into the different stages of developing and implementing a project and for each stage define the standard or combination of standards and best practices that should be used. It is not about writing new standards but rather about standardizing the process – organizing the alphabet soup to give more uniformity.

The Protocols are developed working with financiers, building owners, project developers, government agencies and utilities. It is an open source project co-created by the contributors.

In the US six Protocols have been launched and are now being applied in real projects and programmes. They cover different sizes and types of projects in commercial and residential buildings.

As well as Protocols the Investor Confidence Project is also developing accreditation for Project Developers, and they now the first eight accredited developers. There is also a programme of accrediting software, that is project development software that automatically follows the Protocols. In the US they have six accredited software providers and I can tell you that we already have two European software providers working on software that will be ICP Europe compliant. Finally there is a Quality Assurance programme and very soon the ICP will announce its first QA providers in the US.

All of these components come together to make a project "Investor Ready Energy EfficiencyTM". The final output is a badge, a seal of approval. When we talk to investors, including some of Europe's largest real estate investors and lenders they say that is what they want – a stamp that gives them confidence that a set process has been followed every time.

So let's look at the Investor Confidence Project Europe. In our project, which is supported by Horizon 2020, we are focused on getting early adoption of European Protocols in five countries: Germany, the UK, Portugal, Austria and Bulgaria. We will go beyond those countries – and already are – but they are our immediate priorities under the grant.

We have an Investor Confidence Project Europe Steering Group which provides direction and oversight and includes some of Europe's largest energy and efficiency companies, major lenders and investors, important trade associations representing the energy efficiency industry, and government agencies.

We also have a network of nearly 50 allies already. Please sign up on the website – **www.eeperformance.org/europe**

It does not cost you anything and gets you in the conversation.

Note these two red boxes – this is an example of how the Investor Confidence Project has already helped put projects in touch with an investor. SEA, an Italian ESCO, was looking for an investor in residential projects and we put them in touch with Joule Assets, a US investor now active in Europe.

The Investor Confidence Project Europe is in three phases:

- creating the tools
  - protocols
  - accreditation
  - labels
  - open data
- take the tools to market
  - private investors
  - public programmes
  - developers
  - property owners
  - utilities
  - associations
- be a catalyst for change by:
  - inspiring action
  - connecting projects to capital
  - creating working examples of functioning markets for energy efficiency finance

Capacity building on the demand side

Now let's go back and look at the other parts of the jigsaw – starting with capacity building on the demand side. We have to acknowledge that lack of demand for energy efficiency retrofits is a problem that we have to address. Generally people do not wake up in the morning and say they want to buy some energy efficiency.

We also have to acknowledge something that is hard to accept for those of us who have spent our lives in energy efficiency. Energy efficiency is just boring – for most people most of the time it is extremely dull. People are not interested in energy efficiency or if they are it is only for a fleeting moment now and again. Only when we recognize that can we move forward.

One the most promising ways of making energy efficiency less boring is to talk about the layer cake of benefits that come from energy efficiency. It is always good to talk about cake – especially in Germany. Those co-benefits, or non-energy benefits, occur at different levels; in the energy supply system, in the participant or host, and in society at large. Here I am only concerned with the benefits to the host, the project owner.

These benefits include things such as; improved productivity, increased retail sales, increased quality and reduction in hours lost at work, and they are increasingly being recognized and they are just starting to be measured in a few leading edge organizations. The important thing here is that often the value of these benefits will be much larger than the value of the energy savings alone. Also they are often more likely to lead to a management decision to invest in energy efficiency. For example, when a retailer recognizes that LED lighting retrofits lead to an increase in sales (as some have done) and starts to value that benefit, you can be sure that energy efficiency rises up the management agenda. That subject will be on the board agenda, things will happen.

Capacity building on the demand side should include ISO50001 – which is great for putting in place an energy management system, the importance of valuing the co-benefits, the massive benefits that can come from true integrated design, and consideration and evaluation of outsourced energy services that bring with them external expertise and finance.

Mind the development gap

Let's talk about the development gap. Anyone familiar with the London Underground will know – we have an expression "mind the gap" – which means don't fall down the gap between the train and the platform. The gap I am talking about is the gap between potential projects and bankable, actionable projects. We know the potential is huge but still there is a lack of high quality bankable projects, particularly at large scale.

To overcome the development gap requires:

- vision about what is possible at the top level
- technical and financial skills – particularly around the issues of portfolio optimization and sub-project interactions
- finance – developing projects, especially big projects, costs money, money that is at risk
- standards – we need to develop multi-building projects all using the same standards which is where the Investor Confidence Project comes in.

We need to learn how to develop these kinds of projects, how to finance the development process and how to increase the rate of project development. In energy supply projects there are established ways of developing and financing the development process but we don't have that for large scale energy efficiency projects. There is real potential here in cities for instance, which can bring scale quickly, but financing the development process is difficult for cities with tightly constrained budgets.

Product offerings

Let's talk about the product offerings from the energy efficiency industry.

Let me say that Energy Performance Contracts are not the answer that some people seem to think they are. It is a model that evolved to meet the needs of a particular market segment (public sector) and originally to exploit certain sources of finance that are available in the US – Federal money or municipal bonds. The EPC model has never grown to the extent that people thought it should but when you analyze it there are good reasons including:

- debt is on the balance sheet of the host
- debt is constrained by mortgage covenants or finance structure
- the guarantee is not a credit enhancement
- transaction costs are high
- they don't address the split incentive.

In summary they may work in the public sector but they don't work in the commercial sector. For too long the energy efficiency industry, new entrants and some policy makers have pushed EPCs as if they are the answer to everything – let me tell you that they are NOT.

Innovation is appearing around the world in the form of services agreements such as ESA, MESA and MEETS and we need more innovation like that.

Building capacity on the supply side

On the supply side we need to build capacity in different ways. The energy efficiency industry needs to learn to work with the finance industry right at the start of the project, not just at the end. As I have said we need to learn how to develop projects at scale and be innovative. Most importantly the energy efficiency needs to understand markets better and sell co-benefits. Traditionally the energy efficiency industry has been very bad at understanding the market's real needs and motivators and has relied on the rationality theory; "it is a two year payback period project and therefore you should do it – it is a no brainer – it is low hanging fruit". Well, as the real marketing experts know, people are not rational.

Building capacity within financial institutions

Within financial institutions we need standardization and capacity building on:

- the co-benefits – what they are and how to value them
- technologies
- contract types
- standards
- available support for development and project work such as EC or national programmes.

Assembling the jigsaw

So now we have considered each of the pieces in turn we have to put the whole jigsaw together.

By the way, you can use a laser cutter like this one to make very precise jigsaw pieces but if you don't have all the pieces you can't finish the jigsaw. Work on all the pieces together. I think many of the programmes around the world have focused on making one or two very precise pieces but not thought about the other pieces of the puzzle, and then they have problems deploying money.

A few words on policy

I was asked to comment on policy in this area. I am always reticent to talk about policy in other countries but I have some general views that apply everywhere. They are as follows:

- Reward all the value streams i.e. all the value that is created by energy efficiency projects, not just the energy component
- Design the energy market to value and pay for all the benefits
- Consider benefits that cut across normal Ministry or departmental boundaries e.g. spending money on energy efficiency can save money in health budgets. In the UK we are experimenting with doctors prescribing insulation or new boilers to people who are in fuel poverty and as a result have lots of health problems. It actually works, spending health budgets on insulation actually saves money because after the works are done, the people visit the doctor or the hospital less frequently. Institutionally this is difficult to do but policy makers need to make it happen
- Ensure that supply-demand decisions are balanced e.g. network operator regulations. In the UK the DNOs acknowledge that in some cases investing in demand side measures like energy efficiency and demand response is more cost-effective than investing in supply side infrastructure upgrade projects such as putting in bigger cables. However, the regulations have not caught up with this and the DNOs are still only incentivized to invest in supply side assets. If we can change that it will have a large effect
- We need to move away from top down programmes towards creating a real market for energy efficiency. For forty years governments have been carrying out a big experiment in energy efficiency based on the notion that it is somehow special and needs exhortation, public subsidies, energy company obligations or top-down bureaucratic programmes. We need to move towards creating a real market for energy efficiency and we are starting to see the tools for that appear such as Measurement & Verification, new contract forms and the Investor Confidence Project
- Stable policies or clear policy trajectories are always good. In the UK we have had examples of policies being changed at short notice for short term political expediency. That does not work

The future

So what about the future? This by the way is a German cigarette card from the 1920s or 1930s which shows two ladies who appear to be using Skype on an early form of iPads! Amazing. If anyone can get me an original set of those cards I would be grateful.

1920/30s cigarette card – one of a series portraying the future

So back to my jigsaw. I am positive and I think we can complete assembling this jigsaw.

What would it look like when we finish the jigsaw? We talked earlier what would a healthy energy efficiency market would look like and how we don't have that now – clearly if we do build the jigsaw we will have those things in place and there we can focus on other problems.

At that point energy efficiency financing will look just like energy supply financing – it would be:

- standardized
- mainstream
- large volume
- and be available from multiple sources.

In short there would be more deals than conferences and that is a future I would like to live in.

Thank you very much. I look forward to talking to you further and working with you in future on the Investor Confidence Project Europe and putting together the other parts of the jigsaw.

6.16 Financing energy productivity growth. 25 Oct 2016

Between the 18th and 20th October I was fortunate to attend the 7th Forum on Energy for Sustainable Development in Baku and to present a short summary of the work at KAPSARC on financing the transition to high energy productivity growth. It was great to visit Baku which is one of the real birthplaces of the oil industry. The first oil derrick was built there in 1871 – only 12 years after Drake struck oil in Pennsylvania – although there is evidence that Baku's oil was used in the 3rd and 4th centuries and it was referred to by Marco Polo (1254 – 1324). It is a very interesting city, particularly the old town.

As usual when I report my presentation this is the ideal, cleaned up text of my speaking remarks and may not reflect my actual words on the day.

Good afternoon everybody. I wear several hats, all to do with financing energy efficiency and as you heard earlier from Panama one of those hats is the Investor Confidence Project. Today though I am wearing a KAPSARC hat.

Yesterday Nick Howarth introduced the KAPSARC work on energy productivity. In the interests of time I am not going to rehearse the arguments for using energy productivity as an indicator but I will stress one thing on this slide: "significant capital investment is needed to transition to higher energy productivity growth". Everyone can agree that we need to accelerate the rate of improvement in energy productivity (or efficiency) to achieve climate goals, we heard earlier someone say we need to accelerate the rate of improvement to 4% per annum from current levels of 1 to 1.5%. This acceleration requires significant increases in the investment going into improving energy productivity.

So how do we do that? Firstly we need to understand the different types of investment that drive improvements in energy productivity. There are four types.

Energy efficiency retrofits – these are the investments in things like LEDS or new Building Management Systems that are added to an existing building, industrial facility, transport system or energy facility with the purpose of improving energy efficiency. It is these investments that much of the energy efficiency industry and most energy managers are most concerned with. They are important but they are only one small part of the big picture.

Next we have ***investments that refurbish buildings or industrial facilities*** where the main purpose is not energy efficiency. It is something else like bringing a building up to date to make it more attractive to tenants. One of the best known energy efficiency case studies of recent years was the Empire State Building project but this was widely mis-understood. The main project was a $500m refurbishment to bring the building into the 21st century and combat declining rental income. The energy efficiency parts were an add-on, and a very good example of what can be done and opportunities that are being missed every day of the week as building and industrial facilities are refurbished with no real attention being paid to energy efficiency. It is true of course that refurbished buildings tend to be more efficient than unrefurbished – although this is not automatically true – they may use more energy as improved services and comfort levels are achieved.

Next we have ***new build, buildings, industrial facilities, transport systems or energy systems***. Again new facilities tend to be more efficient than old ones – especially as building codes and Minimum Energy Performance Standards on things like electric motors come into force, and technologies just get better. However, as in refurbishment projects many, many cost-effective energy efficiency opportunities are being missed every day. Project owners have other objectives, speed, minimum capital cost etc – and often a lack of knowledge of what can be done with just a little more thought and effort at the design stage. On the supply side engineers and designers tend to repeat the conventional designs even though they are not optimum in terms of energy efficiency.

Finally we have those ***investments that change the structure of an economy towards a less energy intensive mix of activities***. Examples would be a Middle Eastern country investing in a car assembly plant, or a shift towards financial services.

The first type, energy efficiency retrofits, I call "energy efficiency investments", the others I call "normal investments". These are investments that are happening every day of the week – as we speak investment committees and boards are making decisions to invest in these kinds of things all over the world. And in many, if not nearly all, of these cases, the potential for cost-effective energy investment is not being taken up and therefore we are locking in a higher energy future than we need to. We need to maximize the use of all these cost-effective opportunities – so how do we do that?

At KAPSARC we have summarized some of the possible tools to increase investment in both energy efficiency and normal investments. So let's start with the energy efficiency investments category.

For energy efficiency investments for many years the energy efficiency industry has complained that the problem is a lack of investment and in response to that, in many countries, specialized energy efficiency funds have been set up – mainly with public money but increasingly private capital. What we have learnt is that providing money for projects is not enough – you need four elements in what I call the jigsaw of energy efficiency finance:

- Finance – project finance but also development finance, the really risky money that is used to develop projects to the stage at which project investors can invest
- A pipeline of well-developed bankable projects. We all know the potential for energy efficiency is huge but there is a massive gulf between potential and real, well-developed bankable projects
- Capacity building – especially in the financial sector which is new to all this stuff, but also in the supply side (the efficiency industry so they know how to deliver bankable projects), and the project hosts so they know what is possible
- The lack of standardization has been identified as one of the major barriers to more capital flowing into energy efficiency. Standardization means standardization of the development and evaluation process (that is where the Investor Confidence Project comes in), standardization of contracts, and standardization of Measurement and Verification. Without standardization you cannot have functioning markets

As I said earlier, traditionally energy efficiency has been thought of as something that is the province of public finance but there is increasing interest from institutional investors in energy efficiency. It produces safe yield and can work without subsidies. In countries like the GCC where energy prices are low the split of benefits between governments and end-users is different than that in countries with high energy prices – this suggests Public Private Partnerships may be appropriate mechanisms.

Everywhere there is growing private investor interest in energy efficiency but everywhere, even in the US and Europe it is a nascent market.

So to maximize investment into cost-effective energy efficiency opportunities we need:

Specialised funds – which recognize the need to have all the pieces of the jigsaw I referred to above. There are good examples of funds all around the world now, albeit mainly using public funds.

ESCO-EPC facilitation – ESCos and EPCs were referred to by an earlier speaker. They are an important component but as I have said many times they are not the be all and end all solution some people seem to think. They work well in certain situations – particularly in the public sector. We do need to facilitate and grow the ESCO-EPC market and again there are great examples of how to do this around the world including: RE:FIT in the UK, the Berlin Energy Agency's work over many years, and in the GCC the Etihad Super-ESCO which is a world class example.

Then we need to put in place the ***market infrastructure,*** the standardization I described above but also evidence bases to help de-risk energy efficiency for the financial sector, and capacity building at many levels.

By the way, all of these tools are of course supported by "normal" energy efficiency policies like strong building codes and MEPS, and building energy management capacity through ISO50001.

Now let us look at "normal investments".

One of the easiest measures is to ***adjust the investment criteria of existing public investment infrastructure funds***. Many countries have public investment funds that invest in new buildings, factories and infrastructure of all types. They are often deploying billions of dollars. By incorporating energy productivity into their investment criteria of these funds we could capture more of those cost-effective opportunities that are currently being missed and have a big impact. As well as changes to investment rules, for example including the requirement for a new building or facility to be in the top quartile, or even top decile, of energy productivity, technical assistance can be provided to help project hosts identity and develop cost-effective improvements to their base designs. These base designs are usually more efficient than existing buildings or factories because of tightening codes and better technology, but they almost always miss cost-effective opportunities to go beyond Business As Usual – something that we really need to do. This is the approach used successfully for many years by the EBRD to incorporate energy efficiency into all investments. It has two effects, it helps improve cash flows for the project host, thus reducing risks, and it increases loan amounts for the fund – helping capital deployment.

As well as using existing funding mechanisms it is of course also possible to ***create new funding vehicles*** specifically aimed at improving energy productivity. These can be financed through green bonds (although this requires scale and standardization), or Sharia' complaint funding. A green bond or green sukuk financed umbrella fund could be created as part of sovereign wealth funds with pockets aimed at different types of projects. Creating a new fund or vehicles though is always more difficult that adjusting those you have already. On the plus side they have a clear focus.

A more radical idea we are working on is the ***negabarrel market***. For oil producing countries a barrel of oil saved domestically has several positive economic effects, it reduces government spending on energy subsidies (where these are still in place) and it frees up a barrel for export or for higher added value purposes such as petrochemical production. The monetary value of these benefits to the government can be calculated and a price per negabarrel set. If negabarrels can be delivered by project developers at less than that price – either through energy efficiency investments or through high energy productivity normal investments – it is worth the government buying negabarrels from the market. This incentive will encourage the development of high energy productivity projects and provide extra revenue to project hosts to offset any additional capital costs (although additional capital is not always required). There are issues of measurement and verification but these can be overcome with clear transparent standards and modern M&V techniques.

At KAPSARC we have assessed the likely impact and the difficulty of implementing all these tools. The easiest, large impact measure would undoubtedly be changing the investment

criteria of existing funds to include energy productivity targets and providing technical assistance to identify opportunities for improvement within normal projects. At the other end of the scale in terms of ease of implementation is the negabarrel market concept.

You can read much more detail in the **KAPSARC paper**.

So to conclude:

- we need to massively ramp up investment into energy productivity,
- to do that we need to increase investment into pure energy efficiency projects and ensure "normal" projects go beyond Business As Usual in their energy productivity.
- there is growing interest in investing in energy efficiency from institutional investors which can be tapped into, ultimately through the green bond or green sukuk markets.
- governments can take a range of measures to maximize investment into increasing energy productivity ranging from the simple adjustment of investment criteria for existing infrastructure funds through to creating a negabarrel market.

If we can implement some or all of these ideas I think we will be surprised how fast we can accelerate the improvement in energy productivity.

7 Technology

Technology is all around us and often ignored until it goes wrong. Improving energy efficiency and the energy transition is often thought to be a technical problem, but it is much more than that, being more about the multi-dimenstional interplay between available technology, economics, finance, policy and people. At the same time technology is always fascinating, it can be both a demonstration of our intelligence and our foolishness.

7.1 The ghost in the machine. 27 July 2015

News this week that Chrysler were recalling 1.4 million cars because they are vulnerable to hackers taking control of dashboard functions, steering, transmission and brakes was somewhat alarming given widespread enthusiasm over the Internet of Things (IoT) and driverless cars. The Sunday Times followed up with an article saying that hackers would be able to use smart fridges to access smart home networks and hold people to ransom in the same way they do with computer hard drives – pay up or we crash your smart home. Although journalistic this article did raise some serious issues about the security of smart devices and smart systems – the emerging internet of things (IoT).

Much of the discussion around the IoT has an energy focus, smart and interlinked thermostats like the Nest are part of IoT and now every light fitting in a building, and now even **every light bulb**, can be internet enabled. The benefits for energy saving and maintenance can be very large and no doubt this kind of application will grow dramatically because of those real economic benefits. This trend is part of the fusing of energy supply and energy demand that is disrupting the energy market everywhere. In the past every energy using device was simply a fixed load and the electricity supply network had to deliver enough power to meet the load at all times. Variation of load was simply an addition of all the fixed loads that were on at any time. Now with IoT enabled devices each individual load can potentially be varied or switched on or off, and of course linked directly to supply network intelligence, enabling a more dynamic, two way interplay between supply and demand.

At the International Energy Research Centre's conference in Cork in May there was an interesting session called "the internet of energy things" (IoET?). I took away the idea that the IoET is a sub-set of the IoT which impacts on the energy sector. (It is almost certainly the largest subset although there can be non-energy using IoT enabled objects). Now, as well as the things in the energy generation, transmission and distribution system, (which tend to be big bits of kit), joining the IoET we are now seeing more and more (small or even tiny) end-user energy using devices also joining the IoET – adding to the complexity of what is already our largest machine, the electricity system. At that meeting I did raise the issue of security of the IoET, citing the infamous **Stuxnet virus** which was used to infect Siemens motor controllers which were attached to centrifuges in the Iranian Natanz Nuclear Technology Centre which were enriching uranium, possibly (probably?) for use in a nuclear weapon. If someone can use Stuxnet to take out centrifuges in what is presumably Iran's most secure facilities, (by the way the Siemens motor controllers weren't even connected to the internet the virus was put into computers inside the plant from a USB stick), the risk to internet enabled devices in the energy system has to be serious.

There is no doubt that the benefits of the IoET could be huge in terms of energy savings and more dynamic markets, but the issue of security is critical and I am not sure it is receiving the attention it deserves. Of course there is always the possibility that it is but we never hear about it for security reasons. Anyway, we definitely have to add cyber security to all the other growing risks to the energy system.

7.2 Ad agency buys thermostat company. 20 Jan 2014

The acquisition of Nest by Google for $3.2 billion only three years after being founded made the specialist cleantech press and even the mainstream press last week. Nest, is the

developer of the Nest thermostat, a product that changed the thermostat market by being the first thermostat to be "cool" and one of the products on my **Energy Efficiency cool wall**.

The Google Nest deal is interesting for several reasons.

Firstly it is a Trojan horse product for the smart home. Smart homes have been talked about as long as I can remember but to date three things have been missing, the technology hasn't really been there, the infrastructure hasn't been there and there hasn't been a cool product that excites people enough to make them buy it. Nest changed that with a thermostat that looked cool and does some clever things as well as being connected with the internet. The fact that a $249 thermostat sold out and created a public buzz in its early days is amazing, a cool thermostat. Take a look at your thermostat or heating control at home, it is almost certainly anything other than cool and probably isn't even very effective. How often do you touch it? Do you know how to programme it? Is it attractive? Nest changed all that and effectively created a new market.

Nest also enables demand response and in the US various utilities are using Nest at the centre of demand response programmes, see **this** for example. Google brings its massive IT infrastructure to Nest. Its skill and resources in big data processing will certainly enable new ways of understanding energy demand in much more detail and the aggregation of demand side (both demand response and demand management) measures into significant scale – allowing new business models that will further threaten energy suppliers.

Another aspect of the Google Nest deal, which made a lot of money for the original VC investors, was its likely influence on the wider cleantech investing market. The irony was that it happened in a week when the influential TV programme in the US, "60 Minutes", ran a **piece** talking about the "death" of clean tech. As always life is more complicated than the media portray. Cleantech is alive and well, albeit in a different form to how it used to be seen, with a focus on resource efficiency and capital light innovations (including business model innovations) rather than capital heavy and very long-term energy generation technology innovations. The theme of energy and resource efficiency has to be a great investment theme for the next couple of decades, whatever happens in energy supply. The nature of innovation and venture investing of course is that there will be failures – think about how many failures there have been around the internet – particularly in the internet bubble of the 1990s. And as for "60 minutes" comment on the arrogance of silicon valley VCs – what can you say, they do tend toward arrogance but they changed the world.

On as lighter note I did enjoy Greentechs "top twitter reactions to Google buying Nest". My particular favorites are shown below. Inclusion of the tweets here does not constitute agreement with the opinions expressed.

Ryan Block (@ryan): Oh PS with Nest's built-in sensors now Google knows when you're home, what rooms you're in, and when you're out. Just FYI.

Michael Nagy (@thenagman): Nest also changing name to NSAest

Lawson Kight (@lawsonkight): Ad Agency Buys Thermostat Manufacturer

Chris Nelder (@nelderini): They know when you are sleeping. They know when you're awake. They know if you've been bad or good, so be good for goodness' sake!

Annie (@bloodlesscoup): #GlennBeck predicted that the Feds would control/know your thermostat 5 yrs ago. Not so stupid now huh?

Esquire Magazine (@esquiremagazine): Google's Nest purchase means it probably wants to take over your home. But wait, wasn't it already doing that?

Sam Faulkner Biddle (@samfbiddle): If your house is burning down you'll now get gmail ads for fire extinguishers.

PS – My Nest, which I have had for two years thanks to John Picard, sits on my desk – the consequences of living in a 1900s apartment block where the heating is communal and the controls consist of radiator valves and windows. It is a cool paper weight though.

7.3 #Electrifyeverything. 5 March 2019

I must admit I used to be a sceptic of the call to "electrify everything" but then that was back in the days when the carbon intensity of the UK electricity system was c.500 gCO_2/kWh whereas now that intensity is down to c.250 gCO_2/kWh. I also have to admit that I have been a sceptic on heat pumps and guilty of falling foul of one of the 'human' barriers to better energy management I identified back in my PhD in the early 1980s, i.e. a bias against a technology resulting from out of date experience, in this case the view that heat pumps were over-hyped and under-performing.

One of the problems with a long career in one field is that there are cycles of fashion and interest that seem to repeat, albeit with differences. Back in the early 1980s there was a push for industrial heat pumps. As is often seen in non-technical, or even semi-technical explanations of heat pumps it was said that "heat pumps are like refrigerators in reverse" (which we all know is wrong anyway as they are "running in the same direction" as refrigerators). One esteemed and highly technical expert at the time, who in fact wrote the book on industrial heat pumps which I still have on my shelves somewhere, said; "*comparing heat pumps to a refrigerator is like comparing a Ferrari to a Mini. They both have four wheels and an engine but there is a huge difference in their complexity, their maintainability and their running costs*". That comment clouded my views on the enthusiasm to use heat pumps as an answer to decarbonising heat. Also, as with any technology there is no question that there were many bad installations, as always happen when there is a bubble and consumer facing hype gets ahead of installer capabilities.

My scepticism was made worse by stories like the one I reported in a **blog** on 28 March 2014 when the front page of the Independent on Sunday reported: "*Exclusive: Renewable energy from rivers and lakes could replace gas in homes*" and the article started by saying "*millions of homes across the UK could be heated using a carbon-free technology that draws energy from rivers and lakes in a revolutionary system that could reduce household bills by 20 per cent*"**.** That piece of pure hype, which was wrong in so many ways, was aided and abetted by the then Secretary of State Ed Davey who really should have known better.

However, things change and when they do it is time to change your mind. The quote; '*when the facts change, I change my mind. What do you do sir*?' is attributed to John Maynard Keynes although as with many other famous quotes apparently there is no proof he ever said it. It is clear that heat pump technology, particularly for space heating, has moved on. An article on LinkedIn by Paul Kenny of Tipperary Energy Agency, "**How did the beast from the east affect heat pump performance**" was very interesting as it recorded real-world performance of 16 residential heat pump installations during extreme cold weather in March 2018.

As well as advances in heat pumps the other thing that got me thinking more about electrification was some surprising data about the effects of gas cooking on indoor quality, particularly the effect on CO, CO_2, NO_2 and VOCs. Having grown up cooking with natural gas most of us have ignored the effects, thinking instead, if we did at all, that indoor air quality problems resulting from cooking were confined to developing countries where people cook on wood fires or kerosene stoves in poorly ventilated spaces. It turns out that we have an indoor air quality problem from cooking as well – particularly in badly ventilated kitchens. Lloyd Alter produced a good summary **here**. The answer is to go electric. Induction hobs are the way to go for fine control of cooking as well as improving indoor air quality.

It is clear that we are moving to a more electrified future, in heat and ultimately transport. For new build the only way to go is to mandate Passive House standard and therefore cut heat loads so much that direct electric heating (possibly with storage to allow households to take advantage of PV generated power and to interact with the electricity market) is viable. For retrofit situations where taking the building to Passive House standard is not possible technically or economically there is definitely no one silver bullet and fully electrifying the entire current heating load is clearly not going to be possible because of its impact on the electricity supply system, as **Michael Liebreich** pointed out, **"***in a normal year,*

*the UK's winter heating load – which is practically zero in summer months – reaches peaks six times as high as the country's electricity load, and it can cycle up and down by a factor of three in just a few days***."** Having said that heat pumps will have a growing role to play, either for individual homes or perhaps group heating schemes with thermal stores that also interact with the electricity flexibility market. Other emerging technologies such as "heat batteries" or thermal stores will also have a role to play in electrifying heat alongside heat pumps.

For more real world examples of completely electrifying homes in the harsh climate of the US mid-West check out the excellent work of **Nate The House Whisperer.**

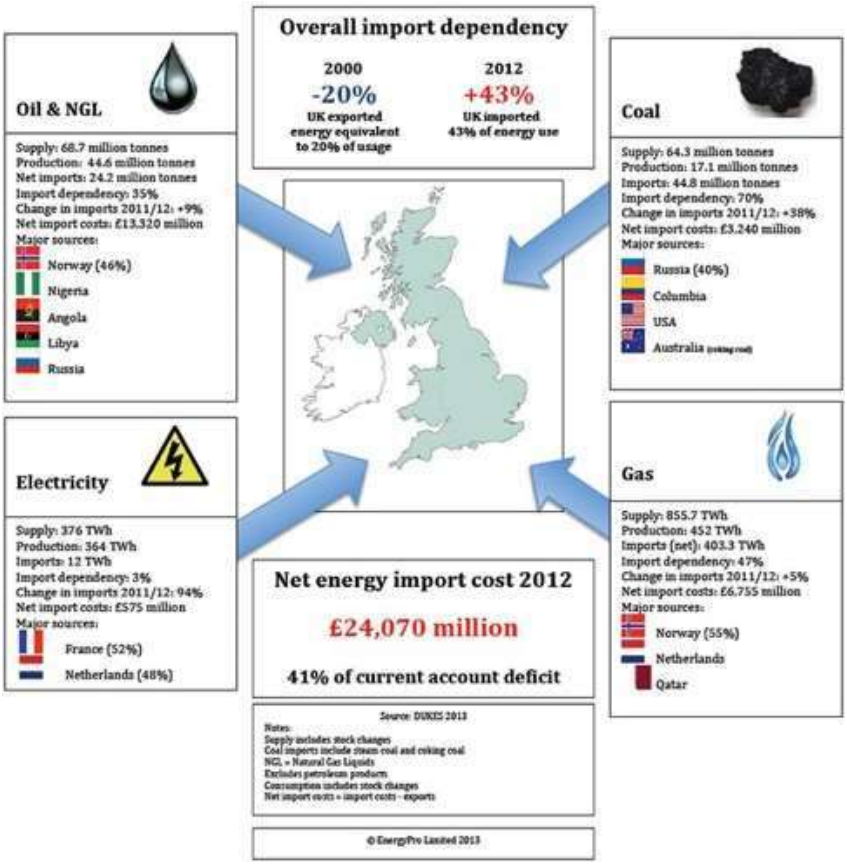
After finishing this blog I discovered the DryFiciency project, an EU Horizon 2020 funded project to develop high temperature industrial heat pumps with the aim of reducing specific energy for drying/dehydration/evaporation processes by 60-80%. Industrial heat pumps may yet have their day.

8 Energy security

Energy security has been a recurring theme since at least the oil crises of the 1970s and an area where we, (at least in the UK), never learn. Current (Feburary 2022) events centred on Ukraine have brought it back into focus once again. The power of energy efficiency to improve energy security has even now not been fully recognised. In importing energy we cede power to the exporter, obviously their inclination to use that power varies from country to country and leader to leader, but we always lose a degree of freedom when importing energy. I did once argue that a massive energy efficiency programme should be on the defence budget as it would greatly help our security. The question of energy security also reminds us that there are very real and deep links between energy (power) and political power – both internationally and nationally. Recent scandals in the US where power companies are paying the politicians who oversee regulations have also highlighted this fundamental truth. The link between energy efficiency and distributed power, and political power and democracy is a rich mine for future blogs and even future PhD students.

8.1 Our growing dependency on energy imports. 26 Aug 2013

Following my note on DUKES one of the important aspects of the UK energy picture that is illustrated by DUKES 2013 is the growing dependency on imports – the dependency has increased from -20% (i.e. net exports equivalent to 20% of energy supply) in 2000 to +43% (i.e. net imports equivalent to 43% of energy supply) in 2012. This infographic summarises the supply, production and import statistics for crude oil, gas, coal and electricity. Net energy import costs in 2012 were £24 billion, 41% of the current account deficit and c.1.5% of GDP.



UK energy imports 2012

8.2 Energy security for the UK and Europe. 5 March 2014

The current events in the Ukraine have once again raised the important issue of energy security for the UK and Europe. Most attention is paid to Russian gas but most UK gas comes from Norway and Qatar (as LNG) and the real hidden issue for the UK is coal. In Q3 2013 Russia provided c.50% of steam coal consumption – the coal that in provides about 39% of our electricity. Energy security is often cited as a driver for energy policy, and specifically energy efficiency policy, but it is a term that is not often unpacked or thought about too deeply. What do we really mean by energy security? In my mind energy security is a measure of the vulnerability of maintaining the flow of fuel and electricity into, and within, a country or region. Energy security should, of course, be a major concern for politicians, whose jobs would become very insecure very rapidly if the industrial scale flows of energy we have become dependent on were to be interrupted. It should also be a concern for business leaders and community leaders, as well as ordinary citizens, because even the perceived threat to energy supplies can lead to business and social disruption and ultimately social breakdown.

In March 2012, the perceived threat of a disruption to UK fuel supplies due to threatened strike action by tanker drivers caused widespread panic. Francis Maude, a government Minister, suggested people should keep a jerry can of petrol in their garage, which exacerbated the situation and led to long lines for fuel and petrol stations running out of supplies. In this case and surprisingly the politician kept his job and a strike was averted but it does illustrate the sensitive nature of keeping energy supplies flowing.

Energy security is most often highlighted at the macro level and, in particular, in relation to oil supplies. Twenty per cent of the world's oil output – and 35 per cent of tankered oil – is shipped through the Straits of Hormuz. Any disruption of oil traffic through the Straits of Hormuz, either by a country or a terrorist group, would disrupt oil supplies to many countries and have a major impact on the oil price in the short term. Although in the US and Europe oil demand is relatively flat or declining, these countries, along with the rest of the world, remain almost entirely dependent on oil for transportation of all kinds, road, rail, air and maritime.

The threat of supply disruption by energy supplying nations is always going to be a risk for energy-importing nations. In 2011, in response to an EU embargo on Iranian oil imposed as part of the international effort to limit their nuclear programme, Iran threatened to disrupt oil supplies through the Straits of Hormuz. The threat helped drive oil prices higher. This was not the first time the threat had been made and despite some diplomatic progress Iran remains a significant risk. The significant US and international navy presence in the area, however necessary, makes the risk of a deliberate or accidental clash quite high. The events and aftermath of the Arab Spring could still threaten the security of oil and gas production in several countries and could of course still spread to other oil exporting nations.

Russia provides about one quarter of the gas consumed in the European Union, and about 80 per cent of this flows through Ukraine. Due to a dispute over gas sales, Russia cut gas supplies to the Ukraine completely in January 2006. After four cold days the dispute was settled. Supplies were also reduced in 2008 and 2009, directly affecting gas supplies in some EU countries and leading to price spikes. Action on energy supplies remains an obvious option for Russia in trying to force its will on the current events in Ukraine.

Despite success against terrorist movements such as Al Qaeda in some parts of the world, all countries remain vulnerable to terrorist attacks on energy supplies. Choke points such as the Straits of Hormuz or major gas and electricity transmission and distribution centres make enticing targets. Destroying, disrupting or damaging them would lead to high levels of disruption, economic damage – and global publicity. The tragic events in Algeria in January 2013 when terrorists targeted the Amenas gas production facility and killed more than 35 hostages highlighted this vulnerability once again.

Saudi Arabia holds 25 per cent of the world's proven oil reserves, produces 12.5 per cent of the world's oil production, exports 16 per cent of the world's total oil exports, and has the largest surplus oil production – approximately 1.1 to 1.8 million barrels a day, so the security of

Saudi oil facilities should be a particular concern to everyone. In 2004, an attack on oil facilities in Yanbu was thwarted by the authorities with no damage, and in February 2006 terrorists attacked the Saudi Aramco Abqaiq facility. This plant includes one of the largest oil fields in the world, with reserves greater than those of Mexico or Canada, and a processing facility with a capacity of seven million barrels a day – about 70 per cent of Saudi oil production – which stabilizes oil for shipment by controlling dissolved gas, natural gas liquids and hydrogen sulphide contents. The attack led to oil prices rising by $2/barrel to around $62/barrel. In 2007 the Saudi authorities arrested 700 alleged terrorists suspected of plotting to attack oil installations. As well as oil fields, processing facilities and export terminals, Saudi Arabia has about 11,000 miles of pipelines which are vulnerable to attack.

The total budget for security of oil facilities in Saudi Arabia was estimated at $1.5 billion in 2005[3]. This does not include the cost to the US and other countries of securing the Straits of Hormuz, which for the US has been estimated by Stern[4] at $6.8 trillion between 1976 and 2007, an average of $227 billion per annum. This is roughly $83/barrel of Saudi exports, of which only about 20 per cent go to the US, raising serious questions over the real value of this expenditure to the US and what may happen in future when the US becomes less dependent on imported energy due to the unconventional oil and gas boom. Sheikh Yamani, the Saudi Arabian Oil Minister famously said in 1988 "… America will be forced to rely on the Persian Gulf, which is a part of the world, I assure you, that you do not want to allow yourselves to rely upon." With shale gas and unconventional oil the end of that reliance on the Persian Gulf may be in sight for the USA but certainly is not for Europe and much of the rest of the world.

With continued terrorist activity, particularly in nearby Yemen, and political and religious turmoil throughout the Middle East, the threat of oil disruption in Saudi Arabia remains a major concern. But it is by no means the only area for concern. In Nigeria, rebel groups have repeatedly attacked oil installations and kidnapped oil workers. These attacks led to oil production being reduced by 40 per cent in 2009 and, despite an amnesty, production in 2012 was still one million barrels a day (26 per cent) below capacity.

Nowadays it is not only the threat of damage from explosives and other physical weapons that security professionals have to worry about – cyber warfare is a very real danger. The Stuxnet virus was targeted at the controllers of the uranium enrichment centrifuges in Iran's nuclear programme and sent the centrifuges into an unstable condition that destroyed them. In October 2012 it was reported that in August cyber terrorists attacked the computers of Saudi Aramco with a virus that wiped the memories of 30,000 computers[5]. The IT network, which in this case was not linked to the production control systems, was disabled for some time and fortunately the attack did not directly impact on operations. Two weeks after this attack a similar attack was made on RasGas, the Qatari natural gas company.

As well as these obvious energy security risks other risks exist including industrial action by key energy workers including power station employees or fuel tanker drivers. In 2000 a series of protests against high fuel prices led to a petrol supply crisis and a contributory factor that was not anticipated by the authorities, was that tanker drivers were intimidated into not driving through the protests, partly because of the risk of having their photos taken by camera phones and used on web sites, a threat that did not exist before the advent of camera phones and the web.

Energy security is an issue that has both short-term and long-term time horizons. In the short term even a small, short-lived disruption on any day can cause major economic and social

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3 Al-Rodhan, K.R. 2006. The Impact of the Abqaiq Attack on Saudi Energy Security. [Online]

4 Stern, R.J. 2010. 'United States Cost of Military Force Protection in the Persian Gulf, 1976–2007. Energy Policy, 2010. [Online]

[5] Perlroth, N. 2012. 'In Cyberattack on Saudi Firm, U.S. Sees Iran Firing Back'. *The New York Times*, 23 October 2012. [Online]

disruption. In the longer term, given the projected increase in global population to about 9 billion by 2050 and the likely entry of 2.5 to 3 billion into the middle class by 2030, energy demand is set to increase dramatically – particularly in rapidly developing economies such as China, India, Brazil and SE Asia. In the future, these countries will compete to buy energy resources and act to ensure the supply of energy to their own economies, putting upward pressure on prices.

The issue of energy security is usually talked about in terms of national energy security but it is – and should be – increasingly viewed as a regional or local issue. Even within a country there may be technological or social issues that constrain the flow of energy, for example the design of and ageing electrical grid may no longer be appropriate for the spatial distribution of growth. In cities such as London and New York physical constraints such as the space available for underground cables may constrain maximum loads in new buildings whereas in rapidly growing economies such as the Middle East or India new developments may outstrip the availability of reliable power supplies. Improving energy efficiency can improve energy security by reducing the need to import energy sources at a regional, national or local level.

The bottom line is that importing energy remains a high-risk strategy for any country and puts a country in a position of weakness compared to the supplier country. In colonial days major powers such as the UK were able to secure oil fields by occupation and military power – but this is not a moral or even practical option in the modern world. The right choice is to reduce import dependence through a range of policies, not least of which is aggressive action to improve energy efficiency across all sectors.

8.3 US grid attack. 6 March 2014

Following my blog on energy security I was sent a link to a US news story on energy security I had missed. Jon Wellinghoff, a former Chair of the Federal Energy Regulatory Commission (FERC) and therefore a very reliable witness, drew national headlines when he reported a potential terrorist attack on the US power grid. Apparently last April there was a military style assault on a Californian sub-station feeding Silicon Valley. Jon Wellinghoff decided to go public because of his concerns that not enough is being done to protect the grid. It seems that snipers opened fire on the sub-station and over 19 minutes took out 17 transformers. The shooters disappeared when police arrived and no arrests have yet been made. Military experts regard it as a professional job. Jon Wellinghoff said "what keeps me awake at night is a physical attack that could take down the grid". Worrying indeed.

8.4 More on US energy security. 12 March 2014

After the last post on the attack on a US sub-station and Jon Wellinghoff's warnings I was alerted to another development. Firstly there is still no news on who perpetrated the attack. Secondly FERC has issued an order to the "North American Electric Reliability Corporation (NERC) to develop reliability standards requiring owners and operators of the Bulk-Power System to address risks due to physical security threats and vulnerabilities."

I had to remind myself that NERC is "a not-for-profit entity whose mission is to ensure the reliability of the bulk power system in North America" and that "entities under NERC's jurisdiction are the users, owners and operators of the bulk power system, which serves more than 334 million people" across the US, Canada and the northern portion of Baja California, Mexico. A big job indeed when the system covers 400,000 circuit miles and 55,000 transmission sub-stations.

To quote from the FERC press release; "The reliability standards directed by today's order require owners and operators of the Bulk-Power System to take at least three steps to protect physical security. First, owners and operators must perform a risk assessment of their system to identify facilities that, if rendered inoperable or damaged, could have a critical impact on the operation of the interconnection through instability, uncontrolled separation, or cascading failures of the Bulk-Power System. Second, owners and operators of critical

facilities must evaluate potential threats and vulnerabilities to those facilities. Finally, owners and operators must develop and implement a security plan to address potential threats and vulnerabilities. NERC has 90 days to submit the proposed standards."

Of course the potential cost of beefing up physical security is enormous and there needs to be prioritization. There also needs to be action on cyber security and using intelligent grid concepts to improve resilience. No doubt this story will run and run – and of course the European grid system has the same issues.

8.5 Don't mention energy security again. 26 April 2014

For a while I have been thinking and talking about the need to change the language around energy efficiency because the old language that we grew up with isn't working well. If it was working we wouldn't have "low hanging fruit" and huge untapped potential for cost effective investment in energy efficiency. We wouldn't be hearing the same old objections to energy efficiency we have been hearing for more than 30 years like, "energy efficiency doesn't work", "you can't measure the results" and "it is not strategic" etc etc.

At the recent workshop I attended at KAPSARC (**King Abdullah's Petroleum Studies and Research Center)** one of the participants made an excellent point about changing the language of energy security. As he pointed out we don't actually want energy we want services like comfort, light etc and therefore we should not talk about ensuring energy security but rather ensuring the security of the services that energy provides. This comment was "a light bulb moment" for me, not about energy services of course – this has long been a given – but about the potential effects of changing the language around energy security.

Think about it – if you say "energy security" you immediately think about how do we physically secure the physical flow of energy commodities – usually oil, gas, LNG or coal. That takes you into trade deals, (there is nothing wrong with trade of course but let's face it – some energy deals have had a heavy moral price), strategic investments in pipelines and other infrastructure to gain preferential treatment, potentially having to outbid the competition for energy supplies, and of course ultimately military force projection starting with the question all US Presidents supposedly ask whenever there is a crisis, "where are the aircraft carriers?", to all out invasions and occupations. Historically and to this day much overt military force and of course lots of covert military and espionage work is dedicated to causes related to securing energy supplies.

So how does this change with changing the language to one around securing energy services? First of all it makes you focus closer to home (literally) – the services are needed/consumed here – not in some remote place where we get physical energy supplies from. Next it pushes you towards a strategy in which you look at how to reduce the energy you need to use to deliver the services – energy efficiency gets elevated as a way of securing supply of comfort in people's homes. Ensuring security of energy services – for example comfort in people's homes – becomes less about doing deals to buy gas from Russia or elsewhere, or making sure the Straits of Hormuz stay open to ensure the flow of oil, and more about making sure we have as many near zero energy consuming households through super insulating new homes and retrofitting old ones.

So here is an idea – next time someone talks about "energy security" just say "we should not be interested in energy security – only in the security of the services that energy is used to supply". Then start a conversation about the true cost of "securing energy" as opposed to "securing energy services". Putting aside the non-financial costs and as a starter on the financial equation the US spent $6.8 trillion between 1976 and 2007 on military force projection in the Persian Gulf[6], an average of $323 billion per annum. Given c.17 million

[6] Stern, R.J. United States cost of military force projection in the Persian Gulf, 1976–2007

barrels of oil a day go through the Straits of Hormuz[7] this represents a cost of c.$50 per barrel of oil – and only about 10%[8] of this goes to the US so for the US the cost of oil is c.$500 per barrel – on top of the actual price of just over $100 per barrel. Of course that only counts the US contribution and does not count the considerable expenditure in the Persian Gulf by the UK and many other countries.

Of course we could not reduce expenditure on keeping the Straits of Hormuz open to zero even if we didn't need the oil – which I think we always will if only for petrochemicals – free trade and the idea of free passage on the high seas should be defended as a general principle otherwise the pirates and the terrorists will take over and that is not good for anyone.

8.6 Cyber attacks on the energy system in Ukraine. 17 March 2016

I have written before about the threat of physical and cyber attacks on critical energy infrastructure (**here**) and so my eye was caught by an article highlighting the US Department of Homeland Security's report into the power outages in Ukraine in December.

The background is that on 23 December 2015 three Ukrainian regional power distribution companies experienced power outages that affected 225,000 customers. A US team with representatives from the National Cybersecurity and Communications Integration Center (NCCIC), the Industrial Systems Cyber Emergency Response Team (ICS-CERT), the US Computer Emergency Readiness Team (US-CERT), Department of Energy, Federal Bureau of Investigation and the North American Electric Reliability Corporation travelled to Ukraine and investigated with the full co-operation of the Ukrainian authorities. Although the team were not able to independently review technical evidence, based on their interviews with those with first hand experience of the attacks, they concluded that the outages were caused by "synchronized and coordinated external cyber-attacks".

Apparently the attack wiped some systems after the attack using KillDisk, a utility for wiping hard drives. The perpetrators also corrupted the firmware of devices at sub-stations and scheduled disconnects in Uninterruptible Power Supplies, actions designed to interfere with efforts to restore power. Each company also reported that they had been infected with BlackEnergy malware. Apparently there have also similar cyber attacks on a mining company and a train company in Ukraine.

The US Department of Homeland Security has reported that cyber attacks on pipelines and electric power infrastructure have been occurring at an "alarming rate". In 2015 the former Director of the National Security Agency, General Keith Alexander, warned that the US and their allies were facing a growing cyber security threat and that energy infrastructure was the most likely target. The current NSA chief Michael Rogers has testified that China is capable of cyber-attacks that could cause 'catastrophic failures' of the water system or the electricity grid. In January Israel's Electric Authority was hit by an "extreme cyber attack". This paralyzed many computers but did not seem to affect power supplies.

The threat of cyber attacks on energy infrastructure is becoming more alarming. It seems to be another argument for aggressively driving demand down through energy efficiency and decentralized power, as long as the various bits of decentralized infrastructure are suitably protected against cyber attacks. A decentralized "smart" energy system sounds attractive but a highly connected system could be just as vulnerable although of course with suitable protection it may be easier to contain problems and any particular problem is likely to have smaller consequences. It also seems to be another argument against large, massively complex systems like nuclear power plants that contain millions of lines of software and

[7] Energy Information Administration. World oil transit choke points

[8] Energy Information Administration. U.S. Imports from Persian Gulf Countries of Crude Oil and Petroleum Products

potentially massive consequences of failure. We need to design new energy systems that are robust and resilient against cyber attack, as well as physical attack, and rapidly improve the cyber security of existing infrastructure.

9 Examples of energy efficiency from around the world

Throughout my career, and indeed my life, I have been fortunate enough to visit and experience many different countries, some over an extended time. It is really interesting to compare progress on energy efficiency across countries and it is important to avoid the syndrome of thinking the grass is always greener on the other side. The problems in energy efficiency and increasing investment into energy efficiency are fairly universal, the knowledge and the solutions are not evenly distributed yet but the power of modern communications and international discourse mean it is easier to learn from each other.

9.1 Who is ahead in energy efficiency – the US or Europe? 12 April 2013

On my recent travels through the American mid-west (my favorite and a much maligned part of the US) I was asked the question, "who is ahead in energy efficiency, the US or Europe?". This is an interesting question I have thought about a lot over the last few years. The first part of my answer is that the grass always looks greener on the other side. On an earlier visit to the USA to attend the 2012 ACEEE financing forum I was intrigued by the general reaction to the UK situation which was characterised as, 'you guys over there have it so good because of all the advanced policies you have'. I explained that what may look like great policy from afar doesn't always look like that when you see it up close and have to work within it. As we know the UK energy efficiency policy has evolved a lot in the last 2 years but it is still far for ideal, with a multiplicity of policies and programmes and still much uncertainty, particularly about using the Electricity Market Reform to boost demand for demand side activities.

So back to the question. The next part of the answer is of course is that the USA is actually 50 countries with a common currency and generally a common language whereas Europe is 27 countries with no common language and 23 with a common currency. This makes it difficult to compare the US and Europe. Anyway, having caveated the answers with all of the above here is my take on the question.

In parts of the US (and an increasing number of places) the realisation that energy efficiency is a huge opportunity to create value has sunk in and as always when that happens in the US a lot of very talented people and a lot of investment flows into the opportunity. Secondly efficiency has been decoupled from the climate change issue which removes a lot of debate and allows believers or non-believers in climate change just to get on with it. Thirdly the link between efficiency and job creation is really starting to be taken seriously, more so than in Europe. Some US (and Canadian) cities are making great progress on long-term energy plans based on efficiency and linked to economic development. Energy efficiency financing is more advanced in the USA where the market is growing and transforming itself from a publicly funded activity (mainly stimulus and rebates) to a privately financed activity. In Europe my take is that most often 'energy efficiency financing' implies public funding of some kind.

There is probably more potentially transforming technologies coming out of the US than Europe, and that is everything from systems that seriously reduce the cost of re-lamping with LEDs to totally radically data centre cooling technologies. That just reflects the huge scale of R&D in the US and the interest of the Venture Capital industry. The UK and Europe is better at energy management, particularly around Monitoring & Targeting (M&T) and motivation programmes. On the subject of policy the answer depends entirely on what you are comparing. There is little doubt that advanced US states like Massachusetts are way ahead in areas such as decoupling electricity revenues for volumes. They now appear to have decoupled electricity demand growth from economic growth. Europe (although not the UK) is ahead on integrated utilities selling power and heat generated in efficiency CHP and DH stations.

So at the end of the day, it depends which jurisdictions you are comparing, what you are comparing and where you are looking from. There are examples of bets practice in both the

USA and Europe. I can't help feeling though that 'Yankee ingenuity' and the pursuit of value will in time produce better rates of improvement (from different bases) in the USA than in Europe.

9.2 Ireland – an emerging leader in European energy efficiency? 14 May 2013

I had a great trip to Ireland recently, speaking at the IERC conference and getting updated on the various private and public energy efficiency initiatives. Ireland is really making impressive strides to improve energy efficiency.

In February the government published its second National Energy Efficiency Action Plan (NEEAP) which highlighted the potential benefits to Ireland, a country that imports c.88% of its energy and has ageing power infrastructure. In the first NEEAP in 2009 the government estimated that by implementing the NEEAP Ireland could save €2.36bn, generate 5,000 jobs, a critical issue in Ireland, reduce energy use by 32,000 GWh and reduce emissions by 7.7 mt of GHG emissions.

The NEAAP set a target of 20 per cent savings across the economy and a target of 33 per cent saving in the public sector by 2020. The plan includes 97 specific actions and these include: obliging the public sector to address consumption, procurement and reporting of energy use, writing guidelines on Energy Performance Contracts (EPC), the establishment of an €70m energy efficiency fund with €35m being invested by the government, and establishing a domestic and non-domestic Pay as You Save (PAYS) schemes.

Another interesting initiative is the International Energy Research Centre (IERC), based at the Tyndall National Institute in Cork. IERC is a vehicle for co-operative research backed by an impressive number of large multi-nationals including United Technologies, General Motors, IBM, Alcatel-Lucent and HSG Zander and local companies such as Bord Gais. The IERC brings together industrial partners with academic institutions to undertake collaborative research in integrated sustainable energy system technologies. The IERC is already supporting a number of collaborative, industry-academia research projects driven by real industrial needs and has recently attracted additional support. The idea is to carry out research, use Ireland as a test bed and then use the technology developed in international markets.

Ireland is a small country at the edge of Europe but judging from the National Energy Efficiency Action Plan and other initiatives such as IERC it is quietly taking a leadership role in Europe in energy efficiency.

9.3 Energy efficiency in the windy city. 21 May 2013

The City of Chicago, (my all time favorite US city and one that is well worth visiting), is a leader in the US and the world on promoting energy efficiency and sustainability generally. Chicago has a unique history in buildings, the skyscraper was invented there, and as well as many historic buildings it still has some of the tallest buildings in the world in the form of the Willis Tower, (formerly and still to most people the Sears Tower,) and the John Hancock Building.

The city, whose official motto is 'Urbs in Horto' or 'city in a garden', has the aim of being more liveable, more competitive and more sustainable. It has had sustainability programmes for a number of years and has achieved the following:

- been voted 'most sustainable large community'
- number 1 in number of LEED certified buildings
- has the largest urban solar capacity (10 MW on brown field site)
- number 1 in green roofs, with more than 5 million square feet
- has the 3rd largest concentration of green jobs in the US

- has recently shut down two urban coal fired plants, thus improving air quality.

The city's sustainability efforts have been accelerated under the leadership of Mayor Rahm Emmanuel and the city has 24 goals for 2015 in 7 key areas ('24/7') with 100 specific activities being monitored. Number 2 in the 7 key areas is 'Energy efficiency and clean energy'. It is refreshing to see that the order is energy efficiency first, rather than clean energy. Energy efficiency also clearly links in with number 1, creating jobs, and number 7, addressing climate change.

The city undertook a study of energy use split into census blocks and the numbers show that there is $3 billion a year spent on energy in 600,000 buildings and that 71% of Chicago's carbon dioxide emissions come from buildings. This realization led to the creation of the Retrofit Chicago programme which has three sub-programmes, one for public buildings, one for commercial buildings and one for the residential sector.

In the public sector the City set a target of reducing energy use by 20% in its 10 million square feet of facilities. Recognizing that finance could not come from public funds the City created the Chicago Infrastructure Trust which is designed to bring in multiple, private sector finance partners to invest in infrastructure upgrades. Although less than a year old, and still, as the Deputy Mayor described it at the recent ACEEE Financing Forum, an 'infant that has probably got too much attention', it is working on financing energy efficiency retrofits in buildings, large pumping stations and schools.

The Commercial Buildings Initiative (CBI) was launched as a voluntary, opt-in, programme. It initially had 14 million square feet of buildings owned by major real estate companies signed up but now has 32 buildings with 28 million square feet. It both "makes it easier" for building owners to have a retrofit and provides recognition. Interestingly enough finance is not considered a barrier in the CBI as these are major buildings owned by large real estate companies.

The Residential Partnership used the data on energy use at a census block level to identify twelve zones with a high potential for energy efficiency. This information is available through the city's information portal and the city is encouraging people to come up with new ways of using the data. After less than a year 1,300 retrofits have now been undertaken with a total of 2,600 across the city (including areas outside the twelve zones). As in other residential retrofit schemes a critical issue is accelerating demand and the city uses an out-reach team using various techniques including house parties.

For more information on Chicago Retrofit see **here**.

Many US cities are doing really interesting and effective things to improve energy efficiency but 'the windy city' is definitely up there amongst the leaders and worth studying.

9.4 Energy efficiency in the rainbow nation. 10 June 2013

My recent first ever trip to South Africa was too short (36 hours) but exciting and fascinating. The African sun and energy of the people I met was truly invigorating, especially after a long cold and wet winter in the UK. The commitment to energy efficiency, which of course is vitally important to the country, was also good to see.

As is well known South Africa has a power supply crisis and on the 23rd May this year ESKOM's (the power supplier) supply margin was a frighteningly tight 0.4%. Any additional failures or a small amount of extra load would have led to demand exceeding supply capacity. Because of this supply situation, increasing the uptake of the energy efficiency resource has a critical role to play in South Africa's energy future. Much good work has been done and many initiatives have been taken or are planned.

Chief amongst these are ESKOMs IDM (Integrated Demand Management) programme which since 2004 has removed 3.5 GW from the system. IDM has several elements including:

- Energy Efficiency Demand Side Management (EEDSM) – to identify and promote more efficient electricity use through technology enhancements and behavioral change
- Energy Management Programme (EMP) – assisting Corporate Customers to enhance energy efficiency
- Solar Water Heating Programme – providing financial incentives for consumers to switch to solar water heating
- Power awareness and communications campaigns
- Coordinated internal energy efficiency programme
- Energy conservation scheme (ECS) – to achieve a 10% energy reduction amongst consumers using more than 25GWh per annum
- Demand Response (DR) – system operator pays customers to reduce load on instruction to balance demand and supply
- A Standard Offer programme in which ESKOM pays for verified savings between 50kW and 5MW. The project host, or an ESCO, is paid a standard price per kWh for three years

In addition ESKOM has an Internal energy efficiency programme which has a target of a 15% energy reduction for non-essential consumption (Eskom buildings and substations).

The Industrial Development Corporation (IDC), in conjunction with KfW, has established a ZAR 500 million (c.GBP 32m) Green Energy Efficiency Fund (GEEF). GEEF focuses on private sector companies and provides loans ranging from ZAR1 million to ZAR50 million at a concessionary rate of prime less 2%. GEEF allows for loan repayments of up to 15 years, depending on the energy efficiency or renewable energy technology. To date, 17 companies have been financed utilizing ZAR 174 million with 95% committed to SMEs.

I was in Johannesburg speaking and taking part in a panel discussion at the IFC's inaugural ESCO financing conference. I was given the task of speaking on the thorny issue of on-off balance sheet financing and the implications of accounting rule changes. Perhaps not the easiest or most exciting subject but one that will become globally more important as the IASB and FASB harmonize on issues such as leasing and 'balance sheet window dressing'. As someone who was at Enron at the end I particularly like Sir David Tweedie's quote when he was Chairman of IASB, 'the purpose of accounting is to keep capitalism honest'. We need more honest capitalism. Despite the lobbying of the leasing industry it looks like these changes will come into effect in 2015/16.

9.5 Green buildings in Singapore and arcologies. 7 Oct 2014

On a recent visit to Singapore where I spoke at the International Green Building conference on "Innovations in energy efficiency financing", I learnt more about Singapore's commendable policies to promote green buildings. The island state of Singapore, which will mark the 50th anniversary of independence next year, has made sustainable development a national priority and has made impressive progress in many areas. It has a vision of becoming "a global leader in green buildings with special expertise in the tropics and sub-tropics, enabling sustainable development and quality living". The Building Construction Authority (BCA), my hosts for the trip, launched their green building standard Green Mark in 2005. Comprehensive measures to promote green buildings were included in the 1st and 2nd Green Building Master Plans and the 3rd Green Building Master Plan builds upon these earlier programmes and includes initiatives such as; a Green Buildings Innovation Cluster, an incentive scheme to encourage more owners to adopt Green Mark, mandatory periodic energy audits and mandatory energy reporting. There will also be more of an emphasis on behavioral change for tenants and occupants.

There are now more than 2,100 property developments that meet one of the Green Mark standards, which like LEED has different levels of certification – Certified, Gold, Gold Plus,

Platinum. A Platinum building can achieve 30% better energy efficiency than a code-compliant building. The total gross floor area of Green Mark buildings is now 65 million square meters, which equates to 25% of the total built up area and the national target is to have 80% of all buildings qualified as Green Mark by 2030

At the conference the BCA launched the inaugural Green Building Benchmarking report. The report covered more than 800 buildings covering offices, hotels, retail buildings and mixed developments. From 2008 to 2013 the total electricity use of commercial buildings increased by 14% but gross floor area went up by 20%. The Energy Utilization Index (EUI – measured in kWh/m2 year) of these buildings had increased by 5%. For each category of buildings in the benchmarking report a top 10 list was produced and the report highlighted some interesting results from 54 buildings that had been retrofitted. On average chiller plant efficiency had been increased by 38%, from 1.05 kW/RT to 0.65 kW/RT. The average total building electricity of retrofitted buildings was reduced by 16%, equivalent to S$30 million each year. In a separate study the BCA looked at the value of 40 retrofitted buildings and concluded that for retail buildings Operating Expenses of retrofitted buildings were reduced by 13.5% and capital value increased by 2.7% while for office buildings Operating Expenses were reduced by 11.6% and capital value increased by 2.3%. This is important evidence to support the business case for green retrofitting.

The conference was also an opportunity to stay in the Marina Bay Sands hotel. Marina Bay Sands is the largest single Green Mark certified building in Singapore and its green credentials include; regenerative drives on the lifts, LED lighting and intelligent lighting controls, water saving features, District Cooling and green roofs. Its most famous feature, however, is the amazing 150 m long infinity pool, on the 200 metre high cantilever platform which spans the three towers. I was pleased to experience the infinity pool even if going to the side was "interesting" given that I now seem to dislike being near the edge in high buildings. Being in the Marina Bay Sands hotel, the associated shopping mall and conference centre, really is like being in a science fiction movie – sort of like being in a benign "*Blade Runner*" or an arcology. The arcology concept – a large self-contained building that contains living, working and agricultural facilities and is sustainable – was pioneered by architect Paolo Soleri and although it never gained much traction it seems to have been almost implemented in buildings like the Marina Bay Sands. A great science fiction book involving an arcology, which I thought of often while in the Marina Bay Sands, is "Oath of Fealty" by Larry Niven and Jerry Pournelle. Written in 1981 it describes the technologies of an arcology but also examines some of the social issues we now live with every day such as the pros and cons of continuous CCTV surveillance: **http://www.amazon.co.uk/Oath-Fealty-Larry-Niven/dp/1416555161**.

Back in the real world Singapore recognizes the barriers to meeting its ambitious green building and energy targets but continues to be a leader in designing and deploying policies to increase the uptake of green building techniques. Its policies and programmes are well worth studying and it is certainly well worth visiting.

9.6 Energy efficiency in Saudi Arabia. 22 Oct 2014

It may be surprising to some but Saudi Arabia has a vigorous programme to promote energy efficiency. The rationale for this is an analysis that shows the rapidly increasing Saudi population, and rising wealth coupled with very low energy prices means that Saudi electricity demand is growing at 7% per annum and domestic use of oil is growing at 5% per annum. In 2012 domestic oil use reached 35% of production and in 2011 Chatham House estimated that by c.2035 domestic oil consumption could equal production1. Clearly if that scenario ever happens the Saudi economy, and no doubt political structure, would be under severe pressure and there would be a major impact on the global oil market.

With this in mind, in 2003 Saudi Arabia launched a national effort (the National Energy Efficiency Program, NEEP) to enhance demand side efficiency. Between 2007 and 2010 there was an initiative by the Ministry of Petroleum to transfer the NEEP to a permanent entity and in October 2010 the Saudi Energy Efficiency Center (SEEC) was formed. The mission of SEEC is

to "reduce energy consumption and improve energy efficiency to achieve the lowest possible energy intensity".

Its key tasks are to:

- develop an EE plan covering policies, regulations and initiatives
- monitor the implementation of the plan
- promote EE awareness and support building capacity
- promote the EE industry.

In 2012, SEEC in conjunction with ministries, regulatory authorities and major companies launched the Saudi Energy Efficiency Program (SEEP). SEEP is purely focused on demand side management and its remit does not include the issue of price reforms. The subject of energy prices, which are heavily subsidized to consumers, is highly sensitive in the Middle East. In 2012 there was civil unrest when the Jordanian government changed the subsidy regime on fuel and there is no doubt that all Middle Eastern governments are very conscious of the social impacts of changing energy subsidies – especially at this time of instability in the region.

The SEEP is focused on three sectors; industry, buildings and transport.

Industry represents 42% of total energy use with 80% of the energy going into the petrochemical, cement and steel industries. Feedstock is not part of SEEP as it is handled by the Ministry of Petroleum and Mineral Resources. In the cement industry over 600 cement plants were benchmarked with the World Business Council for Sustainable Development (WBCSD), all plants were visited to share the methodology, targets were set for existing plants, a defined maximum energy intensity was set for the design of new plants, and the new roles and responsibilities were developed. In addition SEEC is looking to enhance its mandate to include the collection of data, the setting of targets and their enforcement. Another major energy user in Saudi Arabia of course is desalination of water and there are programmes to improve the efficiency of desalination.

Buildings account for 23% of Saudi's energy use with not surprisingly 70% being used for cooling. The aim is to catch up with the rest of the world in terms of standards and codes. In Buildings the key energy efficiency initiatives have included:

- updating the efficiency standards for small capacity air conditioners to ASHRAE standards
- developing an efficiency standard for large air conditioners
- updating thermal insulation product standards
- finalizing efficiency standards for residential lighting products
- developing efficiency standards for commercial and street lighting products
- updating efficiency standards for refrigerators and washing machines
- updating the Saudi Building Code energy conservation section (SBC 601) to ASHRAE standards
- developing a process to ensure proper enforcement of SBC601.

Transport accounts for 23% of total energy use. There are 0.7m Light Duty Vehicles (LDVs) entering the market every year and the stock of LDVs is forecast to reach 20 million by 2030. Incoming LDVs have low average fuel economy given the nature of the fleet mix. In transport SEEC, working with its partners, has developed fuel economy standards in line with international benchmarks. Specific measures include:

- developing a Saudi specific fuel economy standard for LDVS (to catch up with US CAFE standards over time)
- adopting a fuel economy label design similar to EU's to be enforced on LDVs from model year 2015
- developed a tyre rolling resistance and wet grip standard for LDVs

- identifying key initiatives for Heavy Duty Vehicles (HDVs) (anti-idling regulations, aerodynamic additives, light weighting and mandatory retirement of old HDVs.

Energy intensity in Saudi Arabia intensity has grown significantly over the last 25 years, particularly since 1985, reflecting the growth of the economy, its level of economic development and reliance on heavy industry. Energy intensity was twice the world average in 2010 and energy use is still growing faster then the economy. The overall objective of SEEC is to reduce the electricity intensity by 30% between 2005 and 2030 and half the peak demand growth rate by 2015 compared to the period 2000-2005.

As well as energy efficiency Saudi Arabia is of course also pursuing renewable energy and nuclear power. It has a target of attracting investment of $109 billion in renewables and building 54 GW of renewables by 2032 (producing half of all electricity demand), as well as 18 GW of nuclear. So far, however, the largest ground mounted PV plant, at the King Abdullah Petroleum Studies Center (KAPSARC) is only 5 MW. Keeping PV panels clean is a major issue in the harsh, dusty climate.

Clearly there is a long way to go but it is encouraging that Saudi Arabia is working to improve energy efficiency. As in many other issues Saudi Arabia faces particular constraints that are rooted in unique social and historical factors – balancing these factors and modernization is a massive challenge. Given the importance of Saudi in the oil market globally and the region generally we should support the national energy efficiency programme's success. The fact that there is a vigorous Saudi's programme just adds to the view that the potential resource of energy efficiency is now widely recognized everywhere, but in Saudi as everywhere else we now need to improve the utilization of that resource and work to make investing in efficiency as mainstream as investing in oil, gas and renewables.

9.7 Energy efficiency lessons from Dubai. 7 March 2016

As some of my readers know I have been spending some time in Saudi Arabia working on an energy productivity and energy efficiency financing project. This has allowed me to look at the various energy efficiency initiatives in the Gulf Co-operation Council countries. It may surprise some people but the GCC countries, including Saudi Arabia, are paying increasing attention to energy efficiency, driven by various factors including the need to reduce the rate of increase in domestic energy demand and national commitments to sustainability. Clearly there is a long way to go and many issues to face, including the low retail price of energy, but there are some very positive developments. One of the most interesting developments is the Etihad Super ESCO.

The Etihad Super ESCO was established as a 100% owned subsidiary of the Dubai Electricity and Water Authority (DEWA) in 2013. It is a commercial organization with the mission of creating a market for energy performance contracting in Dubai. It has the following targets to be achieved by 2030:

- To retrofit 30,000 buildings
- To reduce energy consumption by 1.7 TWh
- To reduce CO2 emissions by 1 million tonnes

It is targeting to catalyze USD 540 million of capital deployed by 2030. The business model of the Etihad Super ESCO is to develop projects, bundle projects, contract with Energy Service Companies to undertake the work on a guaranteed performance contract, and to source and arrange the capital. It targets government and other organisations with large property portfolios.

To date the Etihad Super ESCO has undertaken several projects including:

- a 16 m AED (USD 4.36 m) project for DEWA in seven buildings including 55 energy efficiency measures covering lighting, cooling and ventilation. The reduction in energy consumption is 31%, 5GWh per year with a saving of 2.6 m AED (USD 0.71 m).

A significant improvement in comfort in the HQ building was also achieved. Contract length is six years. Project execution is by MAF Dalkia Middle East.

- a 21 m AED (USD 5.7 m) project to replace lighting in power stations with LED lighting. Reduction in energy consumption for lighting of 68% with savings of 6 m AED (USD 1.6 m) a year. The new lighting also produced better working conditions. Implementation was by Philips Lighting. This is part of an overall 37 m AED (USD 10 m) investment across the DEWA estate including power stations and offices.

It has also signed a number of MoUs that will lead to projects in due course including with the Dubai International Finance Centre, the Dubai Airport Free zone Authority and the Wasl Asset Management Group.

In November 2015 Etihad Super ESCO announced a significant first, the world's first building retrofit project funded through a Shari'a compliant structure. The project host is the Jebel Ali Free Zone and this will be the largest retrofit to date in the Middle East, covering 157 buildings. It is projected to save 26 GWh of electricity a year and 200 m imperial gallons of water resulting in a 22m AED ($6 m) saving. Capital cost is 64 AED ($17.4 M). The funding is coming from the National Bonds Corporation.

The use of Shari'a compliant funding is interesting as the match between infrastructure investments, including in energy efficiency, and the requirements of Shari'a funding have been discussed before but this is the first application to building retrofit projects. The super ESCO seems to be addressing the various parts of the jigsaw of energy efficiency financing I have described before including:

- using a "captive" portfolio to achieve scale (in this case DEWA buildings and power stations and government buildings)
- creating demand at scale through targeting property owners with large portfolio owners rather than single buildings
- taking on development risk for large portfolios of projects
- building capacity amongst customers and suppliers
- arranging finance at scale.

The fact that the super ESCO is part of DEWA is also interesting as it indicates a degree of integration between energy supply planning and energy efficiency.

Dubai, with its rapid growth over the last few decades and famous excesses is perhaps not the first place we think of when we think about energy efficiency but the Etihad Super ESCO seems to be a world class initiative. Other countries in the GCC and beyond, should study the DEWA model carefully.

9.8 Renovation innovation in Latvia. 8 June 2016

I have just returned from my first visit to Riga, the capital of Latvia, which is a very civilized city and well worth a visit. Whilst there I continued a dialogue with a very interesting project to fund residential renovations in Soviet era panel buildings. For anyone not familiar with these, all through the former Soviet republics in central and eastern Europe, through Russia, into central Asia and even China, the default method of building housing was highly systematized and standardized concrete panel blocks. Even in the UK of course we experimented with this kind of technology during the sixties and seventies – usually with bad results. The panel buildings in Latvia and throughout central and eastern Europe are extremely energy inefficient, in climates which get severe winter weather, and are often in danger of collapse through problems of "concrete cancer" and structural defects.

In Latvia, Renesco (a private ESCO) has renovated 15 panel built apartment blocks with some impressive results. Energy savings ranged from 45% to 65%, more comfortable conditions were created, the lifetime of the blocks was extended and residents kept paying the same utility bills – all without additional subsidies. The retrofits are deep retrofits

incorporating insulation, windows and doors as well as other aspects such as structural repairs, roof repairs and upgrading elevators (with high energy savings due to the low efficiency of Soviet era elevators compared to modern high efficiency units). The energy savings allow these other measures – which are essential to the building – to be paid for. Residents buy into the increase in comfort. The Renesco projects were a great example of entrepreneurial effort overcoming many social, economic and technical barriers. Now the project is moving into a new larger and very exciting phase. Renesco, like all ESCOs, was capital constrained and so now the Latvian Baltic Energy Efficiency Facility (LABEEF) – a forfaiting fund – has been established to refinance similar projects carried out by ESCOs once they have been in operation for a year.

This arrangement allocates risks and rewards appropriately. Residents take no risk and their homes increase in value 15 to 25%. Over the lifetime of the financing deal, they can expect over 30% lower costs than other financing models. The ESCOs take the project implementation and performance risk, and the forfaiting fund takes the long-term payment risk. (To date there have been no defaults on payment). The ESCOs or their financing banks can recycle capital. LABEEF has systematized the process, making application easy through an on-line portal, and completely standardized the process. On the technical side it advocates the use of Investor Confidence Protocols as a way of ensuring best practice during project development, implementation and on-going monitoring. Over time, once enough projects have been aggregated, the forfaiting fund should become an attractive investment for pension funds which in the Baltics currently invest mainly in the Nordics due to a shortage of investment opportunities at home.

It is worth considering the potential impact of this project. If applied to Latvia's 50 million square metres of panel apartment blocks the reduction in gas imports – which all come from Russia – would be reduced by 50%. This alone should mean the project should get a lot of attention on energy security grounds. In addition there are huge non-energy benefits such as the effects on health and well-being, and improvements to the social fabric as residents become involved in the long-term future of their block and their neighborhood. The latter kind of "soft" benefit is often forgotten but is very real. When applied to the estimated 1 billion square meters of panel buildings across central and eastern Europe the potential gains are huge – a potential reduction in gas imports of over 10-15 billion cubic meters/year.

The LABEEF forfaiting fund is a world-class example of energy efficiency financing in action and we look forward to following its development and working with it in future.

9.9 India – a global player in energy efficiency. 16 Jan 2018

It has been a while since I have had a chance to write a blog because I have been very busy working with our JV partner EESL as well as on other projects. In November I made my first ever visit to India to speak at the INSPIRE event, so it seemed appropriate to write about energy efficiency in India.

First of all when you look at India you have to get used to the big numbers, starting with 1.3 billion people, installed electrical capacity of 331 GW, and economic growth rates of 7 to 8%. When you project current trends forward you quickly realise that energy efficiency in India is a matter that should concern the whole world. If India gets it right the world has some chance of meeting climate related targets. A clear example of this is air conditioning which is vital in most parts of India, and is a market set to grow dramatically. At the moment the market penetration of room air conditioners (RACs) is only 4-5%, roughly where it was in China in 1995 (compared to a c.53% market penetration in China today). The projected growth of RAC in India as incomes increase could result in additional peak loads of 143 GW (about twice the total UK installed capacity!), requiring 300 additional 500 MW power stations. Work is currently under way on a national cooling strategy which aims to mitigate the growth in power demand from cooling and will include measures such as enhanced efficiency regulations on RACs, driving innovation in cooling, promotion of passive cooling, and district cooling using trigeneration.

Energy Efficiency Services Ltd (EESL) is a central player in the Indian energy efficiency market. EESL was established in 2009 by the Ministry of Power as a JV of four utilities, the National Thermal Power Corporation (NTPC), Rural Electrification Corporation (REC), Power Finance Corporation (PFC) and Power Grid Corporation (PGICL). The vision behind EESL is to unlock the $11 billion market for energy efficiency, amounting to 15% of present consumption. EESL works closely with the Bureau of Energy Efficiency and leads the market related activities of the National Mission for Enhanced Energy Efficiency. From 2009 to 2013 little progress was made and then there was a change of leadership that led to amazing results, including growing revenues 46 times.

EESL is best known for its LED programme, UJALA, which has distributed more than 270 million LEDs across India. EESL's model of aggregating demand and large scale procurement has driven the price of LEDs down by a factor of ten. Critically the UJALA programme does not rely on any subsidies, it is a commercial model in which consumers and utilities pay as they save. The savings have been around $338 million. Another effect of the growth of the LED market has been a surge in domestic manufacturing. LED production in India has grown from 5 million units in 2013 to 600 million units in 2017, creating 185,000 jobs in 2016/17. The UJALA programme aims to replace 770 million LEDs by 2019.

A similar aggregation approach has been applied by EESL to replacing street lighting. As well as using LEDs EESL has implemented a Centralised Control and Monitoring System (CCMS) for street lighting that provides remote monitoring 24×7. Globally we have started to recognise the importance of non-energy strategic benefits of energy efficiency and EESL has taken steps to measure these through social audits which show that citizens are a lot more satisfied with the LED lighting and feel an enhanced sense of safety and security.

EESL has also moved into several other key areas including agricultural pumps, domestic appliances, smart meters and electric vehicles (EVs). Towards the end of 2017 EESL procured 10,000 EVs to lease to government departments (which have a huge fleet of cars for the use of officials). The procurement brought the price of the EVs down by 25%. EESL will lease the EVs and charging infrastructure to departments for less than they currently pay for petrol driven cars. A further procurement of EVs will follow.

As the world's largest publicly owned super-ESCO EESL has been remarkably successful. It has been highlighted by the International Energy Agency and the World Bank as a model for deploying energy efficiency at scale and it is certainly a model that all countries can learn from, North as well as South. At EnergyPro we are proud to be working with EESL to combine both sets of experience to build a portfolio of projects in Europe and beyond.

The data in this blog has mainly been taken from the EESL coffee table book: "UJALA. I LED the way." With thanks to EESL and AEEE for the opportunity to present at the INSPIRE event in Jaipur.

9.10 The improving ratio of deals to conferences in the Paris of the East. 19 June 2019

One of the most memorable phrases I first heard at the ACEEE Finance Forum in 2012 was that 'the problem with efficiency financing is that the ratio of conferences to deals is too high'. That remains true although there are good signs that the ratio is improving, the number of conferences seems the same (or maybe higher) but the number and value of deals is definitely increasing in lots of places around the world. On my recent trip to Bucharest for the 2nd Round Table on Energy Efficiency Financing held under the auspices of the Sustainable Energy Investment Forum I saw more evidence of this change. The meeting was encouraging because a) several banks were in the room leading the conversation (& deals) and b) there are a now a number of successes to point to.

The first of these was a UNDP Global Environment Facility project which I had a small part in designing when I first went to Bucharest in the 1990s and was implemented from 2003 through to 2006. This project was executed extremely well with only $2m of UNDP money

which supported project development assistance and capacity building, and yet catalysed nearly $70m of private investment into 34 energy efficiency projects, compared to a target of $12.5m and 20 projects. Although I had not developed my jigsaw of energy efficiency financing back then on reflection the project had the four pieces of the jigsaw, finance (development and project), building pipelines, standardisation, and capacity building within the demand side, the supply side and the finance industry. The implementing consultants carried out activities in all four areas. Although it is now a long time ago, the project merits study for anyone designing programmes designed to catalyse private investment using a small amount of public money.

Since the UNDP GEF project there has been a series of EBRD Green Economy Financing Facility (GEFF) facilities that ran between 2008 and 2018; the Energy Efficiency Finance Facility (EEFF) – for private sector industrial companies, the Municipal Fund for Energy Efficiency (MFFEE) – for municipalities, and the Romania Sustainable Energy Finance Facility (RoSEFF) which financed projects in SMEs. These facilities provided technical assistance to help develop and close projects and used a mixture of grants from the EU (between 10% and 20%) and loans to finance projects. The EEFF made 129 investments totalling €111m, the MFFEE deployed €10m into three public lighting schemes, and the RoSEFF made 341 investments totalling €69m. The current GEFF in Romania was launched in 2017 and is a €100m financing framework for the household sector, the first time this sector has been specifically addressed. Concessional financing is provided by the TaiwanICDF through EBRD to local financial institutions Banca Transilvania and UniCredit Bank and to date $64m has been deployed. The facility consultant, Tractebel, trains local financial institution branches how to recognise and act upon energy efficiency lending opportunities which builds capacity and ensures extensive outreach throughout the branch network.

The other exciting project is the Romania Green Building Council's 'Smarter Finance for Families'. This project developed a low-cost, local green home certification system in which homes have to achieve an energy performance more than 30% better than an A rated home and have other green features including use of non-toxic materials and reduced construction waste. Furthermore the scheme links this to green mortgages from major banks which offer lower interest rates for homes certified to the standard. The programme now accounts for about 10% of total new home building in the country. This would have been unimaginable back when I worked in Romania in the mid-1990s and is a great achievement by the Romania GBC who are now replicating it in 11 countries with the support of a Horizon 2020 funded project. Like the other successful projects it has the four elements of the energy efficiency financing jigsaw.

The last time I had been in Bucharest was for the total solar eclipse on 11 August 1999 and after twenty years away it was great to see some old friends and colleagues as well as the big changes in Bucharest, which is a lot more pleasant to be in than it was back then. There is a lot of building rehabilitation underway, rehabilitation that has to improve earthquake resistance as well as thermal performance. Much work needs to be done to increase the flow of capital into increasing the performance of the building stock in all aspects but that applies everywhere. The country is moving in the right direction and the continuing dialogue between banks and other stakeholders catalysed by events such as the Roundtable, coupled with the available tools such as the Romania Green Building Council standards, the Investor Confidence Project, the EEFIG Underwriting Toolkit and the De-risking Energy Efficiency Platform (DEEP), will help accelerate the trend.

Although I greatly enjoy speaking at conferences our real work is working to improve the ratio of projects to conferences – that is getting more investment into energy efficiency. If you share this mission and want to discuss how EnergyPro can help you let me know.


What did we know about energy efficiency financing back then?
NOT MUCH
- Shortage of money for EE
- Global warming wasn't a big thing
- It was all about energy cost savings
- It was all about Energy Performance Contracts
- EE had no risk
- Little or no investor interest
- EE was a 'cause'
What do we know about energy efficiency financing now?
A BIT MORE
- No Shortage of money for EE
- Global warming is a big thing
- Not all about energy savings
- Not all about Energy Performance Contracts
- EE has managable risk
- Lot of investor interest
- We have the tools to derisk it and create a financing market at scale

10 Energy Policy

Over the years I have dipped into and out of policy circles. I once had the grand title of 'High Level Policy Adviser on Energy Efficiency to the Government of Romania', a title greater than my actual influence on the Government of Romania. I have also written policies and guides for policy makers. In the UK I go through periods of interacting with policy makers on specific issues, usually when there is a change of government or Minister, and then withdraw – when it starts to feel like banging my head against a brick wall. Policy is of course important and we need better policies – mostly though I would rather spend my time doing stuff 'on the ground' rather than writing policy and banging my head against the same brick wall.

10.1 Crisis and opportunity in UK energy policy. 28 May 2013

An interesting recent research note by Liberum Capital highlighted the problems at the heart of UK energy policy and the very real risk of a crisis in electricity supply. This was of course not new news, while at Matrix I published a research note outlining the same problems – 'The Ghost in the Machine', 24 November 2009 – and the threat has been widely reported, but the Liberum report was a good piece of integrated analysis tying together the physical situation and the current reality for investors. At the end of the day, whatever energy sources we want to use, we need investors to invest in new plant and infrastructure and right now they are not likely to do that.

The background is relatively well known. The 2003 EU Directive committed member states to a 20% reduction in average greenhouse gas emissions and endorsed a target of 80% by 2050. The UK Climate Change Act went further than the EU target and set the 2020 and 2030 targets in law. The previous government committed the country to massive expansion of renewables, particularly off-shore wind – a technology that can only provide intermittent power, is unproven at scale, and staggeringly expensive. The off-shore wind industry believes it can achieve a long-term cost of energy of £100/MWh by 2020 – compared to the current wholesale cost of power of c£50/MWh – but many think this is optimistic. Even if it isn't it assumes a massive increase in power costs that need to be paid by the consumers, either directly or indirectly through subsidies.

At the same time a significant proportion of UK generating capacity is set to close due to a combination of the Large Combustion Plant Directive and the need to retire ageing nuclear plant, most of which have already has their lifetime extended far beyond the original estimates. Although the supply margin, the difference between total available generating capacity and peak load is currently ample, it is likely to decline quickly as older gas plants are mothballed as the current spark spread (the ratio of gas to power prices) is insufficient to justify either operating the plant or investing in refurbishing them at the end of their twenty year design life. Liberum estimate that the margin between available dispatchable capacity and peak demand in the winter of 2015/16 could get below 10% which is tight. At this level the risk of the lights going out somewhere increase. On 12 December last year the National Grid had to call on all available capacity to meet demand, which is fine as long as everything works as it should but the problem will come when there is a coming together of a sequence of unlikely events, any of one of which in itself wouldn't cause a problem. Most large blackouts, aircraft crashes and industrial accidents are caused by long chains of unlikely events coming together (see **this** for a time line of events behind the 2003 blackout in NE USA and Canada).

In the words of the Liberum report governments (the current and the previous) have been playing Russian roulette with energy policy. There is a serious risk of an electricity supply crisis, either in the 2014 to 2017 time frame or post 2020. This could manifest itself as the lights going out or as a spike in wholesale electricity prices with consequent effect on retail prices. With one in five households in energy debt and six million households in fuel poverty, retail energy prices are already a major social and political issue.

The country has effectively placed a very large bet on energy prices increasing – a bet that according to Liberum will cost £161 billion by 2020 and £376 billion by 2030.

The Electricity Market Reform (EMR) was designed to address the problem and unlock the massive amount of investment needed to build new plant and energy infrastructure. It all but nationalises the electricity supply industry as all investment decisions will be dependent on prices set by government through the CFD-FIT mechanism. Right now the EMR is having the opposite effect on utilities and investors with most being unable to make any UK investment decisions and several stating they would rather invest elsewhere. OFGEM, SSE and Centrica have all criticised the current policy situation.

So how do we get out of this urgent mess?

We need to rebalance energy policy and recognise that massive deployment of renewables, particularly off-shore wind, is premature and not the least cost solution. Technology transitions in any industry, but particularly the energy industry with its inherently long time-scales, have to be driven by significant advantages and a major driver of change is cost. Renewables do not have that advantage and we have been pushing a rock uphill with subsidies before the technology is ready. We also need to rebalance energy policy by recognising that what we need are energy services and not energy – and that energy efficiency is a major resource that needs to be equally represented at the table of energy policy makers as the energy supply industry. It is not just an add-on, a 'nice to have', or mandatory schemes, but rather should be the central plank of energy policy.

We need to accelerate energy efficiency in all sectors of the economy. Energy efficiency needs to be promoted for what it is, the lowest cost, quickest to deploy and cleanest source of energy services. A **2012 report form the Fraunhofer Institute** shows the average Levelized Cost of Energy (LCOE) for various renewable technologies in Germany and Spain, which range from a low of €75/MWh for on-shore wind through to €130/MWh for off-shore wind and €180/MWh for the more exotic concentrating solar and storage. The number for the existing fossil and nuclear grid is €60/MWh. Fraunhofer don't report on the equivalent LCOE for energy efficiency but averaging various studies from around the world **including this one** by the ACEEE shows that the LCOE of energy efficiency is in the range of €20 to 45/MWh. In addition to these costs there are the additional system costs inherent in deploying renewables (and nuclear). These were **highlighted in a 2012 report** by OECD – these range from, depending on the degree of market penetration of renewables and nuclear, from $0.6/MWh for gas to $83/MWh for solar PV. In stark contrast, energy efficiency brings with it system wide benefits in the form of, reduced investment in transmission and distribution, reduced line losses and capacity savings, which have been estimated by ConEd for a commercial lighting upgrade, distributed generation and demand response examples. For commercial lighting the system benefits, excluding the energy saving and the environmental benefit, is c.$36/MWh. So renewables bring extra costs and efficiency brings extra benefits. We need to recognise system wide costs and benefits.

We should also remember that energy efficiency has contributed more energy services over the last forty years than any other energy source – and that is without us really trying apart from the decade of the mid-1970s to the mid-1980s

The Electricity Market Reform (EMR) needs to include market based mechanisms which encourage consumers, and aggregators, to develop and implement energy efficiency and other demand side projects (i.e. distributed generation (DG) and demand response (DR)) and share in the system wide benefits described above. Right now it looks like the capacity market mechanism within EMR won't do this and proposals in Europe put forward by grid operators seem to be aimed at carving out all the benefits of demand side response for the grid operators.

We need to put more effort into building capacity in energy efficiency and energy management in three areas; the demand side (i.e. end-users at all levels from the board to the shop floor), the supply side (i.e. of energy efficiency goods and services), and the flow of finance into energy efficiency.

We also need to develop mechanisms to deploy Combined Heat and Power (CHP) and District Heating (DH) schemes. CHP and DH schemes lead to significant improvements in overall energy efficiency and should be supported in preference to intermittent renewables. This can be done in a way that engages communities in their own energy supply much more, something that will bring other social benefits as well as local economic gains. What is needed here, as in energy efficiency, is small amounts of support to aid the development of investment grade projects in industry and the built environment.

We also need to step up Research and Development (R&D) of energy storage technologies which will become more important as a tool for managing demand fluctuations as well as intermittent supply from renewables. R&D in energy generally also needs to be ramped up.

In the short-term (2 to 4 years which may be too long for the 2015/16 potential crisis) there are a number of gas-fired plants that could be bought back into operation but even that is not straight-forward. Most have been 'deep mothballed', which means as well as changes to the physical plant the staff have been laid off or redeployed. Taking a large power plant out of deep mothballed state requires something like two years but in order to do this there has to be a financial return to the operator and at the current spark-spread it is not worth doing it. Government will have to do a short-term deal for operators to make this happen outside the main EMR – sooner rather than later.

Finally, however controversial it may be, we do need to develop indigenous shale gas resources. This needs to be done in a transparent way using the best technologies.

The trope about the Chinese word for crisis being made up of the characters for danger and opportunity comes to mind. (Interesting enough in checking this there is some question of whether it is actually true but anyway….). The dangers of the UK's energy policy are clear – power cuts would cause huge social and economic disruption, possibly including social unrest – riots in the streets – and undoubtedly lead to big political shifts – probably even the downfall of the government of the day. The opportunity is to re-boot UK energy policy by:

- moving away from a supply dominated policy environment towards an energy services view-point
- really recognising the powerful effects of improving efficiency and the system wide benefits
- truly putting energy efficiency and the demand side at the heart of policy
- building capacity in the demand side of energy efficiency, the supply side and the flow of finance
- engaging communities in developing and operating the supply of energy services.

Getting this right might not do much to reduce the risk of a short-term crisis (2015/16) but it would help avoid the medium term risk (2020), most importantly doing it a least cost to the consumer, as well as bring benefits of increased productivity, reduced costs, reduced levels of fuel poverty as well as reduced emissions.

10.2 Six impossible things before breakfast? 22 July 2013

I was surprised recently to see a headline (Daily Telegraph Business 3 July) that said 'New nuclear possible by 2020, Davey insists". Apparently Ed Davey, the Secretary of State for Energy and Climate Change, said that Britain could have a new nuclear reactor generating by 2020. My immediate thought was, what did he have for breakfast that day or what was he smoking, as we all "know" that every nuclear plant project around the world is years late and way over budget. I decided to check into this by looking at the statistics on the World Nuclear Association (WNA) website which helpfully has a lot of data on every nuclear power station and project.

For details see: **http://world-nuclear.org**

So is it really possible for the UK to build and commission a new nuclear plant by 2020 which is six years and five months away (77 months)?

Here is some data from the WNA website to help you judge. For the first pass I just looked at reactors that had been commissioned since 2000.

The average time to build for all reactors commissioned since 2000 was 9.6 years (115 months).

Now this includes all types and sizes of reactors including some 220 MW capacity PHWRs (Pressurised Heavy Water Reactors) whereas the planned UK reactors at Hinckley Point C are PWRs (Pressurised Water Reactors), or to be more precise EPRs (European – or Evolutionary – Pressurised Reactors). The EPRs are 1,650 MW capacity. So let's take the non-PWRs out of the equation and just look at the build times of PWRs, build time is defined as construction start date to date of first commercial operation.

The average time to build for all PWRs commissioned since 2000 was 10.4 years (124 months)

To be fair there are some obvious outliers in the data, mainly Russian, Ukrainian and Czech reactors that took inordinate amounts of time to build – an amazing 27 years in the case of the Rostov 2 reactor, (started 1st May 1983, commercial operation 10th December 2010). Clearly there were special circumstances, i.e. the little matter of the fall of the Soviet empire. So let's take out all the plants that took longer than 15 years to build.

The average time to build for all PWRs commissioned since 2000, excluding all those that took longer than 15 years to build, was 6.4 years (77 months).

To move one step further and to favour the nuclear industry, let's take out all those PWRs that took longer than 10 years to build.

The average time to build for all PWRs commissioned since 2000, excluding all those that took longer than 10 years to build, was 5.1 years (61 months).

So let's look at the track record of EDF building EPRs. The other EPRs being constructed are Olkiluoto 3 in Finland and Flamanville 3 in France. Construction of Olkiluoto 3 started in 2005 and originally the station was supposed to be completed by 2009. It is now expected that operation will start in 2016 – implying a build time of 11 years. Originally the cost estimate was €3.7 billion, (an obvious low ball bid!) but the cost is now expected to be €8.5 billion. Flamanville 3 construction started in December 2007 with an estimated build time of 54 months (4.5 years), implying commercial operation some time in 2012. Estimated costs have, like Olkiluoto 3, risen from €3.5 billion to €8.5 billion, and estimated completion is now in 2016 (implying a build period of 9 years, 108 months). EDF Energy has, according to the Telegraph, "refused to give an up-to-date timetable for building" the reactors at Hinkley Point C (perhaps not surprising!). Ed Davey did hedge his bets by saying; "*We are still hopeful we could see new nuclear generating in maybe 2020, 2021. I'm not going to say it will definitely be there because we haven't signed a deal yet*." In may, Chief Executive of Centrica, which pulled out of the project in February, said, "*instead of … taking four to five years to build, EDF were telling us that it was going to take nine to 10 years to build*" – which implies EDF are less optimistic than Ed Davey of generation by 2020. Given the experiences at Olkiluoto and Flamanville nine to 10 years seems a more realistic estimate than the six to seven years implicit in Ed Davey's comments.

So is it really possible that we could have a new EPR nuclear plant up and running by 2000? Looking at the data, and being positive you have to say it is possible but it certainly doesn't look likely.

I can only assume the comment by the Secretary of State was designed as part of the current reassurance campaign that the lights won't go out as the supply margin gets smaller as older nuclear plant and large coal plants are decommissioned. It is clear that the risk of the lights going out is increasing, but then we knew that a long time ago and previous governments ignored the issue. To quote "*Old Sparky*", who writes the "*Keeping the Lights On*" column in Private Eye (which should be essential reading for all energy analysts), Plan A

for keeping the lights on was "windfarms, new nukes and pixie-dust", Plan B was a new dash for gas. Plan C is to "pay large electricity consumers to switch off when requested; encourage industrial companies and even large hospitals to generate their own diesel-fired electricity (not a hard sell when the grid can't be relied on); hire diesel generators to makeup for the intermittency of windfarms." Plan B – the dash for gas – probably won't ease the problem in the next three to four years, (neither will EMR), but plan C probably will……with any luck…….and a following wind, (or more accurately good wind days on days with high demand),…….if nothing goes wrong on the wrong day at the wrong time.

Never having read Alice in Wonderland I decided to look up the quote about believing six impossible things before breakfast. In response to the White Queen telling Alice that she is one hundred and one years, five months and a day old, Alice says:

"I can't believe that!" said Alice.

"Can't you?" the Queen said in a pitying tone. "Try again: draw a long breath, and shut your eyes."

Alice laughed. "There's no use trying," she said: "one **can't** believe impossible things."

"I daresay you haven't had much practice," said the Queen. "When I was your age, I always did it for half-an-hour a day. **Why, sometimes I've believed as many as six impossible things before breakfast**."

Now, believing six impossible things before breakfast is a useful skill, especially when thinking about the future or for people who want to change the world like entrepreneurs. However, I am not sure it is a useful skill for politicians in charge of energy policy.

I am going to cover the topic of Electricity Demand Reduction (EDR) and the Electricity Market Reform (EMR) soon, that is the essential piece of the puzzle that is being ignored in all of this debate. All I will say for now is, as new nuclear is getting a £10 billion guarantee and a strike price in the range of £80 to £115 per MWh, can we have let's say a £1 billion guarantee for electricity demand reduction projects and a strike price that is a fixed percentage of that for nuclear – let's say 75% – and let's see how many MWh (or more accurately negawatt hours) the energy efficiency industry can deliver by 2020.

10.3 The close link between electrical power and political power. 15 July 2013

It is easy to forget in a modern, developed democracy but there is a very real link between electrical power and political power. This is most noticeable in emerging economies but it is true everywhere – probably because in most countries used to 24/7 reliable power a prolonged (or even a short) time without electrical power would quickly lead to the fall of a government.

This link was most noticeable to me in my time in Romania (1994-1998) which was quite soon after the fall of Nicolae Ceauşescu and communism. There was an old adage in Romania. 'When the President of the country telephones the President of the electricity company the President of the power company may or may not take the call, depending on what he is doing or what he feels like. If the President of the power company calls the President of the country, the President of the country always takes the call.' I am not sure how true it was but it was told to me by a former President of the power company and it really reflected the power of the power utility. It was further brought home to me when during the election of 1996, (which led to the first post-communist change of power and the first President who was not associated with the former regime), when there were stories of local power officials using the threat of power cuts to industrial enterprises to encourage block voting in a certain way.

Anyway, there clearly is a link at many levels – the prolonged absence of electricity could cause civil unrest and ultimately the downfall of a government. If the UK power crisis does get to the situation where the "lights go off", i.e. there are blackouts – which with luck we will avert (luck not the best thing to plan on!) – we will once again see the close link between

electrical power and political power, a link not really seen in the UK since the dark days of the miner's strike and the three day week of the 1974.

For any readers too young to remember the three day week see **http://en.wikipedia.org/wiki/Three-Day_Week** for details.

10.4 All I want for Christmas

I was tempted to write one of those humorous Christmas blogs like "how much energy has been saved by switching to LED Christmas lights" or "how much energy does Santa's sleigh use" but in the end decided to finish my first year of blogging with something more serious – my Christmas wish list.

All I really want for Christmas (apart from my Amazon wish list), is a sensible and honest energy policy for the UK.

What might such a policy look like?

First of all energy policy has to openly address the interlinked set of problems we are facing: rapidly declining continental shelf oil and gas production, worsening energy security, shrinking electricity supply margin, the need to invest in new generating and transmission systems, increasing energy prices and lack of consumer trust in energy companies, the cost and intermittent nature of renewables, the high cost of nuclear, and the fact that the electricity regulation framework is no longer fit for purpose for the new energy world. Political and corporate leaders need to unequivocally acknowledge the problems and realistically assess the options for mitigating them.

Political leaders should understand and explicitly say that energy efficiency is one of the best (cheapest, cleanest and fastest to deploy) and largest energy resources we have. This isn't about saying blah blah blah blah about energy supply and then adding some nice words like "and of course we should not forget energy efficiency". They should recognise the facts that over the last forty years energy efficiency has delivered more energy services than any other source of energy.

Then we need to enact the following policies:

- It should be mandatory that every time someone proposes building new energy supply facilities – of whatever technology – they should have to explicitly and independently assess options to improve efficiency, comparing returns, risks and delivery times
- The regulatory framework should be changed to incentivise Distribution Network Operators to evaluate demand side measures as an alternative to expanding supply options and require them to invest in the demand side option if it has equal or better returns
- Electricity generation should be separated from energy supply
- The smart meter programme should be refocused on improving the metering of the distribution system. Smart meters are an important piece of infrastructure but in its current form the roll-out of residential meters does not have a value proposition for the consumer
- *All* subsidies and tax breaks for the development and deployment all types of energy should be phased out in no more than ten years. A step-down schedule for each subsidy and tax break should be announced and stuck to
- There should be a doubling in R&D in energy technologies and private sector R&D should be encouraged by favourable tax treatment
- Require all buildings to display Display Energy Certificates
- Require all commercial building owners to make their energy use publicly available on-line

- Require firms to report on energy efficiency opportunities identified by ESOS scheme surveys
- The various schemes such as CRC, ESOS etc should be radically simplified so that energy managers can concentrate more time on developing projects and less on completing forms for government
- Require suppliers to government to have ISO50001
- The government should show leadership by launching a series of large-scale, multi-premise Energy Performance Contracts (EPCs) covering multiple central government buildings and facilities across geographical regions. Funding could either be on the public budget or from private sources – the conditions would be that the deals are cash flow positive, utilise integrative design techniques, guaranteed by credible Energy Service Companies and have independent Measurement and Verification. The results and the contracts should be available on-line to encourage greater use of EPC in the public sector

Well, we can all dream about what we want for Christmas!

By the way, I was still wondering how much energy converting all our Christmas tree lights to LEDs would, or perhaps already has, saved. By my calculations, if used universally on the UK's 7 million domestic Christmas trees LEDs would reduce load by about 260MW and save about 29,000MWh of electricity compared to old fashioned fairy lights, with a value to consumers of c.£4m. And as for the energy used by Santa's sleigh the answer is clearly a very big number.

10.5 The demise of DECC. 15 July 2016

The unfolding events since the Brexit Referendum result have been hard to comprehend and of course the real implications will only be visible in years to come. I was contemplating writing a piece summarizing my views on the Brexit vote but like with other major, world changing events, it is taking longer to work out what I really want to say. I was also trying to avoid the "Brexit means this for energy/environmental policy" type of piece which we have all been deluged with in the last week. I have given up reading most of these as I think the bottom line is we don't actually know what it means and most of them are "click bait". However the splurge of items on the demise of the Department of Energy and Climate Change (DECC) has pushed me into print.

Clearly, as with everything else, it is too early to tell what the implications are going to be but I actually think it could be a positive move because it may focus attention more on the energy demand side than the supply side. Let's not forget, the real origin of DECC and in fact Departments of Energy in nearly all countries is the energy industry. In the UK and the USA more than 50% of the energy department's budgets are tied up in nuclear issues. In fact according to one analysis 95% of DECC's budget went on nuclear clean up.

Also DECC was always dominated by supply side thinking with little real appreciation of the demand side. Even to this day there has never been a real bottom-up demand side modeling exercise to work out what energy supply we need. All modeling is supply side dominated – usually based on selecting a set of favoured technologies. Also the energy industry has people in and out of DECC all the time, ranging from regular meetings to full-time secondments. The energy efficiency industry has never been able to get equal billing – it only had its first short-term secondee into DECC a few years back which was a novel experience for both the industry and DECC!

Also if you haven't read the UK ACE report *"Corruption of Governance"* before, read it to get a good idea of how things work.

We need to move from energy policy driven by what the supply industry wants (including the renewables industry) to an energy policy that starts from what the real demand for energy is (and could be) – what do we need and how do we manage demand through energy efficiency and distributed generation and storage. At least if energy is part of Business and

Industry there is a hope, and it is only a hope at the moment, that the demand side may get better recognition.

I may come up with some specific recommendations soon but right now I am distracted by the terrible events unfolding in Nice. On energy policy at least I am always optimistic but delivery is everything.

10.6 Five ideas for Greg Clark. 25 July 2016

Back in 2010 I was part of a small group asked by Greg Barker, then Minister of State at DECC to "give me five things I can do on energy efficiency*". Well now that we have a new government and a new department it is time to refresh those five things for the new world we find ourselves in. Since 2010 we have learnt a lot about energy efficiency and how to accelerate investment into it although the reality has yet to catch up with the potential. So here are my five things for Greg Clark.

1. The incorporation of energy into DBEIS is a perfect opportunity to change the narrative around energy and energy efficiency to one of energy productivity. As I have argued in **previous blogs energy productivity** is a powerful organizing theme for energy policy. It is also really hard to argue against improving productivity, and energy productivity focuses attention on both retrofit and ensuring new infrastructure is as efficient as possible. We know there is a need to improve productivity generally and energy productivity should be one element of that. We need to join the growing list of countries that have set energy productivity targets and establish a clear energy productivity target.
2. Start an independent energy modelling unit that produces demand-side driven models rather than supply-side driven models. Amazingly the UK has never really had this capability in government.
3. Simplify the complex world of business energy tax and reporting in order to free up energy managers time to develop projects.
4. Promote the use of third party investment into energy efficiency by developing a large-scale programme within the government estate. This requires creating a framework approach that brings development capital, implementation capital, a totally standardized approach to developing efficiency projects (see the **Investor Confidence Project**), and standardized (and public) reporting of results.
5. Move all energy efficiency programmes towards a **pay for performance model** in which we pay for real measured results and not for stuff. This means using advanced measurement and verification technologies to measure savings against dynamic baselines. Doing this will move us away from the forty year old paradigm that energy efficiency has to be some top down mandated programme and towards a real market where energy efficiency is as reliable as energy supply and can be priced and financed properly.

If I can get away with three other key points; firstly start talking much more about the non-energy benefits of energy efficiency which are usually much more interesting and strategic than energy cost savings, make improving energy productivity a national infrastructure priority and finally pull the plug on Hinkley Point.

By the way I was surprised to hear that DECC officials moved immediately. If only everything in government ran as quickly as the removal/arrival of PMs from Number 10 and the movement of civil servants from one building to another.

* If you want to review the five recommendations see Energy World February 2013.

10.7 Zen and the art of energy regulation. 20 Jan 2017

I read that President Trump said that energy regulations are hampering economic growth and that his new administration will dismantle a whole range of regulations. This reflects an archaic way of thinking about economic growth – the old paradigm. My starting point is that we do need to seriously increase global economic growth to get us out of problems caused by poverty. This may be controversial but we only have a real chance of solving our many problems and achieving positive goals if we make everyone rich. The question is what kind of growth do we want or need? In the Trumpian view of the world it appears that all economic growth is good, even if it damages the environment, or health and safety, or exploits workers. Externalities such as pollution, health or wage fairness are not considered. This is the robber baron capitalism typical of 19th century America and which is still being practiced in many other places in the world. It has no consideration of consequences or of the quality of economic growth.

Considering the quality of economic growth led me back to one of my all time favorite books, "*Zen and the art of motorcycle maintenance*" by Robert Pirsig. For those that haven't read it, go and get a copy as soon as you finish reading this but be prepared for a difficult, though ultimately rewarding, read. By the way, it is not about motorcycle maintenance but is rather about a philosophical journey that explores the nature of human experience. Pirsig talks about quality or value and says that it cannot be defined because it empirically precedes any intellectual construction of it. It is that sense you get from the numerous sensory inputs that you have before you intellectualise it.

So what kind of economic growth do we want, and need? Economic growth that pollutes the environment, or is based on exploitation of workers, reduces the quality of our experience – sometimes in a sub-conscious way which contributes to a "dis-ease" – but always with an impact on our experience. It is most obvious in examples such as clean air. People want clean air – breathing clean air is a pleasant high quality experience, breathing polluted air in places like Beijing, or increasingly London, reduces the quality of our experience. This negative effect is over and above the clear economic benefits of having clean air such as reduced health care costs from the reduction in respiratory disease. At the micro-level our quality of experience is increased by certain buildings – you know the ones that make you feel good when you walk into them. Likewise there is that positive sense of well-being, a high quality experience, that comes from being in beautiful countryside.

So we need to have economic growth that improves our quality of experience. This means growth that reduces quality sapping factors such as air pollution, growth that does not rely on exploiting workers at home or abroad, growth that repairs and restores environmental damage, growth that reduces our fears about climate change, growth that builds beautiful buildings and cities, growth that creates beautiful and uplifting landscapes, growth that comes from radically improving energy and resource efficiency.

The Trumpian view of growth may appear to be in the ascendancy right now because of the high profile of the US Presidency, but at the micro level many, many businesses, large and small, as well as individuals, are committing to more sustainable business models and practices. In the medium term the trends are unstoppable because people naturally seek higher quality experience – it is hard wired into our DNA. We are witnessing a short-term reaction from the old guard which is typical of the collapse of a paradigm. The robber baron mentality will ultimately be confined to where it belongs – the history books.

10.8 Tackling the Government on energy issues: How should we view security of supply, energy efficiency and fairer bills. 12 Oct 2017

ESTA invited me to make a keynote address at their UMR Conference in Birmingham on 10th October 2017. Thanks to ESTA and the attendees for the opportunity and the questions. As usual this written version represents a tidied up and more coherent version of what I actually said on the day.

Only Eleven Percent

First of all I am always pleased to be back in Birmingham because it is where I took my undergraduate degree and first studied energy matters. Secondly I am pleased to be in Birmingham as last week I was supposed to be presenting in Barcelona but I don't like going into cities with civil unrest, fortunately Birmingham is not quite ready to declare independence but given the crazy world we live in now let's give it a few years and see what happens.

I was given this title and my first reaction was that it was very different to what I normally talk about – the Investor Confidence Project, energy efficiency financing and making efficiency more investable. And then I realised that those topics are very much related to addressing the issues of energy security, energy efficiency and fairer bills and I should use the opportunity as if I was giving advice to government. I should start out by saying – with apologies to any government representatives in the room – I often find giving advice to governments, and I am not just singling out the UK here, a case of banging your head against a brick wall, I can only do it for so long and then I have to stop for a while.

I know we live in a "post-factual" world but let's start by looking at some facts, many of which are still shocking and which demand a strong response. These are facts that will impact on the global, European and UK energy situation over the coming years and decades, facts that need to be considered when formulating policy.

- The EU spends more than €1 billion a *day* importing energy. It was up to €500 billion a year but the fall in oil prices has helped a bit
- Fossil fuels are still dominant globally. Despite rapid gains for renewables, fossil fuels still account for 80% of global primary energy use
- The US spends about $280 billion a year on US Navy power in the Gulf region, essentially protecting the flow of oil. That works out at about $83 a barrel and yet only 20% of the total flow goes to the US, a percentage that is declining as the US becomes more self-sufficient. In a world with an isolationist US government (if it is isolationist today according to the latest tweets), you have to question how long that may continue
- In 2016 the Kingdom of Saudi Arabia, a country I have been fortunate enough to get to know over the last few years, produced c. 10.5 million barrels of oil a day and exported c.7.6 million barrels a day. Some projections show that by 2035 domestic demand in Saudi Arabia could equal production. Needless to say if this ever happened it would have very significant effects on the oil market and Saudi Arabia. This is undoubtedly being taken very seriously within the Kingdom
- Russia supplies 34% of gas used in the EU, a situation that the EU expects to continue for "at least 2 more decades". That is a major geo-political strategic risk
- When we look globally we see huge economic growth, particularly in China, India and S.E. Asia with projections that there will be an additional 3 billion middle class by 2030. That will be a huge achievement and very welcome, but we know that when people become middle class their demand for energy kicks up dramatically as they start to buy all the energy using devices we take for granted
- There are an estimated 2 million premature deaths a year globally, a result of burning fossil fuels. In the EU the number is estimated at 300,000 and in the UK 50,000. This problem is not being addressed effectively, I think all parts of London now exceed "safe" limits on particulates so we have gone backwards, mainly because of the promotion of diesel cars
- Globally 1.3 billion people are without electricity. There are great strides being made on this, again India stands out as a good example. We need to get everyone using electricity, the benefits in education and health are huge
- On the issue of climate change, the IEA and IRENA estimate that to achieve their "66%, 2°C" scenario the investment into energy efficiency has to be increased to an average of > $1 trillion a year, a five-fold increase on current levels

Jumping back to the UK:

- the UK imports just under 40% of its energy supplies and at the peak in 2012 the financial cost was £24 billion – more than £460 million a week. Perhaps we should put that on the side of a bus. Although things are now moving in a better direction this is still very concerning
- We know the UK electricity system is facing "unprecedented challenges" in terms of supply margin
- We have Hinkley Point C which is an unproven technology which is already late – no surprise there. Also apparently we need the Chinese to finance reactors. I was bemused to read a report this morning that government officials testified to a committee that the decision to build it was "the best value option"
- We still have not resolved fuel poverty after years of talking about it. We have 4 million people including 1.5 million children living in fuel poverty which costs the NHS £850 million per year
- We know that there is a massive, cost-effective energy efficiency potential, equivalent to 22 power stations according to the government. However, despite many successes, we still only scratch the surface of the economic potential. We all know of projects that don't proceed despite great paybacks, paybacks that we would all be happy with in our own investments
- On the positive side, solar is rapidly becoming economic without subsidy, not just in the UK but globally
- We are also seeing great reductions in the price of storage, particularly batteries, that will dramatically change the energy scene. Projects like the famous Tesla giga-factory are starting to have an impact
- In transport EVs are making an impact much faster than many, including myself, would have predicted. Next month will see the launch of Tesla's electric "semi" truck and electrification can offer rapid paybacks in selected freight transport segments. I recently heard of a company working on marine electrification for ferries. That is a great application I would never have thought of, there is a predictable duty cycle and there are less space constraints and technical issues than in cars
- As well as the falling price of solar and batteries we are seeing a fall in the price of energy efficiency. The most obvious example, but not the only one, is the price of LEDs. This slide was shown by the Indian Prime Minister last week and it highlights the work of Energy Efficiency Service Ltd (EESL) who have aggregated demand and bought the cost of an LED lamp in India down from c.$7 to c.70 cents in a very short time by aggregating demand. EESL is now applying that experience to other technologies and other countries including the UK, and I am proud to say that my company EnergyPro is their JV partner here
- All of this change has had a massive effect on traditional utilities. There have been massive financial losses – €0.5 trillion (yes trillion) according to the Economist in 2013 (and more since then) – and big restructurings. All utilities are looking for new business models, if they are not then they are finished
- The effect of solar on the grid is the same everywhere. The arrival of what the Americans call "the duck curve" is being felt in all electricity systems where solar is being deployed i.e. all systems. The duck curve is a rapid reduction in net load during the day as solar output climbs coupled with a steepening of the load curve in the evening as solar output falls away, a steepening that is increasingly hard to match with conventional generation technology

Given these facts (and many others we could talk about) we need to take a new perspective on energy and energy efficiency. If we don't we will continue to bang our collective heads against the same brick wall over and over again, and energy efficiency will continue to under-perform.

So, what is the "traditional" view of energy efficiency? I would summarise it as follows:

- efficiency is something that is tacked onto the end of energy policy. Politicians talk about energy, finish by saying "don't forget about energy efficiency" and then promptly forget about it
- it is "good for you" in the same way that cold showers are good for you
- it has uncertain outcomes – one of the reasons people don't invest in so-called "low hanging fruit" is that they are not convinced they will get the promised results
- it needs to be encouraged by mandates or subsidies
- it is hard to invest in
- it is somehow different to other markets – there are "market failures"
- it is often a "calling", a "campaign" or a "crusade"
- for most people, most of the time, it is really, really boring.

The new and emerging view of energy efficiency is one in which:

- it is central to energy policy
- it is a Distributed Energy Resource (DERs) like other DERs such as local generation & demand response
- it can be reliably dispatched with quantified and known risks
- it can be aggregated
- it can be contracted for using standard contracts that look like Power Purchase Agreements
- it can easily be invested in
- it can be priced per kWh like any other energy resource.

So how do we actually make this view mainstream? We have to create a true market for energy efficiency. At the moment we talk a lot about "the market for energy efficiency" but there is no market for energy efficiency, there are only markets for stuff such as LEDs, boilers, controls, heat recovery etc. You can pick up the phone or go on-line and buy energy, but you can't buy energy efficiency, only stuff and stuff with uncertain outcomes.

To make a market, any market, we need several things; a system of weights and measures, standardization of product, and standard contracts with penalties for non-delivery. If you look at any market, whether it be apples, or sophisticated financial derivatives, these factors are present. The good news is we now have the technologies to make a true market for energy efficiency.

This is now starting to happen in California and spreading to other US states. In California it was driven by new legislation that increased renewable and energy efficiency targets and required a switch from deemed savings to metered savings, combined with pay for performance models. Once you make that change it enables a number of things including:

- contractors can pick their business model and technology. If a contractor can save energy through awareness campaigns then they can be rewarded just as if they had invested in LEDs
- contractors have to perform, or they go out of business
- a programme administrator or a procurer of energy efficiency can compare the performance of different contractors
- multiple small projects can be aggregated and demand capacity sold into the grid
- the grid operators can enforce the same kind of non-performance penalties on energy efficiency they can on energy supply options
- a market can be established by utilities setting a resource curve and procuring efficiency in the same way they procure energy supply, with metering, a high degree of certainty in the outcome and penalties for non-performance

- reverse auctions can be held that set the price for the various energy efficiency resources. For those that are not economic, e.g. fuel poverty programmes or encouraging deep retrofits, governments can add a payment on a price per kWh basis to drive the real outcome they want
- energy efficiency projects can be financed through project cash flows rather than on the balance sheets of project sponsors, therefore becoming just like every energy generation project.

So if government, any government, should ever ask my advice in future this is what I would say:

- avoid chasing the latest shiny bright thing (this month's being Small Modular Reactors)
- treat energy efficiency as a resource like any other
- support the establishment of energy efficiency weights and measures
- require that energy efficiency is metered *not*
- support Pay for Performance models – don't pay for stuff, pay for results
- add programme support for situations that are not economic but desirable g. fuel poverty & NZEBs but pay for performance and not stuff
- encourage innovation only by paying for performance – don't worry about the technology – only the performance.

11 Enron

Enron is most often viewed badly, and for good reason. It is a classic case of corporate fraud and bad governance and much that is wrong with capitalism. However, Enron did some cool stuff, a small part of which I was involved with and of which I am proud. These two blogs capture some of the learnings from my short time there.

11.1 Lessons from Enron. 12 Nov 2013

This week, subject to court approval, Enron Europe moves out of administration – and presumably into history – twelve years after its collapse. Even after this length of time Enron is still a by-word for corporate malfeasance but its legacy – both good and bad – is extensive. Enron was nothing if not innovative. Amongst other achievements Enron:

- drove deregulation of energy markets
- drove standardization of commodity contracts
- combined energy supply and energy efficiency deals
- pioneered online trading of energy
- introduced weather trading.

The Enron organizational culture was one of hard work and high energy as well as open-ness (at least at the operational level), with a big focus on creativity, education and training. The Enron diaspora has gone on to inhabit significant positions in the energy markets in many energy companies and banks but most of us who worked there would agree that there was nowhere quite like Enron as a place to work.

Enron Energy Services used tools and worked on ideas that were ahead of their time – many of which are only now starting to become better known – including:

- data driven design to right size plant and equipment, reducing both energy use and capex spend
- risk assessment of energy efficiency projects using statistical analysis and portfolio management tools
- big data (albeit small by today's standards)
- measurement and verification of savings
- automated distributed demand response across large portfolios of properties
- conversion of traffic and street lights to LEDs.

The two deals I was involved in at Enron and then RWE – Diageo and Sainbury's -were both very different but truly ground breaking. The multi-utility outsourcing deal that Enron pioneered with Diageo led to very large energy savings (40% in the case of the Park Royal brewery) and was taken over and then replicated by the team at RWE Solutions (later part of RWE npower) in Diageo's Dundalk and Dublin breweries. The RWE – Diageo deal at St. James Gate in Dublin, (the home of Guinness), is still in place ten years after it started so it must have worked for both parties. The Sainsbury's deal which combined energy supply and energy efficiency (also originally sold by Enron but implemented by RWE Solutions), installed many hundreds (even thousands) of efficiency projects across the Sainsbury's portfolio over five or more years, helping them to significantly reduce energy use and carbon emissions.

Right now in the UK (and Europe) we need a lot more innovation in the energy markets to disrupt the Big 6 – particularly around:

- transparency
- combining energy supply, energy efficiency, demand response, data and finance
- real customer focus.

We need an organization as innovative and as bold as Enron to disrupt the energy markets and to take market share from the Big 6 – but definitely one without the dodgy accounting!

11.2 Lessons from Enron for a net zero world. 30 Nov 2021

In my third retrospective blog in recent months I wanted to mark the 20th anniversary of Enron's collapse and draw some lessons for the transition to net zero.

I was only in Enron for the last 18 months of its existence but it was quite a ride. When I first joined the London office it was a major shock as up until that point, I had largely worked for small organisations so walking onto what was the largest trading floor in Europe at the time was quite intimidating. Truth be known I had no idea what was going on for the first few weeks at least! It was only when I got involved in developing a project covering a portfolio of several hundred buildings that I got fully engaged. My experience in Strathclyde (**see earlier blog**) was helpful here, though in the end that particular project fell at the last hurdle.

Then the prospect of a project with the Guinness Park Royal brewery arrived which was perfect for me as I had spent most of my PhD working on energy efficiency in industry with a focus on brewing, malting and distilling, (it was tough being a student and visiting dozens of breweries and distilleries but someone had to do it). The vision for the Guinness project was the purchase of all on-site utility plant and provision of all utilities on an 'as a service' basis, and after a long and complex development and negotiation process we were able to implement it, only for it to fall away a few months later when Enron went into administration. Fortunately I was able to save the deal and the team by pivoting it into RWE and we then repeated it twice more in Guinness breweries in 15 year term deals. The Park Royal project turned the highly inefficient brewery to the best in class, reducing specific energy from 200 MJ/hl to 110 MJ/hl (the standard measurement in the UK brewing industry).

The innovative approaches pioneered by Enron included: bundling of energy supply and investment into infrastructure to reduce energy use and operational costs; right sizing of equipment of all types, risk assessment of energy efficiency measures, and aggregating loads for demand response. The time has come to apply many of them at scale. All of our legacy energy and utilities infrastructure, both in the energy grids and behind the meter in industry and buildings, is completely inappropriate for the new realities of climate change and the world of low-cost renewables, large-scale heat pumps, energy storage (power and thermal), flexibility and convergence of technologies.

Rather than tweak systems with marginal improvements we need to mobilize institutional capital in large-scale, multi-utility, integrated upgrades behind the meters of large industry and commerce. These kinds of investment can make the returns demanded by infrastructure investors, or better, and bring about significant reductions in emissions and multiple other benefits. They will however require risk sharing in the development phase and in the long-term operation.

So what are the lessons from Enron?

- Organisations need to think big – really get behind their net zero targets and go for radical change to infrastructure and go for portfolios not just individual sites. The time for tweaking around the edges and small-scale pilots is over. This requires leadership pushing for ambitious targets and not accepting the established solutions.
- You need creative engineering and systems thinking – look for integration and right sizing opportunities and don't just accept the standard solutions on offer from vendors and contractors.

- Look at the entire energy cost picture. Energy costs are more than just the cost of energy itself, they include O&M costs, capital requirements, compliance costs as well as the often hidden costs on people, working environment etc. All the costs and all the benefits need to be considered in the business case which needs to be linked to the organisation's strategic goals and commitment to emissions reduction.
- Think long-term, these are long-term investments and need long deals, 10 or 15 years with the risks that entails. Net zero targets help here – aim for projects that meet or exceed 2030 and even 2040 targets as infrastructure installed in the next couple of years is likely to be still around at least into the 2030s.

What would an Enron-esque organisation be doing today for large corporates? It would be a bespoke service company using a standardised process, and technical solutions would likely include offsite PV with private wires, energy storage, hybrid and integrated power and thermal systems, potentially becoming an energy hub for the neighbourhood, right-sizing, provision of grid services, and lots of connectivity and data providing carbon and wider impact reporting. It would also have ready access to institutional, infrastructure type capital and packages of behind the meter utility infrastructure, beyond just roof-top solar and batteries, a potential new asset class for investors keen to invest in ways that support the transition to net zero. Finally of course it would need sound accounting practices, a lot more humility and a purpose / impact driven corporate culture.

We are starting to see more organizations look for this kind of service and growing interest from investors. Individual suppliers and contractors can provide parts of the solution but the missing pieces are often the development skills and risk capital, and the ability to integrate and stand behind the risks.

At ep group, if you want to explore these kinds of solutions we'd be happy to talk about our approach to enabling them and how we can assist. For more information please go to: **www.epgroup.com** or you can contact us **here**.

12 Tools for boosting energy efficiency

Much of my work, and the work of the ep group, has been about developing tools that enable people to be more effective in implementing energy efficiency or to invest more. The blogs in this section describe some of those tools.

12.1 Launching the energy investment curve. 3 July 2014

If anyone needed reminding this week about the risks around energy supply they only had to look at the widely published satellite image of Iraq's largest oil refinery in flames. Recent events in Iraq as well as Ukraine have once again put energy security high on the agenda for governments and organizations.

Against this background The Crowd held their Green Corporate Energy 2014 event on the 25th June and it was great to be a part of the team that launched a new initiative called the Energy Investment Curve.

The Energy Investment Curve

The Curve is an experiment in peer-to-peer sharing of data about energy investments made by corporates and public sector organizations. It is designed to allow people looking at energy investments to see what their peers are doing, learn from experience, help form business cases and provide a new source of data on what is happening in the market. Our vision is that it will help accelerate investment in energy demand side measures. It was designed to be easy to enter data as energy and sustainability managers are already deluged by numerous forms and data requests – the record for completing it with five investments was 14 minutes (subsequently broken after the event by a new contributor!). Anyone with an energy budget greater than £50k per annum can contribute their own data and once they do they can look at the overall results. The identity of contributing companies is protected.

It asks for information on five energy investments covering; what it is, what was the capex, what is the payback period as well as general information about energy spend and payback thresholds. You can see an overview of the information we are collecting here. Once you have entered your information you will be able to access the results – you have to share to be able to benefit from the experience of The Crowd.

We think that the Energy Investment Curve will help you to:

- find organizations that have made similar investments to ones you are considering – you can learn from their insights, and request an introduction
- compare your energy investment programme with others – both within your own sector and across sectors – helping you to see if you missed anything and where have others achieved different results
- support your investment cases, using the validation of others by seeing what their paybacks have been, and where they have found added benefits.

We had an initial 60 seed contributors who have provided data. A big thank you to them all – many leading organizations in energy and carbon management as well as the wider sustainability field. In summary the seed contributors had:

- an aggregate energy spend of more than £1 billion per annum (about 7% of the UK industrial and commercial energy spend)
- entered information on 160 investments
- a total investment of £360m
- an average payback period on that investment of 3.2 years.

The Energy Investment Curve is designed so that the data can be looked at through three lenses:

- investment and payback
- co-benefits
- quality.

Investments and paybacks

Figure 1 shows the total investment by technology with payback period on the y-axis and the amount of investment in each category shown by the width of the column.

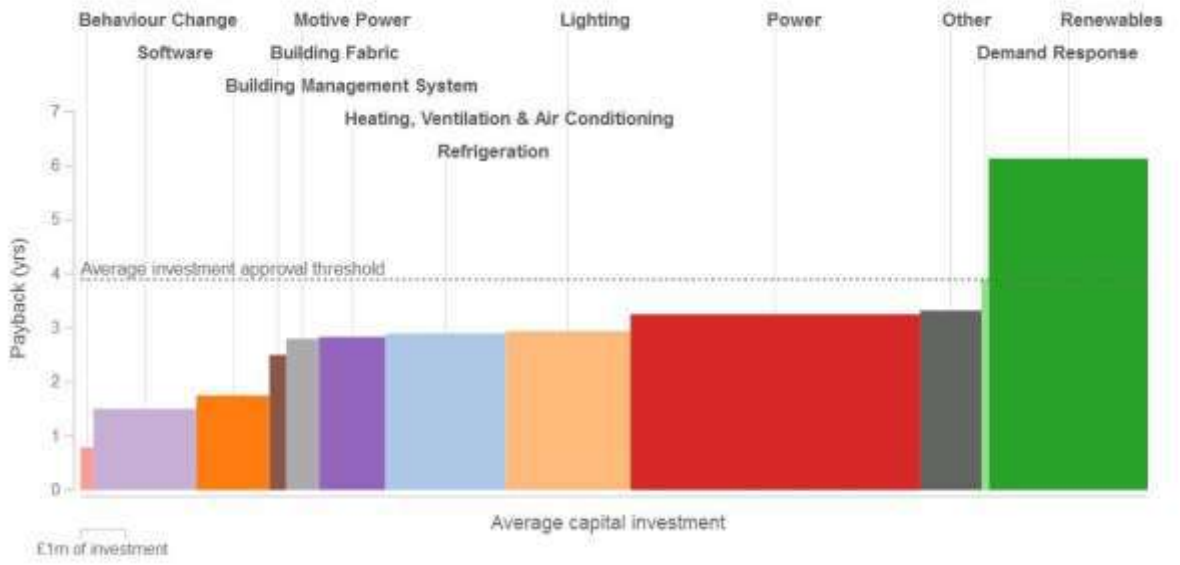


Figure 1

Even at this level the curve shows a number of interesting things including:

- the average payback period that is accepted for renewables (which includes CHP) at about 6 years is about twice as long as the average for all investments. Clearly organizations are accepting longer payback periods for renewables than for other investments
- a large investment in power – this was skewed by a large investment in voltage optimization
- behavior change and software measures had quick payback periods which would be expected as they are both capital light measures

Wouldn't you like to run through this list to check you haven't missed possible investments? Well now, you can. And imagine if instead of 160 investments there were 1,600 rather than 160. The question to ask yourselves is "how long will it take you to identify all of these possibilities through the normal ways of doing business?" This is a tool for reducing the discovery time and it is a tool for sharing knowledge between organizations working to invest in energy demand side measures.

The curve allows you to search by sector so that you can see what your sector peers are doing. Figure 2 shows the curve for the retail sector.

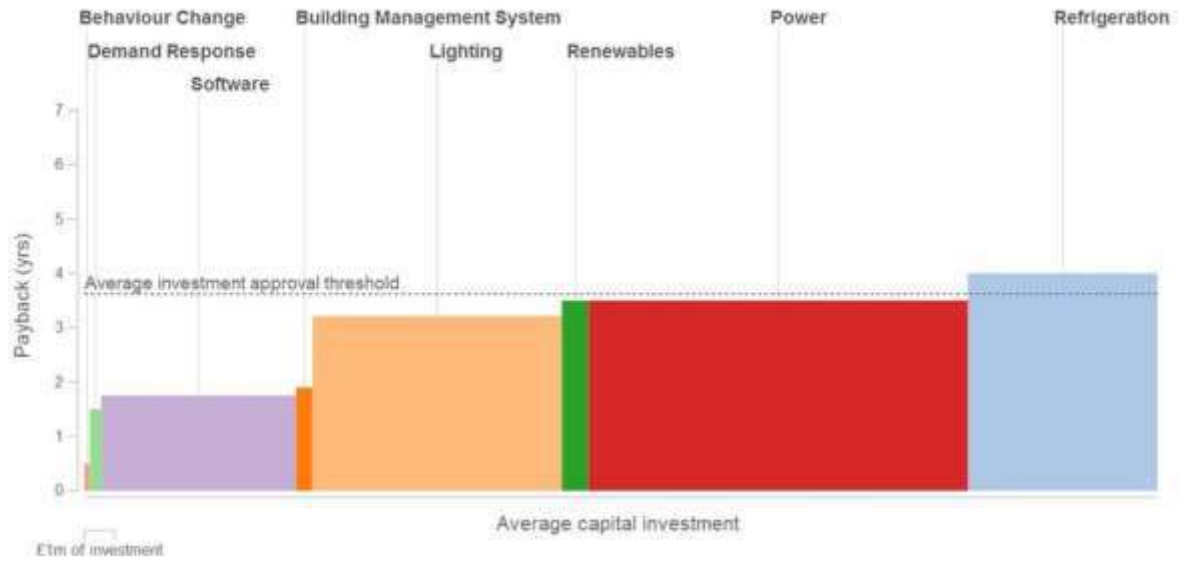


Figure 2

There are 29 investments in the retail sector. Payback periods are slightly higher than the overall sample – 3.7 years versus 3.2 average. As you might expect the investments are dominated by power, refrigeration and lighting measures – which reflects the energy breakdown in the retail sector.

Using the Energy Investment Curve, energy professionals in organizations, suppliers and government can actually see the pattern of energy investment across different sectors – really for the first time. As well as helping organizations one of the problems for the energy demand side industry and government is simply measuring it – the Curve is a tool that enables measurement of the industry size and its breakdown between categories. This is important because we have always had trouble measuring the size of energy efficiency and demand side investment. If we take the sample as representative of the industrial and commercial sector as a whole (which may not be quite right due to the fact that the sample is large firms), we might estimate that the total investment in the energy demand side is of the order of £6 to £7 billion – which should be compared to the £12 billion that was invested in energy supply in the UK in 2013.

One of the problems in the whole energy arena is confusion of terms. A few years ago a group of us started using the phrase "D3" to encompass all demand side activities – D3 is Demand Management (permanent reduction of load – more commonly called energy efficiency), Demand Response (temporary shifting of load), and Distributed Generation (generation on the distribution system such as on-site renewables and CHP). The Energy Investment Curve showed that investment was split roughly 2/3rd to demand management (energy efficiency) and 1/3rd to distributed generation with only a small amount on demand response. Given the pressure on the electricity grid and the increasing number of schemes to encourage demand response the small investment in demand response was surprising – and perhaps worrying for the grid. It will be interesting to see how this changes over the coming years.

The investment in distributed generation was split as follows:

- Biomass (various forms) – £48m
- Photovoltaics – £47m
- CHP/trigeneration – £19m
- Wind – £5m
- Hydro – £1.8m
- Solar thermal – £30k

There were 13 investments in PV with a total investment of about £10m – ranging in size from £5,000 to £3.75 million.

Given the revolution in LED lighting that is happening it was not surprising to see the level of investment in LEDs. Of 25 lighting investments, 19 specifically mentioned LEDs and of the £49m invested in lighting, about £46m of this was in LEDs.

A quick and dirty calculation suggests that the energy investments produced a levelized cost of electricity of about £30/MWh and a levelized cost of £8/MWh for gas – supporting the contention that energy efficiency is the cheapest way of delivering energy services. Refinement of this calculation would be helpful for making the case that efficiency is cheaper than new supply.

Counting co-benefits

The second lens we can look at the Energy Investment Curve data through is co-benefits. The co-benefits of energy efficiency investments are really important and increasingly being recognized. The IEA is about to publish a big piece of work on co-benefits and some research shows that co-benefits of energy efficiency investments can actually be worth four times the energy savings, which would take a four year payback period project on energy alone to a 1 year payback period if those benefits are properly quantified and evaluated. That is only counting the benefits to the host – not including wider social benefits. Examples of co-benefits include better quality, removing production bottlenecks and increasing employee engagement.

A lot of the smarter energy management programmes are incorporating added benefits into their business cases. Tim Brooks of Lego (my all time favourite toy and inspirer of engineers everywhere) talked about this in his excellent presentation at GCE14. I can't resist saying that Lego build up their investment case block by block incorporating co-benefits where they can. The uncertainty of some co-benefits is recognized in the process.

Other organizations are just recognizing the existence of benefits in their business case. For many years I have argued that energy and energy efficiency is a strategic matter – a matter of competitive advantage – and not just about cost savings. Catherine Cooremans, a business academic in Switzerland, has written extensively about the need to recognize the strategic value of energy efficiency investments (**source 1** and **source 2**. Competitive advantage has three dimensions – COST, VALUE and RISK. Energy efficiency addresses all these three but my contention is that the energy efficiency industry has not been good at making this case – it has always focused on energy costs alone. We need to stress the existence of co-benefits and always include them in business cases. A rejoinder to this is that they are hard to measure – and that can be true – but business cases for other things like increased advertising are also often based on hard to measure variables. Co-benefits need to be valued wherever possible but at least recognized.

The Energy Savings Opportunities Scheme (ESOS) is coming into force soon in the UK and will mandate large organizations to have an energy survey every four years to identify energy saving opportunities. A good feature of ESOS introduced by DECC is that the survey has to be signed off by a board director. One of my concerns, however, is that energy surveys are done by energy efficiency specialists – who have also written the standards for doing energy audits such as EN16247. Standards for things like energy audits are good but traditionally audits only look for energy benefits and that is now enshrined in a standard. Energy efficiency industry and energy managers need to raise their game – particularly around ESOS otherwise we are in danger of repeating history and producing energy audit reports that identify opportunities but sit on shelves – unused because they don't recognize co-benefits and the strategic value of energy efficiency. Back in the 1980s and 1990s we had to teach energy managers about investment appraisal techniques like IRR and NPV – now we need to teach them to look for and value co-benefits. It is no good complaining that the board does not recognize the co- benefits if no one identifies and evaluates them.

We looked at 13 co-benefits in the Energy Investment Curve including the obvious reduction in carbon emissions through to brand enhancement, employee engagement and reduction

in supply risk. Figure 3 shows the results from the seed contributors for co-benefits – the size of the dot reflects how many times the benefit was mentioned. The most often mentioned co-benefit – no big surprise – is reduced carbon emissions. The second biggest is employee engagement, particularly in renewables and lighting, which are perhaps the most visible energy investments.

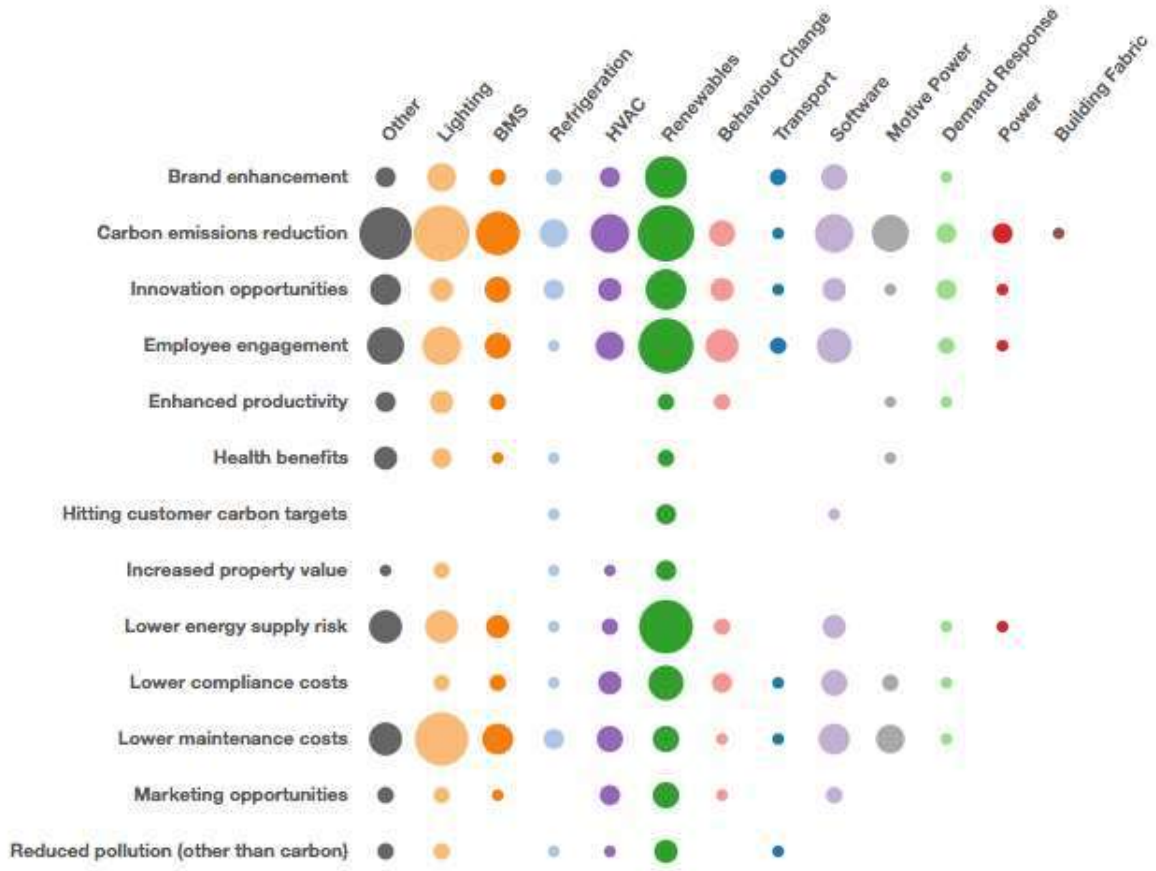


Figure 3

Interestingly renewables produced the largest employee engagement benefit as well as the largest carbon emission reduction benefit. Presumably this is to do with the very visible nature of many renewable investments such as PV and the ability to show data on energy production.

An example of co-benefits is given by the following example. A £1.75m resource conservation programme was rolled out across the west European sites of a Manufacturing / Industrial company. It paid back in around 18 months, and the company described it as "an excellent opportunity to engage with employees about what they can do to reduce energy & water usage" and gave it 5 stars.

Investment star ratings

The third lens that you can use to look at the data from the Curve is star ratings of investments. Generally ratings were high but of course that can be expected as people are more likely to submit their good investments – the ones that went well – rather than the ones that went badly. Renewables had the widest range of star ratings – all the way from 1 to 5. This may reflect the fact that the renewables boom has attracted many new entrants, not all of whom may be high quality organizations, or perhaps more charitably it reflects the fact that this is a new area in which we are all learning. Figure 4 shows the ratings in the seed contributors' data.

Only Eleven Percent

In the data you'll find a 3rd party financed PV array by a retailer with a comment: "The third party funded nature of the array limits financial gain to our organisation but provides a visible carbon reduction and energy efficiency story to our customers, team members and stakeholders." if you're thinking about making a similar investment, you'll be reassured by the comment and note the co-benefits but you'll wonder why they only gave it a 3 star rating. If you do then you can use the Curve to request an introduction and find out more.

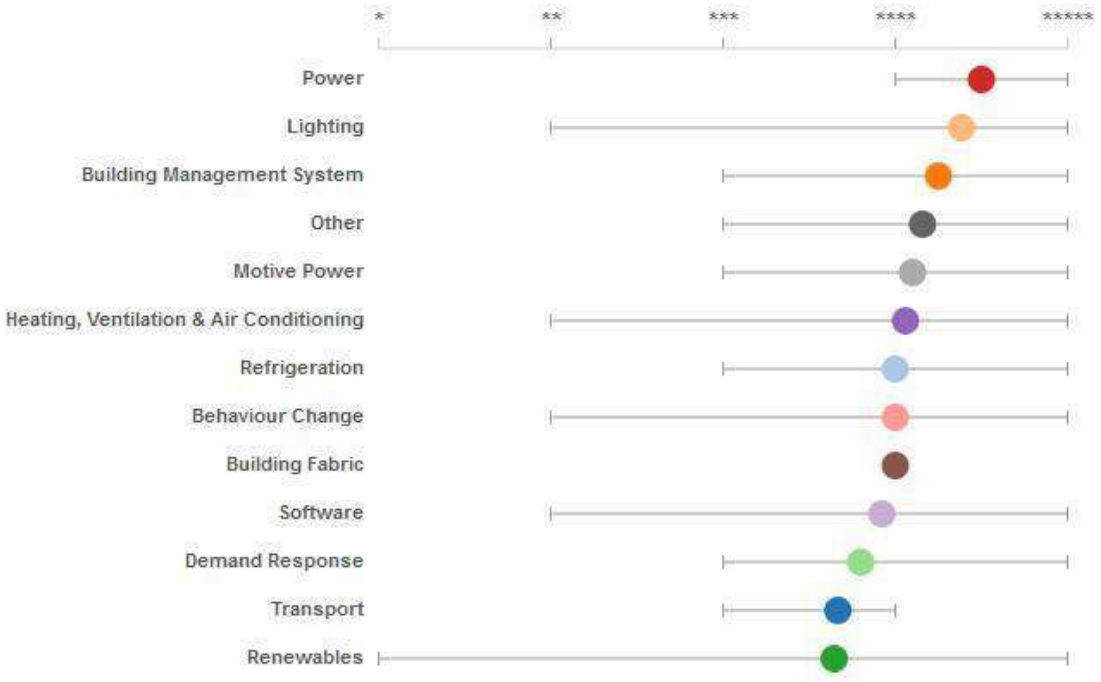


Figure 4

Problems with the data and improvements

The Energy Investment Curve we launched at Green Corporate Energy 2014 was a prototype – an experiment in co-creation – and can undoubtedly be improved. Amongst other things we have identified the following issues:

- We only asked for up to five investments – many organizations have made many more than five investments
- We didn't ask about the timescale over which the investments were made
- People are likely to self select their best investments
- There were some issues with categorization of investments
- We should have allowed a free field entry for energy spend
- We are relying on judgement rather than precise measurement but that is the philosophy of The Crowd
- There was no question comparing actual to projected performance of the investments – although it appears that many organizations do not actually measure post-investment performance

In the spirit of The Crowd we want to improve the Energy Investment Curve and expand its reach collaboratively. We are looking to form a small group to help improve it and steer its direction. We also want to expand its reach across the UK – and ultimately beyond – and will keep it open to new data. Please encourage other energy users to complete the data form.

Discussion

We know that there is still a massive opportunity for profitable investment in the energy demand side (D3) – in demand management (energy efficiency), demand response and of course distributed generation. Increasing the level of investment in these areas would bring great benefits to organizations – financial and other benefits – as well as to the country as a whole and the environment. D3 is the cheapest, cleanest and fastest energy resource that we have but it is not often thought about as a resource which sits alongside oil, gas, coal, renewables and nuclear. Many leading organizations over many years have shown that the energy efficiency resource just keeps giving. Companies like Dow Chemicals and 3M have consistently improved their energy efficiency and reduced consumption year after year and indeed decade after decade. Here in the UK BT has reduced its energy use year on year for five years, knocking £131m off its annual energy spend and reduced carbon emission by over 80% compared to 1996 baseline.

We hope that the Energy Investment Curve will grow and be used by many other organizations, helping them to increase investment in energy demand side measures and improve the returns from that investment, both from energy savings and the very valuable co-benefits. If we can do that we will be contributing to greater use of the demand side resource and helping to address the energy related problems we face – corporately, nationally and globally.

12.2 Launching the Investor Confidence Project Europe. 29 Oct 2014

One of the essential pieces of the jigsaw that we have to build to greatly accelerate investment into energy efficiency, particularly third party investment, is the standardization of project development and documentation. This is the area addressed by the Investor Confidence Project (**www.eeperformance.org**), an open-source initiative created by the Environmental Defense Fund in the USA which has created Protocols for developing projects in different categories of building and has considerable traction with banks, investors, the energy efficiency industry, and city and state programmes. As well as Protocols the Project has launched a Quality Assurance system called "Investor Ready Energy Efficiency SM" and an open data initiative. The Investor Confidence Project approach reduces due diligence time and cost, enables aggregation of projects and ultimately will facilitate a secondary market in energy efficiency finance such as the issuance of bonds. It also allows banks and financial institutions to build teams around standardized processes – no bank or investor can build a team around an ad hoc approach where every project is different which is the current state of affairs in energy efficiency. In time it will allow the collection of standardized performance data which can be used by investors. All of these things are necessary to facilitate a thriving and much enlarged energy efficiency financing market as no financial product – or at least no financial product that is used at scale – can exist without commonly agreed standards. Think about the standardization behind mass-market financial products such as mortgages, car loans, credit cards etc, and the bonds being used to re-finance them which draw on the debt capital markets. Unless we can get to that stage with energy efficiency finance we can't finance the huge amount of investment that we need to. The Building Performance Institute Europe estimates that between €500 billion and €1,000 billion needs to be invested in energy efficient renovation of Europe's buildings by 2050. This level of finance can only come from the private sector.

The Investor Confidence Project Europe concept has had some great support, the EU and UNEP Energy Efficiency Finance Investors Group (EEFIG) in its report, "***Energy Efficiency – the first fuel for the EU Economy***," specifically highlighted the Investor Confidence Project and said that "***[Europe needs the] launch of an EU-wide initiative to develop a common set of procedures and standards for energy efficiency and buildings refurbishment underwriting for both debt and equity investments***". The International Energy Agency in its "***Energy Efficiency Market Report 2014***", issued on 8th October said: "***[Investor Confidence Project] will facilitate a global market for financings by institutional investors that look to rely on standardized products rather than project-specific structuring and due diligence.***"

After many months of effort and work with the Environmental Defense Fund we have obtained funding and will be launching Investor Confidence Project Europe in Brussels on 5th November before the Renovate Europe event, and presenting at the BPIE Investor Day on 6th November. Building on the success of Investor Confidence Project in the US, the Investor Confidence Project Europe will bring together investors, banks, property owners and the energy efficiency industry to develop protocols to standardize the development and documentation of energy efficiency projects.

It is important to understand what the Investor Confidence Project is not. It is not developing new technical standards – plenty of these exist, rather it is about using the available standards in a common way through the entire process of developing and documenting energy efficiency projects. It is not about limiting engineering creativity. It is not about standardizing contracts – there have been previous attempts at this in Europe particularly around Energy Performance Contracts. As I have said several times before we need innovation in contract form and the Investor Confidence Project approach can be used with any contract form, or any source of funds – including internal corporate funds (CFOs are investors too). Finally the Investor Confidence Project Europe is not about enforcing a US model – the process of developing a project everywhere goes through the same stages but uses different engineering standards. What will be common between the US and Europe is an approach, not specific standards or protocols. This is essential because the world of finance is international and many of the large institutional investors who want to invest in energy efficiency, but are currently constrained from doing so, operate on both sides of the Atlantic and indeed around the world.

We have built a powerful pan-European coalition of banks, development banks, investors, property owners, ESCOs, energy efficiency companies, government agencies, NGOs and others who are supporting the Investor Confidence Project Europe. We have a Steering Group (still a few spaces left if anyone wants to volunteer) and are recruiting a Technical Panel to contribute to and oversee the drafting of the protocols to ensure they can be readily used. We have a Project Director, Panama Bartholomy, who has a wealth of energy efficiency experience gained in Californian government but now lives in the Netherlands. We are looking forward to kicking off the project. We are looking to further engage with investors, banks, cities and regions looking to accelerate investment into energy efficiency.

To support this important initiative, please sign up as an Investor Confidence Project Ally, volunteer for the Steering Group, a national Steering Group or the Technical Panel.

12.3 Measuring energy management commitment and capability. 9 Dec 2014

I have written before about how – if we are to really scale up the level of energy efficiency activity – we need to increase capacity in the demand side of energy efficiency, the supply side of energy efficiency and the finance of energy efficiency. All three aspects need to be worked on in a systematic way. Part of building capacity in the demand side i.e. amongst energy users, is developing new tools for developing and running more effective energy management programmes. This post is about a new tool inspired by the Innovation Matrix developed by Tim Kastelle[9].

Although energy efficiency had gone through periods where it received attention several times before – notably in the post-war period when fuel was short and the UK was in dire financial straits – energy management started to develop as a more professional discipline in the late 1970s after the 1973 and 1979 oil crises. Several management tools were developed,

9 Tim Kastelle. The Innovation Matrix Reloaded. http://timkastelle.org/blog/2011/06/the-innovation-matrix-revised/

starting with what should be the foundation of any energy management programme, Monitoring and Targeting (M&T). M&T consists of agreeing a base line consumption, setting a target for consumption and recording progress against that target. Another tool developed in the 1990s, (originally by the Building Research Establishment), was the energy management matrix which is a way of measuring where organizations are in the different dimensions of energy management including; policy, organization, training, communication and investment. Despite being adopted (and adapted) in the UK, the US and Australia it never really caught on despite some having potential as a useful tool for agents of change to analyze where an organization was in energy management and what actions were required to improve performance. Fundamentally it didn't go to the heart of the problem – effective action in energy management – like in innovation or just about anything else – needs two things; commitment and capability.

Having seen Tim Kastelle's innovation matrix, which maps organizations according to their innovation commitment and capability, I thought about how to measure these two characteristics for energy management within organizations. Although energy management isn't often thought of as innovation it really is a form of innovation or technical change – even if most of the innovation is incremental and utilises existing technology in a specific application or building where it has not been applied before rather than breakthrough, "first of its kind" type innovation. The two factors, commitment and capability, really are the two critical factors for effective change in area – you can have commitment without capability and you can have (and this is often the case in many organizations) real energy management capability at the technical/energy manager level without real top management commitment. Many energy managers would recognise that situation in their own organization.

Commitment by top management to energy management is vital to success just like it is to any activity within an organization. Without high-level commitment things don't really happen – once that commitment is there they do happen – it is a fact of life.

So I started thinking about what characteristics demonstrate commitment and capability in energy management.

Commitment to energy management can be evidenced by the following:

- Having a board member responsible for energy management
- Regular reporting of energy management performance at board level
- Reporting can be on different frequencies depending on the organization but it needs to happen and everyone in the organization needs to know that it happens
- A public target for energy efficiency improvement, typically expressed in energy intensity but increasingly in absolute energy terms. This would often be included in a sustainability report
- Energy efficiency built into management targets and bonus schemes. Unless management at all levels – and indeed even the shop floor employees – have energy efficiency targets the level of effectiveness of any programme will be hampered. Ideally responsibility for energy efficiency has to be passed to the lowest level of person who can have some influence over energy use – which is often everyone
- At the end of the day commitment is evidenced by investment. It is hard to be certain what the right level of investment is, and this will vary by industry and organization, but back in the 1980s many examples from the public sector showed that it was possible to profitably invest an amount equal to ten per cent of energy spend into energy efficiency every year for many years
- Real commitment to investment will be evidenced by use of a specific allocated amount for energy efficiency, possibly differential IRRs to other investments – reflecting the truly strategic nature of energy efficiency which is not always recognized, or the use of external third party funds through some kind of shared savings deal or bond issue such as that recently done by Sainsburys

- Incorporating best practice, or beyond best practice, levels of energy efficiency into new product development or new buildings shows a high level of commitment. These major decisions always have to have high level support and often opportunities are missed in new building or product projects unless there is high level support, and perhaps even positive pressure, to utilize them

Energy management capability is demonstrated by:

- Having a Monitoring and Targeting (M&T) system that demonstrates energy use, targets energy savings and records progress against targets for each building, factory or facility. M&T was developed in the 1980s and proven to be highly successful in all situations and sectors. Without M&T there can be no effective energy management programme
- Having a full-time energy manager. Clearly this is related to the size of the organization and its energy spend. In smaller organizations this requirement could be relaxed but in those cases there should be access to the equivalent of an energy manager, possibly through retained consultants or an energy management bureau
- The energy manager having a formal qualification in energy management. In the UK this qualification would be through the Energy Institute or in the USA it would be Certified Energy Manager through the Association of Energy Engineers. Energy management is now codified and practitioner should have appropriate qualifications
- Responsibility for energy usage has been passed onto line managers. This is based on the principle that although specialized energy managers can run M&T systems and identify, develop and implement energy efficiency projects they cannot control energy use day by day, minute by minute, in every building or factory within their organization. Responsibility for energy management has to be passed onto those people who can control energy use and that is building, factory, line, cost-centre managers or even shop floor operatives. Many organizations still fail to do this – fostering the belief that energy management is something done by an energy manager or engineering support function
- Staff engagement programmes have been found to be effective in improving energy efficiency. The existence of a staff engagement programme is evidence of further capability as they usually involve training and hence build capacity amongst all staff members. It is important, however, to remember that "awareness is not everything" – most research in the field shows that simply having more factual information about a situation influence peoples' attitudes or action[10]
- Recent work by the IEA[11] and others have documented the multiple benefits of improving energy efficiency. These are many and various but include, even at the level of the host organization, factors such as improved productivity, improved employee engagement, reduced sickness time and reduced need to invest in energy supply infrastructure. Work by Cooremans[12] has highlighted that energy efficiency can be a strategic investment –but is all too often simply viewed as a cost saving investment which inevitably receives less attention than strategic investments. It is important that the strategic nature of energy efficiency investments, and as far as possible, all the co-benefits – are included in energy efficiency business cases. Forward thinking organizations such as Lego do this – even when quantifying benefits

[10] Ham, S.H. Can Communication Really Make a Difference? Answers to Four Questions from Cognitive and Behavioural Pyschology. **http://www.interpretiveguides.org/dbfiles/13.pdf**

[11] IEA, 2014. Capturing the Multiple Benefits of Energy Efficiency
http://www.iea.org/W/bookshop/475-Capturing_the_Multiple_Benefits_of_Energy_Efficiency

[12] Cooremans, C. Strategic fit of energy efficiency. (Strategic and cultural dimensions of energy-efficiency investments). ECEEE 2007 Summer Study.
http://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2007/Panel_1/1.177/paper

is difficult they recognize them and make reasonable, defensible estimates. Inclusion of co-benefits in business cases for energy efficiency is a measure of advanced energy management capability

- ISO50001, the energy management standard, was introduced in 2011. Like all standards it has to be used with care. As someone said about the quality standard ISO9001 you could have ISO9001 for making concrete lifejackets as long as you made them to a consistent standard. However ISO50001 means that for the first time the management of energy is subject to a standardized process. It is based upon the PDCA approach – Plan, Do, Check, Act – and sets out processes for energy management systems that enable an organization to continually improve energy performance. Achieving ISO50001 demonstrates a high level of energy management capability (as well as commitment)

A truly effective energy management programme, one in which the organization consistently improves energy productivity by a combination of good control of day-to-day energy use, employee engagement, and continuous creation, development and implementation of viable energy efficiency projects, is likely to have high levels of both commitment and capability. Effectiveness will ultimately be shown by continuous improvement in energy productivity.

Some of the best management tools use 7 factors; "The McKinsey 7-S Model" by Bob Waterman, Tom Peters and Julien Phillips[13], "Seven Deadly Diseases" by W. Edwards Deming[14] and of course "The Seven Habits of Highly Effective People" by Stephen R. Covey but in this case a 7 x 7 matrix presentation didn't really work so I came up with a 2 x 7 matrix. The final version of the matrix is shown below.

CAPABILITY	Monitoring & Targeting system	Full-time energy manager	Energy manager has formal qualification	Line management responsibility for energy	Staff engagement or motivation programme	Co-benefits included in business case	ISO50001 accreditation
COMMITMENT	Board level responsbile for EE	Regular board level reporting	Public target on EE & reporting	EE built into management targets	Investment in EE (≥10% energy spend)	Specific allocated funds / differential IRR or use of external funds	EE built into new product / buildings

This new energy management matrix can be used by senior management, other agents of change, and analysts to determine where an organization is in both the important dimensions of energy management, capability and commitment, and where it can be improved. The ideal situation is to have a high score, ideally 7, on both scales. My hypothesis (based on years of observation and involvement in many energy management programmes) is that an organization's overall ability to manage energy, its energy management effectiveness – as evidenced by improvement in energy efficiency over time – will be higher the higher the level of commitment and capability. Academic – or practical – research could test the hypothesis. It would be good to get feedback and hear of any results of applying the matrix.

[13] Waterman, R.H., Peters, T.J. & Phillips, J.R. Structure is not organization.
http://tompeters.com/docs/Structure_Is_Not_Organization.pdf

[14] Deming, W.E. The seven deadly diseases.
https://www.deming.org/theman/theories/deadlydiseases

12.4 Launching the Local Authority Energy Index. 17 Dec 2014

On the 10th December I helped launch the Local Authority Energy Index at a reception in the House of Commons. The Index is a new initiative developed by EnergyPro Ltd (my company) in partnership with Knauf Insulation. It is a pilot project with the purpose of providing a measure of performance of authorities on the energy efficiency agenda and to provide examples of best practice that others can learn from.

The initial Local Authority Energy Index covers 25 local authorities in England covering a range of geographies, authority type and socio-economic factors. It uses a range of quantitative and qualitative indicators and draws upon telephone interviews and consulting publicly available data. It looks at four areas that we think are important:

- energy management of the authority's own property portfolio
- energy efficiency in the community (mainly non-domestic)
- energy efficiency in housing
- energy infrastructure.

We gave energy management of the authority's own portfolio a high weighting as we consider it to be the foundation stone for implementing a broader energy agenda. It is important that authorities "walk the walk", understand the processes of improving energy efficiency, and are convinced by the results. Important factors in this category included; having explicit targets and public reporting of progress, existence of Monitoring and Targeting systems, and the adoption of ISO5001.

We identified a number of concerns in this area including the fact that in some authorities the energy management team have been cut back, at a time when efforts should be increased. Also many energy managers, as in other sectors, are having to spend too much time completing data requests e.g. for CRC and not enough time developing investable projects. Also in some cases the carbon agenda had over-ridden energy management fundamentals and although carbon reduction targets existed energy reduction targets did not.

The energy efficiency in the community category covered factors such as whether the authority was proactively working to help building owners (and/or industry) to improve energy efficiency. This could be through programmes like Cambridge Retrofit or supporting grass roots initiatives.

Energy in housing remains a major issue, particularly given the persisting problem of fuel poverty with all of its attendant costs which appear in the benefit system and the health system. In this category we tried to measure how effective authorities had been in mobilizing funds such as those that were available through CERT and CESP. We did not include ECO as the programmes are still in the early stages and there was little data available on results. In future we will include ECO programmes.

The changes in the energy sector, which is moving towards decentralization and greater flexibility, coupled with the high levels of distrust of big energy companies, mean that there are opportunities for local authorities to become more directly involved in the energy system, even build their own infrastructure. This can take different forms including developing District Heating systems, Combined Heat and Power, local renewables and launching their own energy supply and energy service companies. The latter is a rapidly emerging trend with authorities such as Glasgow, Nottingham, Bristol and Peterborough all moving in that direction which promises to be a major disrupter of the energy market.

Finally in the index we also looked at overall indicators such as energy per capita and energy per Gross Value Added. Although these are affected by many factors completely outside the control of local authorities (including economic mix, type of building stock etc) in time these should be the variables we are all trying to influence.

Only Eleven Percent

Over the last few years the large potential for mitigating local and global energy problems through improving energy efficiency has been increasingly recognized but, despite being the cheapest, cleanest and fastest way of delivering energy services, the potential for improved energy efficiency remains under-utilized for a number of structural and historical reasons – some of which can be addressed by local authorities as they have many touch points with energy and can affect levels of energy efficiency in many ways. We believe that those authorities which proactively address this matter in a holistic way will reap great benefits through improved health and welfare, improved finances and local economic development, which will far outweigh the value of energy cost savings alone. Some local authorities in the UK have shown leadership in energy efficiency, either across the whole field or in specific areas, and we hope that the Local Authority Energy Index will help spread best practice and accelerate efforts to improve energy efficiency.

We welcome input and suggestions for improving the index and look forward to developing it in future – both to cover more authorities and to provide improved measures of performance.

Thanks to Knauf Insulation, Michael Floyd and the rest of the Energy Index team and our supporters including Dave Watts MP, Alan Whitehead MP, Dave Sowden of Sustainable Energy Association, Richard Griffiths of UKGBC and many others.

13 The multiple benefits of energy efficiency

One of the most important characteristics of energy efficiency measures is that they bring with them many other benefits – sometimes called co-benefits, non-energy benefits, or multiple benefits – that are probably more important than the energy and energy costs savinsg that result. Traditionally, however, these were ignored and business cases were almost entirely presented in the form of 'invest £y and save £x in energy costs'. It has now been shown that identifying and valuing these non-energy benefits can greatly improve the business case for energy efficiency, both in pure financial terms but perhaps more importantly in strategic terms. I have often said we should present energy efficiency business cases as being about the strategic non-energy benefits, and then say 'by the way you get some energy cost savings as well'. Doing things that way round would greatly improve the flow of capital into energy efficiency. It is a theme I continue to return to.

13.1 The layer cake of energy efficiency. 25 Nov 2013

I have written before about the multiple benefits of energy efficiency beyond purely cost saving. These can include:

- Reduced exposure to energy price volatility
- Reduced emissions of carbon dioxide
- Reduced emissions of pollutants resulting from combustion of fossil fuels such as mercury, other metals, nitrogen oxides and sulphur oxides
- Reduced need to invest in energy supply infrastructure e.g. electrical grid connections at the host level
- Reduced need to invest in energy supply infrastructure in the wider electricity generation, transmission and distribution system
- Reduced
- Improved quality of production in industrial processes
- Higher productivity, health and well-being of employees
- Improved comfort
- Improved health and reduced expenditure on health
- Increased property values
- Reduced local pollution
- Job creation

Now RAP – the Regulatory Assistance Project in the US, has coined a great phrase to cover this point about multiple benefits – "the layer cake of energy efficiency". The article can be found here: **http://goo.gl/bV1bUv**

We need to make sure decision makers in companies, the public sector and government appreciate and value all the layers of the energy efficiency cake. Government and regulators need to put in place appropriate mechanisms to ensure that the value of the whole cake is counted in any assessment of demand side versus supply side decisions. At the risk of taking baking analogies too far – we are currently only eating the icing but we need an energy efficiency version of the Great British Bake Off in which we enjoy every layer of the cake!

13.2 Layer cakes and icebergs. 30 Jan 2014

I recently attended a very thought provoking meeting at the International Energy Agency looking at the multiple benefits of industrial energy efficiency, a topic that I have written about before both in the **blog** and in my **book**. Interest in making sure all the benefits from energy efficiency are evaluated at the investment decision point is growing and the IEA is

helping that process by preparing a report setting out what the benefits can be and some policy options to ensure they are included. Several interesting points came out the meeting.

What is clear is that when they are properly evaluated, the multiple benefits of energy efficiency investments – ("co-benefits" or "non-energy benefits") – can be much larger than the energy cost savings. Co-benefits include things like; increased production capacity, increased productivity, increased quality, reduced maintenance costs, reduced waste disposal costs and increased employee engagement and satisfaction. All too often, however, the evaluation of energy efficiency considers energy savings in isolation.

The issue of language and the need to ensure we are all speaking the same language when it comes to energy efficiency and project evaluation came out several times in the meeting, and that is a topic I am going to return to in a later post.

Another critical realisation, prompted by the excellent research of Catherine Cooremans of the Université de Genève was that energy efficiency investments need to be viewed as strategic, value creating investments rather than mere cost saving measures. This emphasis on strategic value creation can help those promoting energy efficiency to get the attention and commitment of senior decision makers. In my view, energy managers and energy efficiency professionals have never been good at this, believing that energy cost saving measures are somehow special. Moving from, in my language, a "defensive" cost-cutting approach, to an "offensive", strategic value creation approach can really help move the energy efficiency agenda "from the boiler room to the board room". As I said at the IEA meeting CEOs don't generally get to the top by cost-cutting but by creating strategic shareholder value. Also there is something inherently dull about saving money, however worthy it is, and something inherently exciting about creating value. I think the excessive focus over the years on energy efficiency as just a cost-cutting exercise, rather than emphasising the co-benefits and strategic value is a major cause of under-investment as well as energy manager frustration!

Another important point made at the meeting was that energy efficiency improvements come in two ways, firstly through investments made specifically for energy efficiency, and secondly through investments that are undertaken for other reasons such as increased production, increased productivity or the introduction of new products or processes. For the former, specific energy efficiency investments, it is critical to ensure that all co-benefits are identified, valued and included in the investment decision analysis. For the latter, investments for other purposes, it is critical to ensure energy efficiency is properly considered at the design stage. The value that can come from proper integrated design at the design stage, as shown by work by **Rocky Mountain Institute** and the **Sustainable Energy Authority of Ireland** can be very significant – bringing greater benefits and reduced capex costs leading to greatly improved return on investment. Corporate and government policies should recognise these two critical "touch points" to improve efficiency and focus on ensuring more of the opportunities are taken.

One of the issues I identified is that EU countries are now mandating energy surveys or audits as part of the Energy Efficiency Directive and national standards organisations are implementing standards for audits such as BS EN 16247-1 Energy Audits. If these don't include guidance on assessing co-benefits we are missing a vital opportunity. My view is that the standards, all of which have been prepared by excellent energy efficiency experts, probably don't emphasise valuing co-benefits. This may lead us into a situation where mandatory audits are paid for and undertaken but remain on the shelf because they just focus on cost savings. We have been there before several times before – in fact this has been a problem as long as I can remember. Energy surveys or audits are only useful as part of an energy management system that identifies opportunities and implements them but they do have to identify and value co-benefits and demonstrate value creation from proposed measures.

Finally of course many of the co-benefits are outside the system boundary of the project host. They fall into the energy supply industry – such as reduced need to invest in energy supply, or society at large – through reduced import bills or reduced emissions. We need to

recognise these and where possible, through energy supply system regulation for instance, ensure the benefits are properly valued and those making the investment – and not just the supply companies – benefit.

The US work I mentioned in a previous blog post coined the phrase the "layer cake" of energy efficiency benefits. One of the contributors at the IEA meeting used the analogy of the iceberg where the energy cost savings are the 10% of the iceberg above the surface and the 90% are co-benefits below the surface. Whichever language we use to describe them this work by the IEA and others is important and I look forward to contributing to it further.

13.3 More on co-benefits. 5 Feb 2014

Following my post on **co-benefits** it seems as if the focus on this important topic is rapidly growing. In the space of a week I have seen two reports that describe the co-benefits of energy efficiency investment. Firstly there was the report from the Rocky Mountain Institute, "***How to calculate and present deep retrofit value"*** *which sets out n*ine "value elements" for deep retrofits:

- Property costs and risks
  - retrofit development costs
  - non-energy property operating costs
  - retrofit risk mitigation
- Enterprise costs
  - health costs
  - employee costs
  - promotions and marketing costs
- Enterprise revenues
  - customer access and sales
  - property derived revenues
- Enterprise risks
  - enterprise risk management/mitigation

The report sets out a framework for considering these costs, benefits and risks and presenting them.

The second report – "*The economic impacts of EE investments in the South East*" – comes from the South East Energy Alliance, a regional energy efficiency organization working in 11 US states and focuses more on the benefits outside the end-user's system boundary. It is an independent report from Cadmus that looks at the wider economic impact of energy efficiency programmes covering direct benefits, indirect benefits and induced benefits. As well as demonstrating actual costs per avoided MWh for power and gas the report looks at avoided capacity costs, jobs created, labour income and total value added.

The overall conclusions are that the $20.2 million invested by the US Department of Energy in the programmes studied led to economic value of $78.3m, a return on investment of 387% and created 347 new jobs.

Whatever we call them, co-benefits, non-energy benefits, secondary benefits or strategic benefits, the recognition of these important benefits is clearly growing. We need to ensure we understand them properly and evaluate them at the point of making investment decisions.

13.4 The real lessons from the Empire State Building retrofit. 14 April 2014

The retrofit of the Empire State Building (ESB) a few years back deservedly got a lot of publicity and helped put energy efficiency on the agenda for commercial property owners – at least in the US. Once completed in all tenant spaces savings are projected to be 38%. The measured savings have exceeded the targets in the first two years. The savings were 5% higher than the target level in year 1 and 4% higher in year 2. The ESB is a brilliant case study of what is possible using state-of-the-art retrofit practice and is now widely referred to. Some commentators, however, seem to miss the real lessons of the ESB project. Based on my readings of the project and talking directly to some of the participants these are my take-aways.

Timing

The ESB project was part of a much larger $500m refurbishment designed to bring the ESB into the 21st century, reduce voids and increase rentals. This is an important point, the best time to do deep energy retrofits is during a major refurbishment. Expecting building owners to do them at any other time is simply unrealistic. Therefore we need to ensure that these opportunities to improve energy (and water) performance are not missed and at that point integrated design techniques are applied. Policies need to be put in place to ensure that the highest energy performance standards apply to major refurbishments as well as new buildings. Right now buildings are being refurbished and major opportunities to do deep retrofits are being missed – locking in excessively high energy consumption and costs for at least the next twenty years until the next major refurbishment.

Energy efficiency can improve yields but it is only one factor

The effect of the energy efficiency projects in the ESB means that tenants have electricity bills about half of those in unimproved buildings. This has a definite effect on the attractiveness of the office space but at the end of the day other features such as location, design, the overall fit with the organisation's needs and ultimately price are likely to be bigger drivers on a relocation decision. The real driver of improved yields at the ESB was that the office space, which had been dated, was brought into line with the needs of 21st century clients.

The need for holistic or integrated design

The ESB retrofit is a great case study of how to implement integrated design and the great benefits that come from applying it. Integrated design gets us away from the argument "efficiency costs more" – in many cases it can cost the same or less when integrated design is applied properly. Integrated design has been promoted by Eng Lock Lee in Singapore, the Rocky Mountain Institute (RMI) and others for many years now but the uptake remains low – at least in the UK – despite the proven benefits of reduced energy usage and often reduced capex. We need to promote the use of integrated design and step-up training amongst engineers and architects as well as clients. Supply of integrated design solutions would be improved if more building owners demanded it. In the case of the ESB it was lucky that Tony Malkin, the owner, was an informed and determined client. Original proposals for the refurbishment did not include integrated design and Tony made it very clear that if vendors and contractors wanted to be on the job they had to do it this way or they would be shown the door. We need more clients who know enough to do this.

The power of leadership and open source information

Tony Malkin is a committed environmentalist but he also insists on a three year payback period on any investment. The use of integrated design and techniques such as remanufacturing the windows on-site meant that the additional capital required for energy efficiency, (net after all additions and subtractions of $13m on top of an original $93m for energy related work), had a three year payback. One of the great things about the ESB project is that all the other New York City property owners know that Tony Malkin insists on a three year payback – this gave the project great credibility and helped lead to other owners starting similar projects on their buildings. Tony also insisted on the project being "open source" and all the contracts and M&V reports are available on-line. He has also spoken

widely about the project. As a result of this leadership and the work of RMI and the other companies involved there are now many other similar integrated design retrofit projects now being worked on.

The importance of Measurement and Verification (M&V)

M&V was built into the process right at the beginning and independent M&V professional report on the savings – calculated using techniques under the International Performance Measurement & Verification Protocol (IPMVP).

Look at all the costs

When looking at energy costs it is important to look at all the costs associated with energy usage. This includes electricity and fuel costs, capex of energy using equipment, operations & maintenance costs and any other associated costs e.g. energy taxes etc. Only a full consideration of all the costs can give the building owner (or an external investor) an accurate investment analysis.

EPC does not need to be externally funded

The ESB often comes up in discussions of energy performance contracts (EPC) in the commercial building sector. The work was undertaken under an EPC but entirely financed by the owner. It does raise the prospect of an externally financed energy retrofit using the same kind of techniques. Integrating external financing into the financing needed for the building itself or a major refurbishment can be challenging but is certainly possible. By adopting more integrated design techniques EPC contractors can differentiate themselves and make externally financed solutions more attractive than they often are now.

So to sum up, the lessons of the ESB for building owners are:

- use the opportunity of major refurbishments to implement deep energy retrofits and don't just accept "business as usual" solutions
- use integrated design – it can reduce capex as well as energy costs
- count all the costs including energy, maintenance and capex in evaluating alternatives
- use independent M&V to prove results and manage contractors.

For policy makers:

- work with the design professions and building owners to improve capacity in integrated design – both on the supply and demand sides
- enact policies (building regulations) to ensure that the opportunities for deep retrofits presented by major refurbishments are not missed.

13.5 Better projects, better business cases. 5 March 2018

The application of the Investor Confidence Project (ICP) continues to grow across the USA, Europe and Canada, with growing interest from India, China, the Middle East and Africa. It is easy to get carried away with thinking the ICP is the answer to the problem of how we significantly accelerate investment into energy efficiency but, as I have always said, it is just one piece – albeit a very important piece – of solving that problem. I have summarized my thinking in the "jigsaw of energy efficiency financing" which has four pieces which need to be in place in the same market at the same time for investment to flow – standardization (ICP), pipelines of projects, finance (development finance as well as project finance), and capacity building for end-users, the energy efficiency industry and the finance industry.

ICP is at its heart just about helping project developers to develop better projects, higher quality projects with a higher probability of delivering the savings that are predicted. Within ICP we always said that by doing that it would bring reduced transaction costs and reduced performance risk. That hypothesis has been validated by MunichRe HSB who as part of their energy efficiency performance insurance offer ICP certified projects lower costs through

both removing the need for clients to pay for a separate engineering assessment, and through lower insurance premiums. The use of energy efficiency performance insurance from a global player like MunichRe HSB can help make projects more bankable through taking on performance risks.

Another element of improving the flow of investment into energy efficiency is building better business cases. Better business cases come about through better underlying projects and better appraisal of value and risks. Business cases that just say this is the capex and this is the projected energy cost savings are not good enough anymore and just result in projects not proceeding and frustrated project developers. This is where the EEFIG Underwriting Toolkit comes in. The Toolkit is a framework that encourages financiers assessing projects to identify all sources of value including the non-energy benefits such as health, well-being and better productivity – many of which are both more valuable and more strategic than just simple energy cost savings. The Toolkit also explore the risks of energy efficiency projects which for too long have been ignored. We need to move from the uncertainty of not knowing the real risks of projects to fully understanding and quantifying the risks – just like the financial industry does for other asset classes. Pretending there is no risk, or just living with uncertainty is not good enough as uncertainty is a major barrier to investment flowing at scale.

So, if you want to increase the flow of capital into energy efficiency develop better projects and build better business cases.

13.6 Using non-energy benefits to build better business cases. 20 June 2018

A few weeks ago I wrote about the need for better business cases for energy efficiency projects. More and more it seems that one of the most effective ways of building better business cases is to identify and value non-energy benefits (NEBs). NEBs are all those benefits that come from an efficiency project that are not energy related, they can include (amongst many others); improved health, reduced absenteeism, better learning outcomes, increased productivity, increased production, and increased asset value. All of these benefits have been identified in specific situations and in most if not all cases have been measured.

The first useful thing about NEBs is that they are usually much more strategic and interesting to decision makers (at all levels from consumers to CFOs) than simple energy cost savings (or even reduction in emissions). This is important because the classical capital allocation model which says that companies should invest in any project that has an IRR greater than the cost of capital just is not how it works in practice. Capital is limited and projects that are considered strategic have higher priority than non-strategic projects. If something is strategic it would be unusual to hear "what is the payback?". It is strategic because it supports the primary mission of the organisation whatever that is and it is something that usually "has to be done".

The second thing about NEBs is that they really do have financial value and once they are identified their value can be measured or at least estimated. It has been said that they are hard to measure and sometimes that is true but the reality is that data that can be used to estimate benefits often exists already e.g. absenteeism records. It is just that traditionally energy managers or energy efficiency engineers have not considered the NEBs and their value in their business cases, or gathered data to support the business case. Valuing NEBs is not an exact science but that applies to many things in business, the point is to recognise that they exist and to come up with an agreed estimate of value – however approximate. Once you do that you can often find that the value of the NEBs is far more than the value of the energy cost savings.

So to make better business cases:

Step 1: identify EE project and energy cost savings

Step 2: identify NEBs

Step 3: link the NEBs to strategic direction i.e. create strategic value

Step 4: appraise financial value of NEBs and include in financial evaluation alongside energy cost savings

Step 5: capture strategic & financial value and include in the business case

To sum up:

Financial value of EE + Strategic value of NEBs + Financial value of NEBs = Better Business Cases = More Capital Flow

14 Management & Leadership

Over the course of my forty year career management education has become more common, although I am not so sure the quality of much what passes for management education is very high. Much of what is called management today seems to be based on jargon and obfuscation. Much of my management thinking was, and still is, influenced by great thinkers such as Peter Drucker. Drucker's work is timeless. Management is focused on doing things but leadership is concerned with deciding what to do. We need better management and more leadership.

14.1 Management speak versus leadership speak. 1 March 2013

I found this great example of all that is wrong with modern management in 'Made to. Stick' by Heath and Heath.

Compare the phrase in JFK's great speech committing America to land on the moon;

'put a man on the moon and return him safely to Earth before the decade is out'

And what the modern management speak version would probably be;

'our mission is to become the international leader in the space industry through maximum team centred innovation and strategically focused aerospace initiatives'

That says it all about what our real problem in energy and all other areas is today, to much emphasis on so called management (most of which is bad management) and not enough leadership.

14.2 Getting to net zero – the missing element. 8th Nov 2019

Net Zero as a target is very clear – net zero carbon emissions by 2050. The old adage about setting targets comes to mind, is it SMART i.e. Specific, Measurable, Attainable (or sometimes quoted as Agreed upon), Realistic and Time based? It is certainly specific, measurable and time based. Is it attainable and realistic? Time will tell.

For people to adopt a target requires it to be motivating. Net Zero is, or should be, highly motivating given the scientific evidence of the potential climate consequences if we don't restrain emissions. A number of senior business people have reported being motivated to action by questioning from their children and grandchildren about what they are doing to avert a climate crisis and there is probably no better motivator. To seriously adopt a target, rather than just paying it lip service, requires leaders of all types of organisations, from the largest to the smallest, to stand up and take a clear position, define a clear path of action and, critically, actually commit resources to following that path.

What does net zero by 2050 i.e. in the next 30 years, really mean in practice? As Michael Leibrich has pointed out the 30 years between now and then spans two business cycles and markets and businesses change a lot in two cycles. Think back to how different the world was in 1990. In 1989 the world's first dial-up ISP came to the market and only 0.5% of the world's population were 'on-line' (at least while dialing up!). Renewables were 'alternative energy' and you could fit the entire UK wind 'industry' in one small room (and we did).

So if we take the idea that we have two business cycles to achieve net zero what do we need to do in this investment cycle? For many users such as hospitals looking at major Energy Performance Contract (EPC) upgrades it is important to fully review alternative technologies to the normal gas fired Combined Heat and Power (CHP) such as heat pumps, but the reality in many cases is that the technology and economics are not quite there yet. By the second investment cycle it will almost certainly be available and viable so adopting the best option for carbon reduction and achieving 30-50% is a sensible strategy. It is also important to consider more radical options like deep fabric retrofits to

reduce demand by 70-90%. These are generally regarded as not viable but with a combination of proper integrated design and better business cases that properly value all the benefits, including non-energy benefits such as better patient outcomes, may tip the balance. To even consider and evaluate these options however, let alone develop and implement them, requires strong leadership and capacity building amongst clients and the supply side.

There are examples of even large organisations moving even quicker towards net zero. The case of Orsted (formerly DONG) is certainly inspiring. The company has moved from an oil and gas company to a renewables company in about a decade. In 2010 half of its earnings came from exploration and production or thermal generation and the rest came from sales, distribution and trading. About 70% of its generating plant burnt oil, gas or coal. By 2017 when the company changed its name 70% of the generating fleet was renewables, biomass or waste and by 2020 this is expected to reach 90%. The company has sold off its oil and gas assets and its carbon intensity has fell from 450 g/kWh to 150 g/kWh between 2007 and 2017 (and has since fallen further). Interestingly, EBITDA and market cap have increased more than the six largest independent European oil and gas companies who were considered their peers, and the company has maintained an increasing dividend. This transformation in a decade is nothing short of amazing and the management of Orsted have shown true leadership. Turning round any multi-billion euro/pound/dollar corporate is difficult, as they say it is like turning a super tanker, but the Orsted example shows it can be done and puts many others to shame.

We have the technologies to reach net zero. The motivation is clear. The economic case is stronger than ever and getting better, especially once people look at all benefits. The missing element in reaching net zero is real leadership, leadership at every level from national and local politicians and boards of major companies down to SMEs.

14.3 Plans are nothing, planning is everything. 12th Feb 2020

In an earlier blog I referred to leadership as the missing element in the drive towards net zero. Now we are seeing leadership on the issue emerging, both nationally – in some countries a lot more than in the UK I have to say – and in the corporate world. Real leadership however goes beyond setting the target, it has to include driving the development of realistic, deliverable plans to achieve the target, and then driving delivery

Achieving 'Net Zero' is a very clear objective, as long as a timescale is incorporated, somewhat like "land a man on the moon by the end of the decade and return him safely to earth". Clear objectives are always useful – they can't be fudged – you either achieve them or you don't and as someone once said; 'objectives are optional, constraints are obligatory'. Once leadership sets, or even considers, a net zero target the organisation has to quickly move into formulating a realistic plan of action which sets out the path to overcome the constraints and achieve the objective, otherwise it is just an aspiration. John F. Kennedy provided the leadership to get to the moon by setting the clear target but NASA drove the plan to overcome the many constraints that existed back in 1961 and marshalled the resources to achieve the target. So what are the elements of a coherent plan for achieving net zero?

Of course the first step is to ascertain the current situation, the base line. Any plan should start with a sound baseline covering Scope 1, 2 and 3 emissions. Clearly Scope 3 emissions are more difficult to quantify for many organisations and a degree of uncertainty is understandable in this area. For instance, how does a University measure travel of students? Pragmatic judgements based on what is possible and what isn't need to be made

Then a range of possible projects or interventions need to identified. Here creativity techniques like brain storming and lateral thinking can be useful. Techniques such as integrated design are critical for making major breakthroughs in energy performance and emissions rather than mere incremental gains. We need to think outside the box of

conventional solutions. Once identified project concepts need to be assessed technically, economically and financially, and contextually.

Technical assessments need to consider the state of technology development and evaluate the reality which is sometimes obscured by hype. It would be unusual for many organisations to take technological development risks, for those that do the decision must be explicit with a full understanding of the risks and not implicit. Technological development is always risky

Financial and economic evaluation needs to consider all the benefits and not just energy cost savings or reductions in emissions. Benefits with strategic value can include market positioning, publicity, an increased ability to recruit the best employees etc. and can be far more valuable than cost savings. A systems' thinking approach is needed to identify and value benefits. Ultimately any plan must be financeable which requires understanding both the organisation's own resources and its ability to utilise external finance. If external finance is to be utilised the plan has to meet investor requirements.

Contextual analysis is a vital but often neglected stage in capital project development. It is necessary to check for interactions both between projects and with other internal and external factors, for instance the long-term future of a site or a product needs to be properly considered if there is a proposed project to reduce its energy use and emissions. Some combinations of projects are additive whilst some conflict. For complex long-range plans there may be many interactions with both internal and external factors to be considered at different levels. Technical, economic and contextual evaluations themselves will often interact in an iterative process.

Any plan needs to consider risks. This should include the risks of inaction as well as the risks of action. It should start with the risks of climate change, the main parameters of which are well known at high level but as far as possible these should be localised to recognise actual risks on the organisation, physically and financially. The risks of action and inaction on all stakeholders including shareholders, employees, customers, and the supply chains should be considered.

Following concept creation and development with a sufficient degree of robust technical, economic and contextual evaluation, supported by risk analysis, a practical portfolio of projects and actions with costs and timings needs to be assembled, a process that may need many iterations. Then the plan should be stress tested before moving into delivery.

To achieve net zero definitely needs vision and leadership, but it also needs a realistic, well-developed plan. Developing such a plan is far from trivial. To then deliver the plan requires hard work and long-term commitment, effective delivery may require changes in remuneration structures to drive the right kind of behavior throughout the organisation, a change that needs to be driven by strong leadership backed by shareholder pressure.

As Dwight D. Eisenhower said; **'***Plans are nothing, planning is everything'*. If your organisation needs assistance with developing a comprehensive net zero plan, and then implementing it, **contact me or Alex Rathmell at EnergyPro**.

15 Nuclear (fission, SMRs & fusion)

My views on nuclear power have changed over the last forty years and now I am 'anti-new nuclear'. My main concerns are that nuclear is highly centralised (see earlier comments on the link between electrical power and political power), new plants are always more expensive and later than advertised, and a nagging worry that today's institutions and organisations don't have the discipline or levels of responsibility to run plants properly and safely over 30 to 50 years. We should certainly keep existing plants running as a source of zero carbon electricity but I really doubt that we should be building more. Governments seem to refuse to learn from past experience and keep getting sold the nuclear dream when they should learn from seventy years of history.

15.1 One giant leap or a very small step? 29 April 2013

It was good to see that The Independent had a big piece on fusion power on Saturday **'One giant leap for mankind: £13bn Iter project makes breakthrough in the quest for nuclear fusion, a solution to climate change and an age of clean, cheap energy'**) as fusion hadn't had much press coverage in the last few years. Once seen as the inevitable future of energy supply, fusion – aka 'the power of the sun' – is still seen by many as the holy grail, offering unlimited, clean and cheap power. In fact, the famous quote about nuclear power being 'too cheap to meter' (made by Lewis Strauss, Chairman of the US Atomic Energy Commission in 1954 and frequently repeated in the 1950s and 1960s) actually referred to the promise of fusion power rather than any reality of conventional nuclear fission power.

The Independent article was covering the ITER project, a huge and important £13 billion multi-national project to advance fusion research. ITER is the latest in a long line of fusion experiments that create very high temperature plasma and contain it in a toroidal, 'doughnut' shaped vessel using magnetic fields to prevent the plasma touching the containment vessel. These vessels are gently called Tokamaks, a term coined in Soviet Russia after they were invented by Igor Tamm and the great Andrei Sakharov, who designed the Soviet thermonuclear bombs and later went on to win the 1975 Nobel Peace Prize after becoming a dissident.

Fusion research, however, has a very long history of being used to feed dreams of unlimited and clean nuclear power. Even if ITER is successful and produces the planned 10 times as much power as it consumes it is a long way from a commercial fusion reactor, if it is ever achieved. 'First plasma' (not the same as actual fusion) is planned for 2022 (2 years later than the last plan – and 6 years after the original planned start-up date) and this will be followed by a gradual ramping up of power and 'going nuclear' with the injection of tritium in 2027/28 (on the current plan). Even if ITER achieves the 10 times as much power as it consumes goal it will always remain an experimental tool. (By the way this often quoted10 times ratio is mis-leading as it means 10 x as much heat produced as power in – not 10 x as much power out as power in). Even on the optimistic scenario a commercial fusion reactor is unlikely before 2050 and it seems that physicists have been predicting that 'fusion is 40 years away' for many years and even decades.

ITER is an incredible project and we do need to carry on with these kinds of experiments, if only to better understand how the universe works, but we also need to be realistic about the prospects for commercial fusion power. Headlines such as 'ITER makes breakthrough in fusion power' are very misleading when all that has happened is that construction has started.

The 'clean' aspect of nuclear comes for the fact that the fusion reaction combines isotopes of hydrogen (deuterium and tritium, abbreviated to D and T) to produce isotopes of helium which sounds great as hydrogen and helium are fairly innocuous until you remember that the D-T reaction produces a very high neutron flux, i.e. a large flow of high energy neutrons, something like 100 times as high a flux as that produced in a conventional fission reactor. This neutron flux will irradiate whatever materials are used to contain the plasma, making them radioactive. When the JET project, a forerunner of ITER in Culham in Oxfordshire, ran a single

series of D-T tests the vacuum vessel was sufficiently irradiated that it required remote handling for a year. The materials problems of fusion reactors are immense. The containment vessel, as well as being irradiated with an extremely high flux of neutrons, has to withstand extremely high thermal loads as the plasma is at very high temperatures (more than 100 million oC no less). Even if the problems of materials can be solved it is impossible to realistically predict the costs of fusion power 40 years from now and it has to be said that the track record of the nuclear industry on cost prediction is abysmal.

I am a technological optimist but on fusion, at least conventional 'big science' Tokamak based fusion I am pessimistic. Every now and then reports surface of unconventional fusion developments emerge. In February 2013 It was reported that the Lockheed Skunk Works (famous in aerospace circles as the developer of spy planes, the U-2 and the still incredible after fifty years SR-71), is working on a 100 MW, "trailer sized" fusion plant with the first prototype predicted for 2017 and commercial units by 2022. Like a lot of these stories you have to be sceptical but as I have said before, the one certainty is that the future won't look like the conventional scenarios predict, and I would be less surprised by an 'out of the box', completely novel new technology than I would be by the Tokamak approach producing a commercial fusion reactor by 2050. Maybe we will be using fusion power by then.

15.2 Should we be buying Chinese nuclear technology? 23 Sept 2013[15]

The press coverage on what looks like DECC's (and Ed Davey's) attempts to attract, ("woo" in the words of the Sunday Times), Chinese firms into the UK nuclear industry highlights one of the many signs of desperation in UK energy policy. EDF is also seeking Chinese involvement in Hinkley Point but apparently China General Nuclear Power Group want some operational control for their 50% stake, (probably not unreasonable from an investor's point of view!).

I have nothing against China and of course the growth in the Chinese economy, as well as their technology development, over the last thirty years has been incredible. I accept that the world is generally better off through globalization but we really should think seriously about encouraging Chinese involvement in nuclear power on three grounds.

Firstly there is a cost to importing the technology – but that of course also applies to French nuclear technology or any other energy technology from abroad (almost all of it now). Secondly there are security risks – we have seen concerns raised about Chinese firm Hauwei supplying technology to the telecoms sector – what are the risks of Chinese involvement at the heart of our nuclear plants – part of the Critical National Infrastructure? Finally there should be legitimate quality control concerns. Although there have been no examples of large-scale failures in the Chinese nuclear sector (that we know about) there have been accidents and concerns have been raised. In 2011/12 there were reports of problems in the China Experimental Fast Reactor (CEFR) and safety lapses at the China Institute of Atomic Energy. A former state nuclear physicist, He Zuoxio, has claimed that a Chinese nuclear disaster is "highly probable" by 2030. Also we have seen a number of problems in Chinese products and technology including high-speed trains, the Chinese cabinet criticized the railway industry for lax safety standards after the Wenzou train crash in 2011, **and milk –** in 2008 the milk scandal had a reported 300,000 victims.

Nuclear power requires the highest levels of safety, 24 hours a day. 7 weeks a year for decade after decade. Of course, we also have train crashes and accidents here – all technology wherever it comes from is risky wherever you are – but we do need to assess all of the risks and all of the costs of all energy options fully.

[15] **https://bit.ly/3nMCSVX**

15.3 Time to stop worrying about Hinkley C. 2 Feb 2016

Like many others I have long been troubled by the UK government's decision to support new nuclear and particularly by the bizarre decision to guarantee the Hinkley C project by agreeing a strike price of £92.50/MWh and up to £17 billion in Treasury loan guarantees. I have never been against nuclear power per se although I have serious questions about the choice of basic technology, (uranium cycle pressurized water reactors), and the risks of failure in very complex systems where the consequences of failure can be huge. I do worry about the wisdom of choosing a reactor design where the two other examples are hugely over-budget and behind schedule. I seriously worry about relying on Chinese funding and Chinese technology to build future reactors.

Having read a piece in the Sunday Times ("New threat to Hinkley nuclear plant cash"), I am now less worried because it looks less likely that the project will ever go ahead. The "new" (not actually that new) information is that the EU's approval of the Treasury's guarantee is dependent on the French reactor at Flamanville having "completed the trial operation period" and other operational milestones by December 2020. In September 2015 EDF announced that the Flamanville start-up was now scheduled for Q4 2018 – the latest in a long-line of delays (as well as budget increases). Even if the French regulator does not force EDF to remove the steel containment vessel, which has been found to have "anomalies" and "lower than expected mechanical toughness values", I have no confidence in their ability to meet this target given their inability to meet any of the previous ones.

The decision from the regulator on the pressure vessel may not even come until the end of 2016. Even if EDF hit the Q4 2018 target (a big if) that only leaves 24 months to satisfy the EU's conditions. So, in my opinion, Hinkley will never get built and prove to be the biggest in a long line of UK energy policy mistakes (and no doubt the tax payer will end up picking up the bill in some way). So, time to stop worrying about Hinkley and worry about how to really solve the problem of the short and medium-term electricity capacity shortage caused by years of inaction by successive governments. The answer is not new nuclear and it is not subsidizing fleets of polluting diesel generators (which we are doing) – the demand side of the answer lies in properly valuing all the multiple benefits of efficiency and making it measurable and an investable asset class, as well as reforming the energy market to allow efficiency to properly compete with supply.

15.4 Hinkley – why can't we learn from history? 7 Oct 2016

The UK government's decision to approve the new nuclear plant at Hinkley Point after a short review has put energy policy firmly back in the news. When the review was announced I had a small hope that the government would show courage and cancel the project but I can only assume that fighting the French on the two fronts of Brexit and Hinkley (whilst simultaneously upsetting the Chinese), was a step too far even for Theresa May.

Not that anyone really needs reminding but here are the salient points about the Hinkley project:

- The project uses unproven technology
- The other two projects using the same technology (in Finland and France) are massively over-budget and years late compared to the original programme
- The French version has been diagnosed with serious "anomalies" in its pressure vessel and the French nuclear safety agency won't even make a decision on what to do about this until the end of the year
- It relies on a fixed electricity price far above the wholesale power price
- It will generate / maintain jobs – but mainly in the ailing French nuclear industry
- It puts major infrastructure under the potential control of China
- The UK government is providing a guarantee to French and Chinese investors

- The future Chinese reactors they have been promised use even less proven technology – effectively making us the guinea pigs for a Chinese nuclear technology
- At best it won't be on-line until 2026 – (anyone for a sweepstake on the year it first generates power? answers on a tweet to @DrSteveFawkes or via the website)

Which of those factors make anyone think it is a sensible project?

If we want to produce 7% of the UK electricity from low emissions technology we could achieve the same result much quicker and at much lower cost through a combination of efficiency, flexible gas fired stations, renewables and storage – much faster and at lower cost.

On the much discussed security issue I believe that there really is an issue – handing over control of major energy infrastructure to a foreign power, one that quite frankly has a dubious track record in lots of ways, at best reduces the degrees of freedom we have in any future strategic dispute. I thought the Chinese Ambassador's protests were a classic case of "he doth protest too much'.

Learning history is really worthwhile if we learn from it – and that applies to both international relations and energy. On Monday evening I attended an event at Chatham House to celebrate my friend Walt Patterson's 25 years at Chatham House. For anyone not familiar with Walt's 40 plus years of pioneering energy work go straight to his website (**waltpatterson.org**) and start reading. Walt reminded everyone of the then Central Electricity Generating Board's plans in the 1970s to order 18 new reactors. (Walt was in the room when it was announced). After many years of delays and wasted public expenditure – including many other grandiose plans to massively expand nuclear power – we ended up with just one new reactor – Sizewell B. My guess is history will repeat itself and we will end up with another one-off white elephant paid for by the taxpayer at great expense.

15.5 Small Modular Reactors and the magpie syndrome. 11 Oct 2016

I saw from the news a few weeks back that Rolls Royce is growing its team working on Small Modular Reactors (SMRs) in response to the government's competition for SMRs. The government has committed to invest £250 million into SMRs.

The basic idea is to be able to put reactors with output of about 250MW "on the back of a truck" and distribute them widely across the grid. The government's aspiration is to have SMRs available in the 2020s. I won't go into the many competing designs (for that see an excellent piece by Andy Dawson on Euan Mearn's website). I am not inherently against nuclear, just against using a form of the technology that was essentially optimized for military applications, is not inherently safe and rely on extremely long-term safeguards. It would appear that many of the 33 (!!) candidates for the SMR funding are proposing Light Water Reactors although there are some pebble bed and molten salt designs. There is clearly scope (and the need) to develop new types of inherently safe reactors as well as using the thorium cycle which has advantages over the uranium cycle – but these are R&D projects, not things that will deliver reliable power in the 2020s or even the 2030s. Adopting existing LWR designs used in submarines does not really seem much of a development. Even if a) SMRs work and b) they are remotely economic, think of the NIMBY protests – the anti-SMR brigade would make anti-frackers look like beginners.

Andy Dawson includes a great quote from Admiral Rickover, the father of U.S. Navy nuclear propulsion – a quote that should be hung on the wall of every energy Minister:

"An academic reactor or reactor plant almost always has the following basic characteristics: (1) It is simple. (2) It is small. (3) It is cheap. (4) It is light. (5) It can be built very quickly. (6) It is very flexible in purpose. (7) Very little development will be required. It will use off-the-shelf components. (8) The reactor is in the study phase. It is not being built now.

On the other hand a practical reactor can be distinguished by the following characteristics: (1) It is being built now. (2) It is behind schedule. (3) It requires an immense amount of

development on apparently trivial items. (4) It is very expensive. (5) It takes a long time to build because of its engineering development problems. (6) It is large. (7) It is heavy. (8) It is complicated."

This quote could also be applied to all new energy technology concepts.

The SMR competition seems to be another symptom of the "magpie syndrome" that seems to affect politicians looking at energy – settle on a bright shiny thing and assume that it will solve all our problems. We have seen this with offshore wind power (and renewables in general), biomass, heat pumps, new nuclear, fracking and now SMRs. This particular bright shiny object was one of George Osborne's ideas – he does seem to have had a particularly bad case of magpie syndrome.

Don't get me wrong – I am not against R&D and developing new technology – far from it – we need to increase spending on R&D in lots of areas – but we have a whole set of technologies that we know work, which are economic and can deliver results in short order. These include: LED lighting, building insulation, Building Management Systems, integrated design tools, Combined Heat and Power, trigeneration, combined cycle gas turbines (CCGTs), CCGTs combined with Rankine cycle turbines. Let's focus on maximizing the application of the technologies that a) we know will work b) are economic c) improve energy efficiency and productivity d) reduce energy and technology imports and e) create jobs – rather than the latest shiny bright thing.

16 Innovation

Innovations, and the process of innovation itself, remain deeply fascinating. Much of my PhD, which was focused on energy efficiency, was about the power of incremental innovation compared to big leaps forward and I was lucky enough to have the late Chris Freeman of the Science Policy Research Unit at the University of Sussex, one the most eminent researchers on innovation, as an external examiner. We definitely need innovation in many areas, but we need innovation in business models and financing as much as we need innovation in technologies. The blogs in this section summarise some thoughts on innovation in the energy system and energy efficiency, covering the history in innovation in the sector, the difficulties of driving innovation forward, and the ever present hype cycle.

16.1 The future isn't what it used to be. 18 March 2013

I saw a **video of a great TED talk** today by Justin Hall-Tipping, 'Freeing energy from the grid'.

The video, along with my current re-reading for the nth plus 1 time of one of Arthur C. Clarke's great science fiction novels, 'Imperial Earth', reminded me of the expression 'the future isn't what it used to be' – usually attributed to the famous baseball player and manager Yogi Berra. If we look back only twenty years, and certainly when we look back forty years ago, the future and specifically the energy future looked very different to what it looks like now. Official energy forecasts in the UK in the 1980s foretold of a future based on 'CoNucCo' – coal, nuclear and conservation, and increasing energy demand. As it turned out energy demand in 2011 was pretty similar to energy demand in 1970, despite very significant growth in real GDP. Coal use has declined but still makes up a significant proportion of power generation and of course the use of gas grew dramatically. It seems as if we serious under-estimated the effects of improved energy efficiency.

Anyway, back to the theme of the future. I am a technological optimist and the presentation by Justin Hall-Tipping focused on the fascinating area of nanomaterials for energy. Examples given included materials that are only a few molecules thick but could convert windows into active components that can allow energy into a building or let it out at will (an old idea which is also being worked on using some other technologies), super-efficient water filtration systems, and super-efficient storage systems. Friends of mine at the University of Illinois in Urbana-Champaign have developed and are commercializing self-healing materials – itself an amazing technology. Now they have applied them to batteries and have technology that can extend battery life and prevent battery fires (note to Boeing – you should check this out for the 787 problem).

It doesn't matter whether the specific technologies described in any examples are really viable, that is the nature of new technology development, some will be winners and a lot will be losers (along with their early investors). The point is that world-wide there is an incredible number of new and amazing technologies, many of which will change the world's energy system and greatly improve energy efficiency, either at the level of individual devices or by completely changing the way we do things. These are the 'unknown unknowns' I referred to in an **earlier post** that will change the future. It is likely that the energy future in twenty years' time will look very different to what it looks like now as some of these technologies – particularly in smart and nano-materials – will have emerged and started to be widely applied. I suspect the future vision then won't include such basic and archaic technologies as combustion based systems of all kinds, nuclear fission, wind turbines and photovoltaics as we know them today. I look forward to seeing that exciting future.

16.2 Innovation and the energy sector. 19 March 2014

The last few weeks for me seem to have been focused on innovation. First I spent a day in Paris with the EDF Pulse awards team pitching to a jury chaired by Henri Proglio chairman of EDF and more exciting for me, Claudie Haigneré, the first French woman in space. (She

visited the Russian Mir space station in 1991 and became the first European woman to visit the International Space Station in 2001. Having met astronauts and cosmonauts but never a French spationaut chatting to Mme. Haigneré was a great bonus on an interesting day.) However – back to energy matters. EDF Pulse is a global innovation award started last year as part of EDF's open innovation programme and the team of eight "sensors", of which I am one, gathered more than 90 early stage companies with technologies in home, health and a mobility into the competition. The finalists in each category will go forward to a public vote and the winners will be announced in April. After the EDF Pulse day I spent a day teaching a module on innovation and financing at the Westminster Energy forum course for new graduates in the energy industry. Then RBS asked me to join the panel and attend two events to launch their Innovation Gateway, an innovative programme designed to bring new innovations that can improve resource efficiency into RBS's 2,500 building portfolio.

All this led me to summarise a few thoughts on innovation and the process of technical change, specifically in the energy world. This isn't designed to be a definitive article on innovation in the energy industry but rather a collection of observations that are often forgotten or discounted.

We need to start by saying that innovation is a greatly misused word. Strictly speaking it means the first commercial use of a technology but in every day use it is often used to mean the process of change and the massive differences between a concept, a prototype, a pilot plant, a first commercial plant and a standard off the shelf, well proven piece of technology are forgotten or confused. A glossy presentation or a graphic showing "a new technology" is not an innovation (and probably not even a technology) – it is a concept, possibly a great concept that will change the world and possibly a concept with no hope of ever making it into reality. A small-scale prototype plant is just that, it isn't a proven technology that can be rolled-out globally and change the world. In reviewing a "new technology" or "innovation" always remember the **hype cycle**. We should also not forget that process innovations and business model innovations can be just as important, if not more important, than shiny new pieces of technology – however seductive they are.

Making innovation happen, whatever the sector, is inherently difficult. New ideas and concepts abound but only a small percentage of ideas ever make it into reality and have any significant effect on the world. This is because turning an idea into reality or bringing about change, the role of the entrepreneur, is fundamentally difficult. As Machiavelli said in a famous quote; "There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things." Making effective and persistent change happen requires human energy and determination, a thick skin, a range of technical, financial and managerial skills, availability of finance, good timing and a lot of luck.

Innovation in the energy system is harder than other sectors for a range of reasons. Firstly of course energy is a massive industry, global energy sales are $6 trillion per annum and account for 7% of global GDP. Global investment in energy is about $1.2 trillion. Even a small energy investment in the energy sector is usually big compared to other sectors. The rate of capital replacement is slow, energy system assets tend to last a time, typically twenty five years plus – there are plenty of power stations out there which are forty years old or more. A 2008 survey of 500 electricity industry professionals in the USA referenced by the NorthWestern Energy Stakeholders Group reported that more than half of electricity distribution assets are at or beyond their intended life. The Black & Veatch 2012 Strategic Directions in the US Electric Utility Industry survey reports that aging infrastructure remains a major concern for US utility managers. The US Department of Energy **reports** that the average large-power transformer in the USA is now more than 40 years old. Another important factor is that the application of industrial energy has significant health and safety risks, it can and does kill people. This goes some way to explaining conservatism in the industry. Next, the energy industry is heavily regulated and in all countries there are strong links between energy supply and politics. (I wrote about the link between electrical power and political

power **here**. These and other factors make change in the energy industry even more difficult than in other sectors.

Despite these difficulties of course the energy industry has always innovated. In electricity we moved from Faraday's first primitive generator in 1831, (if you haven't seen it go straight to the **Royal Institution in London** and see it along with Faraday's original lab – one of the best free exhibitions in London), through the world's first public electricity supply in Godalming in 1881 (powered by water wheels), to Edison's first steam powered power station in Holborn in 1882, (note this was several months ahead of the more famous Pearl Street power station in New York), to the London Power Company's "super power station", the 400 MW Battersea Power Station A in 1934 which included Europe's largest generator set of 105 MW, through to Drax in 1974 with a 660 MW generating set. In fuel we have moved from burning wood to coal to oil and then to gas, with each transition reducing carbon intensity. The first commercial oil well was drilled in 1859 in Titusville to a depth of 69 feet and now we have remote, steerable wells drilling under the ocean floor for more than ten kilometres horizontally at a depth of more than twelve kilometres. After the first oil crisis in 1973/74 the energy industry establishment believed that there was a shortage of natural gas in the United States and persuaded the US Congress to pass laws stopping use of gas for power generation. Now on the back of the shale gas revolution led by entrepreneurs who, if they got any attention at all were originally considered crazy by the energy establishment, the US is heading towards exporting natural gas.

Although it is tempting to think that they had it easy we should remember that Edison and the other energy pioneers also had to raise capital to develop and deploy new technologies and had their own difficulties raising money. The sophistication of financial models and techniques may have changed dramatically but the basic truth that the inventor or developer usually has to persuade someone else to invest in their company or project remains the same – and the fundamental risks are similar.

Venture capitalists (VCs) often talk about the valley of death for early stage companies, the period between the initial funding round and generating revenues. In energy technology investing there are really two valleys of death. The first is between moving from research to pilot plant and the second is between successful demonstration of a pilot plant (assuming this is actually achieved) and mass roll-out. A lot of research projects are measured in the millions of dollars, pilot plants in the tens of millions (sometimes hundreds of millions), and roll-out is measured in hundreds of millions and billions. Many of the venture capitalists moving from the software/IT world into energy technology development did not appreciate the difficulties, as well as timescales and expense, involved in even demonstrating a successful pilot plant. In some cases they also forgot that utilities don't buy mission critical equipment from small VC backed companies, they buy from the likes of GE, Siemens, ABB and Kawasaki Heavy Industries who have decades of experience in the energy sector and very large balance sheets which can guarantee performance.

Just to illustrate how hard bringing innovation is to commercialise consider the AiM market of the London Stock Exchange. AiM was created to support growing companies and became the darling of clean tech and new energy companies. In the period 2004 to 2007 there was a flurry of activity, a bubble really, of such companies coming to the market and raising money and at one point the highest value company on AiM was a wind turbine company. Analysis by Adam Forsyth of Arden Partners shows that as of September 2013, of the 75 new energy and clean tech companies that came to AiM only 11 made their investors more than 20% (since their IPO), 4 made between 0 and 10%, and 60 have lost money. 12 of the companies lost 100% of the money invested and 42 have lost more than 50% of the original investment. This means that if you had spread your portfolio and put £1,000 into each new energy and clean tech IPO on AiM by September 2013 you would have lost £38,500 so your £75,000 would have been turned into £36,500 – not a good outcome. Of course if you had put your £75,000 into the top performing company you would have made £146,000. Technical change and innovation comes at a real cost to investors! The progression of the AiM market (and all other markets were the same) for new energy and

clean tech exhibits all the signs of a classic investment bubble and demonstrates the hype cycle in action.

While I was with EDF I was reminded that in January EDF issued 100 year bonds with a 6% coupon and that the proposed reactor at Hinkley Point is designed to have a 65 year lifetime. Just think how much even the conservative energy world has changed in 100 years. Any energy executive in 1914, no doubt thinking that the "safe" Edwardian world would continue pretty much as it was, lived in an energy system dominated by coal and by gas lighting. The Royal Navy had experimented with burning oil from 1903 (with the first tests failing miserably) and at the behest of First Lord of the Admiralty Winston Churchill was building the new Queen Elizabeth class dreadnoughts powered by oil, although most of the fleet remained coal fired. The British government established Anglo Persian Oil (the forerunner of BP) in 1914 in order to exploit newly discovered oil in Persia and fuel the Royal Navy. Although the Wright brothers had first demonstrated controllable flight in 1903 the aeroplane was still a new and exciting technology, Louis Blériot had only accomplished the first flight across the English Channel in 1909 and in 1914 the world's first commercial airline, the St. Petersburg-Tampa Airboat Line, was launched in Florida with one fare paying customer. Now 8 million people fly commercially every day. Although radioactivity had been discovered at the end of the 1800s (Mme. Curie received the Nobel Prize in 1903) it was still widely regarded as a curiosity with little or no application. It wasn't until the late 1930s that the idea of using nuclear energy to generate electricity was proposed. In 1913 UK coal production peaked at 300 million tonnes with the coal industry employing 1 million men. In 2013 the UK produced 16 million tonnes (and used 64 million tonnes) and employed about 6,000 people. In 1914 gas lighting accounted for about 90% of all lighting systems. Telephones were still reserved for the rich and it was not until 1915 that the first transcontinental telephone call was made in the US. This year we are going to see the number of active mobile phones, at 7.3 billion, exceed the human population. On the road Henry Ford launched the Model T, the car that brought motoring to the masses, in 1908 but its effect was only just starting by 1914 and motoring was still largely reserved for the rich. In 1909 143,000 private vehicles (53,000 cars) were registered in the UK, compared to 34.5 million private vehicles (28.7 m cars) today – of which 1.4 million were Ford Focus and 1.3 million Ford Fiestas.

Whatever your views on the direction of progress and economic development, or on specific technologies, the last 100 years of innovation really is amazing. It was of course driven by "cheap" fossil fuels, mainly coal and then oil – as well as two world wars. The next hundred years may be defined by greatly improving resource efficiency by focusing on end-use rather than energy supply, the deployment of "smart" technology into dumb systems, and possibly the supply of unconventional gas and truly cost-effective renewables using technologies that are not commercial yet (and I don't mean silicon based PV or wind turbines). The only certainty about the energy system of 2114 is that it won't look like that of today.

To finish, some quotes on innovation that are worth remembering.

"Drill for oil? You mean drill into the ground to try and find oil? You're crazy." **Workers whom Edwin L. Drake tried to enlist to his project to drill for oil in 1859.**

"Electric lighting is a completely idiotic idea" **Chief Engineer, Post Office, 1881**

"The substitution of oil for coal is impossible, because oil does not exist in this world in sufficient quantities." **Lord Selbourne, First Lord of the Admiralty, 1904**

"Any sufficiently advanced technology is indistinguishable from magic." **Arthur C. Clarke (science-fiction and science writer)**

"We over-estimate what we can achieve in the short-term and under-estimate what we can achieve in the long-term." **Arthur C. Clarke**

"For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled." **Richard Feynman, Nobel Prize winning physicist**

"..as we know, there are known knowns; there are things we know that we know. There are known unknowns; that is to say, there are things that we now know we don't know. But there are also unknown unknowns – there are things we do not know we don't know." **Donald Rumsfield, US Secretary of Defense**

16.3 Innovation hype and confusion – a perfect illustration. 28 March 2014

A few days after I published my blog on innovation warning about the dangers of technology hype and a lack of understanding of the realities of the innovation process, particularly in the energy sector, the Independent on Sunday provided a perfect **example**. Across the bottom of the front page the headline said (screamed?) "Exclusive: Renewable energy from rivers and lakes could replace gas in homes" and the article started by saying "millions of homes across the UK could be heated using a carbon-free technology that draws energy from rivers and lakes in a revolutionary system that could reduce household bills by 20 per cent". The whole of page 4 was devoted to reporting on this "magic" "new" technology that takes heat out of rivers and lakes and turns it into heat for use in heating buildings. The Secretary of State Ed Davey was quoted as saying it was "game changing" and it reported that he has asked officials at DECC "to draw up a nationwide map showing where renewable heat can be drawn from water to explore the potential of heat pumps". If you read the piece with no prior knowledge you would have thought that this technology would soon be everywhere providing cheap, low carbon heat.

Here are a few facts to consider:

- Using heat pumps to take low grade heat out of rivers and turn it into higher grade (higher temperature) heat is not new. (To be fair the article did acknowledge this). The Royal Festival Hall on London's South Bank had a **heat pump** installed to use the heat in the Thames in 1951 (subsequently removed I believe)
- The main advantage of the Mitsubishi technology referred to in the article seems to be the relatively high output temperature of 45°C. Higher temperatures are usually better but heat pump efficiency goes down as output temperature goes up. (See below for the real innovation in the system)
- A traditional wet heating system using radiators operated with flow temperatures of c.75-80°C but modern systems in well insulated houses can operate at 50-55°C. Large surface area low temperature heating systems such as under-floor heating operate at c.30-60°C but the majority of houses don't have this (unless the sample of houses is from **Grand Designs**!
- The real innovation in the Mitsubishi system referred to seems to be dynamic control of flow temperature rather than the heat pump itself
- The combination of having to build coils in water plus use of low temperature heating systems means this kind of system is likely to be confined to new build and will make it expensive (but not impossible of course) for retrofitting existing buildings
- Fouling of river coils can be a long-term issue that affects performance and hence costs
- Performance of heat pumps is measured by Coefficient of Performance or COP. COP is defined as the total energy out (heat) divided by the electrical energy input. Heat pumps always sound neat because COPs are typically three to five, meaning you get three to five times more energy out than you put in. As output temperature goes up COP goes down
- The total system efficiency is lower than the COP as it takes into account the delivered heat (less than total heat generated) and electricity supplied to circulation pumps and any additional electric heating required. An Energy Savings Trust (EST) report on the Mitsubishi web site reported on measured results in 23 heat pump sites between October 2011 and March 2012. The average system efficiency reported was 2.91 with a standard deviation of 0.37.

A few critical questions:

- How much does it cost (capital, Operations & Maintenance and running cost) and how much does it save compared to conventional systems? There was absolutely no mention of cost in the Independent on Sunday article. The EST report quoted above found in the 23 sites studied that the *estimated* annual operating cost savings were 8%. (These installations may not have been the new system so savings on the new system could be higher). The Mitsubishi web site claims savings of 20% savings compared to conventional radiator systems but does not mention capital costs – either total or marginal compared to a conventional system
- Why is the Secretary of State making such a song and dance about this particular technology and this particular solution provider? Perhaps the Secretary of State is just desperate to show green credentials in the wake of recent pro-nuclear and pro-shale gas decisions he was forced to take? Or was it just to push the Renewable Heat Incentive (RHI) which applies to heat pumps even if they use grid electricity which is currently 67% driven by gas and coal (source: Digest of UK Energy Statistics)
- How many houses and buildings in the UK are close enough to rivers and lakes to benefit from this kind of system? (Hopefully to be answered by the DECC study)

I have always been puzzled by the DECC Chief Scientist's (and consequently DECC's) apparent obsession with heat pumps. Replacing gas boilers with heat pumps theoretically makes sense if you are seeking to minimise carbon and you assume a switch to low carbon electricity. Based on the belief that heat pumps were a good idea and that millions of households (a target of 4.5 million covering both water and air source heat pumps) would somehow switch to heat pumps from gas boilers, along with equally aggressive assumptions about the rate of adoption of electric vehicles led to an analysis that showed electricity demand growing significantly. This whole analysis always struck me as a neat theoretical set of calculations without much real engineering, economic or market reality and yet it was a major driver for the Electricity Market Reform (EMR). As opposed to growth in electricity demand there is increasing evidence that we may well find ourselves in a world where more efficient lights and appliances result in stable or even declining electricity use.

It seems extremely unlikely to me that water source heat pumps will be the solution to the UK energy problems of cost and security that the Independent on Sunday seems to think. This critique is not aimed at the technology per se or the particular solution provider or project developer – more the lack of analysis and quality of reporting on innovation. There will be some circumstances where water source and air source heat pumps may make good sense for some new buildings but they are unlikely to solve the massive problems of a grossly inefficient building stock and fuel poverty.

To sum up when looking at articles like this remember:

- the stages of the hype cycle
- there isn't a single technology solution to our energy problems
- the viability of technologies is usually very site specific
- adoption of technology is usually driven by real cost saving and/or regulation and not by hope
- answers promoted by politicians – especially before any serious analysis has been done – should be treated with a large pinch of salt.

16.4 Startups versus corporates. 2 April 2014

I saw an interesting guest blog on **Steve Blank's blog** by **Henry Chesbrough** who developed the idea of Open Innovation which is relevant to the discussion of innovation in the energy sector. It was comparing start-ups to established companies and defined the difference like this:

- A startup is a temporary organization in search of a repeatable, scalable business model

- A corporation is a permanent organization designed to execute a repeatable, scalable business model

This is simple but profound realisation, and understanding it is critical to success in corporate venturing and creating new products and services within existing companies. "The processes that companies have optimized for execution inevitably interfere with the search processes needed to discover a new business model". Although existing corporations have far more resources than startups this conflict can severely hamper them those very resources can become liabilities in searching for new ventures. A corporate venture effectively has to fight two wars; one in the external market, and internally against the parent company. This is something that those of us who have been in that situation definitely recognize. It is a major issue for energy companies trying to innovate new products, services and business models. It drives you to the conclusion that any corporation that really wants disruptive innovation has to either explicitly encourage and reward it in the culture, as **3M has successfully done** for decades, or if that is not appropriate (and for many companies it won't be) you have to separate people and resources entirely in the manner of a **Lockheed Skunk Works®**.

Given the massive economic and political disruption going on in the energy markets that threatens the very existence of the incumbent suppliers, if I was an energy company CEO I would be setting up a skunk works with the objective of coming up with a repeatable, scalable business model that will disrupt the traditional energy supply model. If the big suppliers don't do it someone else will (or is already).

16.5 Banking on innovation. 6 Jan 2015

Henry Chesbrough, one of the great innovation thinkers who coined the term open innovation, said:

- a startup is a temporary organization in search of a repeatable, scalable business model
- a corporation is a permanent organization designed to execute a repeatable, scalable business model

which neatly summarizes the huge differences between the two types of organizations.

I was reminded of this quote during the **2 Degrees Live Energy Performance Summit** on 12th December when I was part of a panel talking about the **RBS Innovation Gateway**. The RBS Innovation Gateway seeks to identify innovative companies (or concepts) that offer ways of reducing energy, water or waste in buildings. Unlike other corporate sponsored innovation programmes the Gateway actually offers the possibility of trialing the innovations within the extensive RBS estate.

Thinking about the quote from Chesbrough, and about RBS, which is a bank which has gone through massive changes in the last decade, the ambition of the RBS Innovation Gateway is particularly impressive. Here we have a big corporate – and a bank at that – deliberately putting itself out there to interact with innovative startups and SMEs in a programme with a business and social purpose. Well done to the RBS team for taking such a risk. The Gateway has attracted the innovative companies, now the next steps (currently underway) are to trial the innovations in the RBS estate and measure the results – both in terms of individual projects but also at the programme level. From here the programme could go in several directions including being opened up to other corporates (which is already happening), and maybe into some kind of fund structure.

At the 2 Degrees Live event I said "you have to be crazy to innovate" (speaking as someone who has innovated and loves innovation!) and the comment was tweeted. Someone from the US responded "you have to be crazy NOT to innovate". As I said in my response to that tweet, that is one of the paradoxes of innovation. We need to innovate, we have the desire to change things hardwired into our genes and yet innovation is really difficult and at some levels we dislike change.

At the event I also used a few of my favourite quotes related to innovation which I try to bear in mind when looking at innovative companies. Here are some more of them.

"For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled" **Richard Feynman**

"Electric lighting is a completely idiotic idea" **Chief Engineer, Post Office, 1881**

"The substitution of oil for coal is impossible, because oil does not exist in this world in sufficient quantities" **Lord Selbourne, First Lord of the Admiralty, 1904**

"We over-estimate what we can achieve in the short-term and under-estimate what we can achieve in the long-term" **Arthur C. Clarke**

"Success doesn't necessarily come from breakthrough innovation but from flawless execution. A great strategy alone won't win a game or a battle; the win comes from basic blocking and tackling." **Naveen Jain**

"..as we know, there are known knowns; there are things we know that know that we know. There are known unknowns; that is to say, there are things that we now know we don't know. But there are also unknown unknowns – there are things that we do not know we don't know." **Donald Rumsfield, US Secretary of Defense**

"the famous inventor considers his new storage battery the most valuable of all his inventions, and believes it will revolutionize the whole system of transportation". **Harper's Magazine, 1901 (writing about Thomas Edison's battery factory – the "giga factory" of the age)**

"Innovation is the specific instrument of entrepreneurship. The act that endows resources with a new capacity to create wealth." **Peter Drucker**

"If you want something new, you have to stop doing something old" **Peter Drucker**

"Innovation is hard. It really is. Because most people don't get it. Remember, the automobile, the airplane, the telephone, these were all considered toys at their introduction because they had no constituency. They were too new." **Nolan Bushnell**

"Remember the two benefits of failure. First, if you do fail, you learn what doesn't work; and second, the failure gives you the opportunity to try a new approach." **Roger Von Oech**

"It isn't all over; everything has not been invented; the human adventure is just beginning." **Gene Roddenberry**

"You have to take your own bold approach, and if you do you will be rewarded with success. Or calamitous failure. That can happen too." **Steven Moffatt**

"To be successful, innovation is not just about value creation, but value capture." **Jay Samit**

"Innovators are inevitably controversial." **Eva Le Galiienne**

16.6 Edison, hype and electric cars. 18 June 2014

I just finished reading "*Edison Inventing the Century*" by Neil Baldwin, an excellent biography of one of the most prolific inventors and entrepreneurs ever – one who still shapes our lives today. Edison's most important innovation was not the light bulb, the phonograph (the one he was proudest of), the electric voting machine, the moving picture camera, the iron ore separator, the electricity meter, or the electrical distribution system, but the "invention of invention" – meaning the invention of systematic research and development to find solutions to technical problems and then improve upon them.

I have written before of the hype cycle in innovation and there is no doubt that Edison was also a master of hype – often announcing inventions were ready well before they actually were. He did, however, end up with 1,093 US patents (2,332 world-wide) – a number not surpassed by anyone until 2003 – making him one of the most prolific inventors ever. Another

interesting part of the book covers Edison's development of batteries for electric cars – a story with lots of resonance today.

Already by 1896 people were worrying about pollution from gasoline engine cars. Pedro Salom, a chemist, wrote in the Journal of the Franklin Institute; "*all the gasoline motors which we have seen, belch forth from their exhaust pipe a continuous stream of partially unconsumed hydrocarbons in the form of a thick smoke with a highly noxious odour*". Obviously the control of combustion and fuel quality was not what it is today – and as well as pollution people worried about frightening the horses. Salom was not without a vested interest here as he co-founded the Electric Carriage and Wagon Company Inc. at the start of 1896. By 1900 Edison had decided electric cars were the way forward – they were outselling steam cars and gasoline cars at the time – and wanted to replace the heavy lead acid battery. He spent three years testing different alkaline batteries looking for longer life, durability, safety and a much better weight to energy ratio – all those parameters we continue to seek in battery technology today. He settled on using a positive pole of iron and a negative pole of superoxide of nickel with an aqueous solution of potassium hydroxide as an electrolyte – what we call a nickel-iron battery. He crash tested them by having them thrown from a third floor balcony – a great image.

In May 1901 Harper's Magazine said: "*the famous inventor considers his new storage battery the most valuable of all his inventions, and believes it will revolutionise the whole system of transportation*". He built an assembly plant which opened in May 1901 to produce "500 cells daily" with a target cost of $10 and sales price of $15. The plant produced different designs optimised for different vehicles including cars and delivery wagons plus illuminating train carriages. Edison's fame and ability to get publicity led to a good start with strong sales for a year or so before technical issues were discovered. Cells leaked and power losses of 30 per cent occurred under repeated charging and discharging. Edison continued to innovate – adding nickel flake within the positive plate increased watt hour capacity per pound by 40 per cent – but in the end the market rejected electric vehicles as the gasoline engine improved and the problems with batteries were recognised. The business – The Edison Storage Battery Company – carried on making batteries for other applications and was sold to Exide in 1972 who then stopped making nickel-iron batteries in 1975.

Interestingly a 2012 *Nature Communications* article reported that Stanford University researchers had applied nano-technology to the nickel-iron battery with promising lab results – so perhaps Edison's technology will make a comeback.

Edison's friend and collaborator on electric cars, Henry Ford once famously said "*history is more or less bunk*" but history can be helpful for understanding the present. "*Edison Inventing the Century*" has plenty of insight into the development of the modern electricity system as well as the (timeless?) issues around innovation.

17 Low energy buildings

I grew up with a strong interest in architecture and buildings and particularly from the mid-1970s the low-energy design of buildings, even to the extent of 'designing' cool houses with solar panels thermal stores. I followed all the early work on low energy houses as best you could in those pre-internet days. In the early 1980s I got into the super-insulation movement in Canada which was a precursor in some ways to the Passivhaus standard. In 1986 I participated in building a house at the Milton Keynes Energy World exhibition which the last time I checked is still there. There is something fundamentally human about designing and building. It is good to see the Passivehaus standard growing in influence and application – given what we know designing most buildings any other way is just plain dumb. My love of architecture and buildings now has an outlet in the form of ep projects, our design and development company, which is doing some great work. I need them to design me a new house!

17.1 Net Zero Buildings. 7 May 2013

The **New Buildings Institute** (NBI) in the USA turned 15 years old in April. The NBI is a non-profit 'working to improve the energy performance of commercial buildings. The NBI has two very interesting initiatives that deserve wider attention, 'Getting to 50' i.e. achieving savings of at least 50 per cent compared to current building code (regulations) and 'Zero Energy', which is about getting to net zero energy buildings, i.e. buildings that consume no more energy in a year than they produce. Even the 'getting to 50' is an ambitious goal, getting to net zero even more so. So on their 15th birthday it is interesting to look at how things are going with both of these really useful initiatives but particularly net zero energy.

A **recent report** released by the NBI summarized the progress on net zero buildings and took a first look at costs and features of these buildings. The report covered 21 buildings with sufficient data to analyze, 15 of which had actual results and 6 with modeled consumptions. They covered most climate zones in the US and a wide range of buildings including offices, schools and sports facilities. They were small, generally less than 15,000 ft2 but this is representative of the US building stock. The total number of net zero energy (or zero energy capable) buildings in the US is expected to reach 100 by the end of 2013.

The average Energy Use Intensity (EUI) for US commercial buildings is 93 kBTU/ft2. The least efficient of the 21 buildings had an EUI of 35kBTU/ ft2 – i.e. 62% less than the average. The most efficient achieved EUIs of about 10% of the average – i.e. energy consumptions 90% less than the average.

The techniques used included; integrated design, extensive use of day lighting, high efficiency envelopes, high efficiency glazing and advanced heating and ventilating systems and all the buildings included photovoltaic solar systems. All the technologies used were widely available and not particularly innovative in themselves. As energy used for heating and lighting is reduced, the proportion used for plug loads is increased and more effort is then needed to reduce this through both design and better operations.

Measuring incremental costs of buildings is notoriously difficult but it is possible to measure actual costs and compare them to other buildings. The NBI concluded that incremental costs were in the range of 0 to 10% but less than the modeled costs, with paybacks less than 11 years. It is likely that more experience in design teams and the supply chain will reduce costs and there are now plenty of examples where integrated design can reduce total costs.

The NBI's programmes and reports show that designing and building real buildings with net zero, or close to net zero energy use is possible and possible at low (or possibly even zero) costs. What is needed to make it happen more widely is more clients who see the possibilities and the advantages in reduced life cycle costs, and designers schooled in integrated design and appropriate technologies. More aggressive improvements in building codes (regulations) would of course have a major part to play.

17.2 Thoughts on the future of energy efficient building renovation. 26 Nov 2015

An edited version of my panel presentation at the Building Energy Symposium, Lisbon, Portugal, 24-25 November 2015.

I have always been a student of the future. I grew up in the 1960s in the midst of the space race and started a life long passion for space and science fiction. When you read science fiction long enough you realize that it has a habit of coming true – just think about the mobile phone or video calls, not so long ago they were the realm of science fiction and now they are part of everyday life.

My favorite science fiction writer Arthur C. Clarke once said that we tend to over-estimate what we can achieve in the short-term and under-estimate what we can achieve in the long-term. Nowadays it seems as if the long-term has been dramatically shortened – it is only eight years since the launch of the iPhone and in that time smart phones have become the norm. Arthur C. Clarke also said "the future isn't what it used to be" – which I now take to mean that we have become pessimistic about the future with dystopian scenarios of over-population, resource depletion and environmental degradation becoming prominent. Personally I am an optimist and think we can and will solve those problems – and energy efficient building renovation is the one of the best ways of addressing the energy related problems we face.

The focus of this panel is the future and that always starts people thinking about new technologies. It is important to be crystal clear that we can make significant (20 to 40% or more) energy savings in our buildings cost-effectively without any new technology. Today we have seen several case studies that demonstrate this, including the impressive results achieved by Sonae Sierra in shopping malls. And there are many more out there. Accelerating the rate of energy efficient renovation, something we must do to resolve our energy problems of costs, security and environmental impact, is not a technology problem it is a management and institutional problem. Don't misunderstand me, we will always have new technologies emerging and they will help to make energy efficiency easier and cheaper, expanding the massive cost-effective resource that energy efficiency represents. Innovations like factory made retrofit kits will have a massive impact. But where we really need innovation is in processes, management, institutions and finance.

A lot of investors and lenders want to deploy money into energy efficiency as they have realized it is profitable, a big potential market and not dependent on subsidies. At the moment many of them are working out how to deploy capital and several existing funds have had problems getting money out of the door.

In order to scale up investment into energy efficiency we need to think about the problem like a jigsaw, to complete a jigsaw you need all the pieces not just one or two. The key piece in this jigsaw is standardization of the development and documentation of energy efficiency projects – and this is where the Investor Confidence Project comes in. If you develop a wind farm project you have to follow standard processes and produce standardized documents whereas in energy efficiency everyone does it differently. This causes a number of problems for banks and investors, namely: increased risks due to uncertain project performance, higher due diligence costs, inability to aggregate projects, and inability to build teams around standard processes. The lack of standardization has been identified as a major barrier by the Energy Efficiency Financial Institutions Group (EEFIG) and others including the IEA and Citibank.

The Investor Confidence Project (ICP) is a way of addressing this problem. It started in the US and we brought it to Europe with the help of Horizon 2020. Working with investors and lenders and the energy efficiency industry, the ICP has developed a set of Protocols that set out how to develop and document EE projects in buildings. The Protocols cover apartment buildings & tertiary buildings. It is important to understand that the Protocols are not about inventing new standards, we have lots of technical standards, but rather about standardizing

the process and the document set. The Protocols are now available on the website – **europe.eeperformance.org** – and we are now working with pilot projects across Europe including Porto Viva (the city wide renovation programme in Porto), to embed the Protocols into project development.

If you have projects that would benefit from ICP and becoming more attractive to private capital we would happily discuss how we can help you. Please join as an Ally or join the Technical Forum that is overseeing the development of the Protocols – it is free.

Another important part of the jigsaw is capacity building and this has to be in three areas.

- In financial institutions. The EIB has an on-going project to train banks in energy efficiency projects and the EU has a new project to help develop standardized under-writing procedures using the ICP as a foundation
- On the supply side i.e. the energy efficiency industry. We need to develop better skills in integrated design and build supply chains that can deliver whole building retrofits
- On the demand side i.e. the building owners. We need to make owners more aware of the benefits of energy efficiency and particularly non-energy benefits (NEBs). NEBs are growing in importance and are much more exciting that energy saving. Energy efficiency is boring, they include things like health, welfare, additional revenue and economic development. Much work is now going on to value these non-energy benefits. They are much more strategic and exciting to decision makers than energy efficiency and cost savings. We need to talk about the NEBs every time energy efficiency is mentioned

Another important part of the jigsaw is product offerings – the propositions offered by the energy efficiency industry. For many years people have talked about Energy Performance Contracts (EPCs) but they have never really taken off except perhaps in the public sector. We need to accept the limitations of the EPC product and start to innovate new models. In general, at corporate and policy levels, we need to switch to a "pay for performance" model where contractors get rewarded for actual delivered energy savings relative to the baseline consumption. At the moment we have business models and policies that reward buying stuff with no regard to the actual savings achieved by the investment. We now have the technology to measure these savings or negawatt hours. Switching from a "Pay for Stuff" to a "Pay for Performance" model allows all kinds of interesting new business models where producing energy efficiency suddenly becomes a revenue stream, and revenues are always more interesting than cost savings. California has embarked on this switch, if we in Europe can do the same my prediction for the future is that we will be amazed at the results. We

can cut building energy consumption, cut costs for owners, reduce local and global environmental impacts, and reduce Europe's massive energy import bill which is over €1 billion a day.

Thanks to VIDA IMOBILIÁRIA for the invitation to speak and revisit a great city.

17.3 The Greenest Building. 7 April 2017

Having written and talked about the **Bullitt Center** in Seattle and the Metered Energy Efficiency Transactions Structure (MEETS) which it pioneered it was great to finally visit this impressive building during my recent trip to the US. I was lucky enough to be given a personal tour by Denis Hayes, President and CEO of the Bullitt Foundation and noted environmentalist, best known as the co-ordinator of the first Earth Day in 1970 and Head of the Solar Energy Research Institute (now NREL) during the Carter administration.

The six storey, 52,000 square feet building was designed and built for the Bullitt Foundation, which exists to "to safeguard the natural environment by promoting responsible human activities and sustainable communities in the Pacific Northwest". The Foundation needed new office accommodation and wanted something more appropriate to its mission than its old offices in a historic building.

Bullitt Center external view

The decision was taken to build a cutting edge sustainable building that would both house the foundation but also serve as a commercial building. When talking to designers and leading green developers the foundation team were told that their aspirations of a net energy positive, sustainable building for the same (or less) cost than a normal class A building was impossible. Having been told it was impossible the foundation persevered and achieved all their goals. After reviewing different green building standards Denis Hayes settled on using the **Living Building Challenge**. To fulfil the requirements of the Living Building Challenge a building must demonstrate 12 months of operational performance according to 20 Imperatives distributed amongst seven "petals": Site, Water, Energy, Health, Materials, Equity, and Beauty.

On energy the design called for net energy positive and an Energy Use Intensity (EUI) of 16 (measured in the quaint US units of kBtu/square feet/year), equivalent to the output of the 244 kW rooftop PV installation. This should be compared to the following EUI benchmarks:

- Average for all Seattle office buildings: 92
- Seattle energy code building: 50
- Medium Office designed to ASHRAE 90.1 – 2007 (all climates): 47.7
- LEED Platinum building: 34

When the building was commissioned the EUI was certified as 12.3, a 74.2% saving from the ASHRAE Medium Office benchmark. With the building 85% occupied the actual EUI is 10.

Much effort was put into the glazing and lighting design with the aim of maximizing the use of daylight. On average the building is 40% glazed with the main daylighting facades having 60% glazing. The triple paned argon filled, low-E glass windows are in vertical strips to maximize daylight. External shades keep out excessive solar gain and at night the windows can open to allow warm air out. A ground source heat pump system delivers heat and occasional additional cooling on the rare hot days in Seattle.

Bullitt Center interior view

On water the target was simple – net zero water. Despite Seattle's reputation as being the wettest place in the US it's average-annual rainfall is less than several other major cities. Beneath the PV array a membrane roof takes rain water to drains that flow into a 56,000 gallon cistern in the basement.

Bullitt Center water treatment system

Rainwater from the cistern is pumped through several increasingly fine filters and then exposed to UV light before passing to showers and taps. Interestingly, beyond the technical difficulties, the water system faced bureaucratic and legal issues. The building had to be established and regulated as an independent water system separate from, but surrounded by, the City of Seattle's municipal water system. Grey water is treated by filters and a green roof. Perhaps the most challenging aspect of the water system is the use of composting toilets with on-site black water treatment.

Composting toilets (since removed)

The health petal was addressed by avoiding paints with Volatile Organic Compounds, including biophilic elements, and utilizing radiant floor slabs for heating and cooling.

The materials petal started with wanting to avoid the Red List, a listing of fourteen categories of materials that the International Living Future Institute prohibits in any Living Building. To help meet this goal the number of materials to be used was minimized but it still took two years to research, co-ordinate and source materials. The building sits on a concrete base but above the third floor all framing is from heavy timber 100% certified by the Forest Stewardship Council, (as is all wood in the building). Concrete formwork used salvaged plywood and plastic tree fencing, which is used to protect trees during construction, utilized fencing used on other nearby projects rather than new plastic netting shipped from China. The Living Building Challenge imposes strict requirements on the distance different materials are allowed to travel to get to the project site, requirements that the Bullitt Center met.

The Bullitt Center integrated approach to addressing the Living Building Challenge is both technically and aesthetically attractive. It is nearly fully leased to a range of tenants including an engineering firm, a technology company amongst others – proving the economic argument as well as the environmental arguments. It is a truly a landmark project and a great example of what can be done with a highly motivated client and a design team truly prepared to truly push the envelope.

Thanks to Rob Harmon of the **MEETS Coalition** and Denis Hayes of the **Bullitt Foundation** for taking the time to show me the building.

18 Smart cities

Following on from buildings the next subject is smart cities. It is one of those concepts much given to hype but somewhere in all the hype there is useful stuff. We do need to re-design and re-build cities in a new, smarter way. That will include some 'smart' technology for sure, but even without that, a focus on creating a pleasant, green city with great public transport and fewer (or even no) cars would go a long way.

18.1 Common barriers to smart cities and energy efficiency. 16 Feb 2015

I attended a smart cities seminar at Osborne Clarke on the 27th January. I have to say that I regard much of the talk about smart cities as simply that, talk with a lot of hype and not much reality. Firstly as Alan Kell, a long term smart building and smart city pioneer says, we are really talking about smarter cities. "Smart" isn't a point in time or a single fixed state. Secondly many of the technologies talked about in the smart cities conversation like energy storage, are either only in their infancy, not yet deployable at scale or depend on some regulatory changes that have yet to happen.

Anyway the seminar was based on some research by Osborne Clarke looking at barriers to smart cities. The report seemed to to conclude that finance was a barrier and that we needed some innovative finance. This reminded me of much of the discussion on energy efficiency finance and to my mind is misguided.

Simple availability of finance is not a problem in energy efficiency (EE) or smart cities, the problem is the lack of well-developed bankable projects at the scale necessary to attract serious levels of investment and cheaper capital. In both EE and smart cities we don't yet have the capacity (the know-how) to be able to develop large multi-building, city wide projects at scale. That lack of capacity sits on both sides, on the demand side the customers (cities) don't have enough capacity to know what they want and how to get it (they need to become smarter customers). They are inundated with offers from suppliers, all with their own agenda of selling kit and services. On the supply side there is a lack of capacity to develop large projects, and a shortage of development funding to take concepts through to fully worked-up bankable projects. There is also a lack of clarity over business models for a lot of the smart city concepts.

We need capacity building for both the demand and the supply side of the equation. We also need development finance which may have to be public or soft money in the first instance abut ultimately can be paid back out of the implemented projects. We also need standardized ways of developing and documenting processes as well as gaining standardised performance data, something that in EE we are addressing through the **Investor Confidence Europe**.

Interesting, unattributed comments I liked included the following:

- The DNOs are clear that the Low Carbon Networks programme has demonstrated that demand side activity can be more cost-effective than network upgrading. The issue here is that regulation still only encourages capital going into network upgrading. From the early days of the Electricity Market Reform some of us argued that we needed to change the regulations to incentivize DNOs to invest in demand side activities. Even though the RIIO (Revenues = Incentives + Innovation + Outputs) approach is an improvement it still isn't sufficient
- Very few elections change anything but the one in May will in the way that 1945 and 1979 brought in revolutionary changes, the welfare state in 1945 and Thatcherism in1979
- The EU defines a smart city as a city that has done one smart city project. Smart is not a destination but a continuum

- Smart city developments require new models of collaboration between cities, government and the private sector
- The real barrier is the need for new business models. There is plenty of money around for well-developed projects

Thanks to Osborne Clarke for the research and hosting the event.

Interetsing historical note: Osborne Clarke were lawyers to Isambard Kingdom Brunel.

18.2 Smarter finance for smarter cities. 1 Nov 2018

Last week I attended the "Smart Finance for Smarter Lighthouse Cities" seminar which brought together cities, investors and others working on the Sharing Cities Lighthouse project. This project brings together six cities across Europe with the ambitious aim of triggering €500 million of investment into smart city solutions and engaging with 100 cities. The interactive day was very productive.

The first question asked was "what does smart finance for smart cities mean?". My answer was that it is finance that comes with the other pieces of the jigsaw that are essential to ensure a continuous flow of financeable deals, i.e. assistance to develop pipelines of bankable projects ("project development assistance"), capacity building for customers, project developers and the finance community, and standardisation that enables aggregation. The experience in energy efficiency is that finance alone (i.e. project finance) is not enough, there is no point just having finance for projects – that is what I call "dumb finance". There is a wall of money seeking bankable projects, particularly projects with green credentials. I think the smart cities domain is in the same place.

Bankable projects have to be developed and that requires both skills and resources, technical, financial and managerial. Such skills are always in short supply, technical skills of all sorts are particularly in short supply at the moment, even in basic energy systems and particularly in emerging areas like smart cities. Furthermore cities everywhere lack resources, smaller cities have enough problems managing existing infrastructure let alone developing new projects, a problem made much worse by a decade or so of austerity. Somehow we need to build development skills, capacity and resources. Investors and financial institutions looking to deploy capital into smart infrastructure really need to address this problem which ultimately, in the absence of grants will mean accessing some high risk equity type capital. Perhaps cities, financial institutions and governments can come together to share and build resources through projects like **Sharing Cities**. We look forward to working with the project.

19 Sustainable financing and impact investing

One of the most significant mega-trends of the last five years, and particularly the last three years, has been the rise of sustainable financing and impact investing. The flow of capital into sustainable finance, Environmental Social Governance (ESG) and impact investing has been incredible and is one of the most positive signs that we can solve the environmental andf other problems we face. Yes of course there is a degree of 'green washing' or 'ESG washing' but the trend is clear. Investors want to invest in companies and projects that have a positive impact on the environment and the other problems. It is no longer about 'green finance', a small niche, but rather about 'greening finance'. Some of our work, particularly through the Energy Efficiency Financial Institutions Group (EEFIG) and on energy efficiency financing vehciles is part of greening finance. To use two cliches; 'money talks', and 'follow the money'.

19.1 Divesting is easy – investing in energy efficiency is hard. 1 Sept 2015

The divestment campaign, encouraging investors to divest from investments in fossil fuels has always slightly puzzled me but it does seem to be growing in strength. One issue with it is that if an investor sells their shares in an oil company someone else buys them, the company itself is unaffected unless there are far more sellers than buyers and then the share price will drop to a new equilibrium. Shareholding is about ownership and the shareholders are the owners of the company, surely a counter strategy to divestment would be to invest more and start taking a tighter control of the asset that you own – the gulf between shareholders and management is a major contributory factor to many corporate ills in my opinion. If you own 100% of a company (or even a majority) it pretty much has to do what you want which could of course include investing more in alternative energy assets or electric cars or private rockets or whatever you want.

The other issue that the divestment campaign has is that it is predominantly negative and if large investors do divest they then have to find an alternative home for their wealth, preferably one that has the same (or better) risk and reward characteristics that they were seeking by investing in fossil fuel companies. Clearly there are opportunities to invest in renewable energy and green infrastructure and ultimately of course energy efficiency. With recent changes in the UK to support mechanisms renewables may not look as attractive as they once did and dependence on government subsidies should now be considered a significant risk factor in all jurisdictions. This is likely to increase the amount of capital at least considering energy efficiency as an alternative. Those of us in the energy efficiency business would argue, with some considerable evidence, that there is still massive potential (even at low oil prices), to increase investment into very cost-effective, profitable energy efficiency opportunities which as well as bringing energy cost savings, reduction in exposure to energy price volatility and reduced emissions can also bring significant non-energy benefits such as improved health and welfare.

The problem is not about potential however, it is about how to turn potential into real investment opportunities at scale and there are a number of significant barriers to doing that.

Firstly, as we looked at in a previous post Energy Efficiency as a Resource the fossil fuel industry has a well-developed and fairly standardized system for developing and valuing fossil fuel resources and reserves in the shape of the Petroleum Resources Management System (PRMS). There is no equivalent in energy efficiency although the **Investor Confidence Project Protocols** (currently available in the US with European versions to be launched soon) are the basis of a similar system for energy efficiency projects in buildings. Utilization of the Protocols will help standardize the development and documentation of energy efficiency projects which will reduce transaction costs and improve the consistency of technical performance. They are being used by a growing number of developers, investors and programme managers. The Investor Confidence Project in the US has also launched a quality management system under the title of **Investor Ready Energy Efficiency℠**. The

European Commission has recently launched a project that will work with the financial sector to develop a standard approach to under-writing energy efficiency projects which is likely to build upon on the Investor Confidence Project approach.

Secondly there is very little available data on the actual technical and financial performance of energy efficiency projects. Many organizations investing in energy efficiency don't conduct post-investment analysis and even if the performance data sits somewhere in their energy monitoring system (assuming they have one!) it is not readily available without considerable data mining and manipulation. Host organizations who have used Energy Performance Contracts, or their Energy Service Companies do have data on performance but again it is usually proprietary. For investors, considering energy efficiency projects there is no place to get actuarial data on the performance of buildings and projects similar to the ones they are considering. This is being addressed in the US by projects such as Department of Energy supported **Building Performance Database** and will be addressed in Europe by a forthcoming European Commission funded project. In the fossil fuel industry project performance data is easier to get hold of, oil companies' revenues are based on oil production and the oil price, capex figures are generally available (at least for public companies) and there are industry forums for benchmarking the capital cost of projects.

Next there is the lack of human capacity within the financial sector to understand, evaluate and underwrite energy efficiency projects. Investors in and lenders to the fossil fuel industries have considerable human capacity with a deep understanding of the industry, typically they have specialized teams, including people with direct working experience in the industry and access to analysts who really know the sector. Twenty-five years ago there was no equivalent capacity in the renewables sector, the growth of the renewables industry (particularly wind) has been mirrored (and indeed enabled) by the growth of human capacity in renewables within the financial sector. There is very little capacity around energy efficiency in the financial sector. Of course it is only really possible to scale-up human capacity around standardized systems such as those of the Investor Confidence Project and standardized under-writing procedures. You can't build teams or companies when every transaction is done in a different way.

Another part of the problem is that compared to fossil fuels and even renewables there is a lack of development capacity and by this I mean specifically the ability to develop large-scale, investable projects. Large property owners in both the public and private sector lack the technical capacity, and the development finance, which is risky capital at the end of the day, to develop large-scale, multi-property, bankable projects. In the fossil fuel industry there is a well-developed network of project developers ranging from small E&P oil companies, often with very few resources when they start, through to the oil majors. Building owners and energy efficiency developers tend to work on a single (small) project by project basis or at best an individual building. A number of factors contribute to this including the small capital cost of efficiency projects, the fragmented nature of the energy efficiency industry and the fact that efficiency is not seen and valued as a resource like fossil fuels or wind power is.

All these problems make investing in energy efficiency hard to do at the moment. Specialized efficiency funds that have been established in the UK, Europe and around the world are finding it hard to deploy capital. The development of the Investor Confidence Project and establishment of project performance databases are critical enabling conditions to foster a growth in investment into energy efficiency. Interest from the financial community and desire to invest in the sector is growing, particularly amongst investors who have previously invested in renewables and now find them less attractive, as well as investors with social and responsible investing objectives. To convert the potential into reality now requires building capacity in both the demand side, the building owners, the supply side, i.e. the energy efficiency supply chain, and the financial sector.

So if investors want to divest from fossil fuels and invest in energy efficiency they need to put some seed money into solving these problems first. Just providing project investment funds will not cut it.

19.2 European developments in sustainable finance. 19 Feb 2019

The Paris Agreement of December 2015 signalled an international intention to mitigate climate change and attempt to contain the global temperature rise. To have any chance of achieving the targets we need to step up investment into clean energy and energy efficiency. The World Economic Forum stated that the Paris Agreement was a $23 trillion investment opportunity. Carbon Brief estimated that to achieve a 1.5°C investment into clean energy would need to be 50% higher. The IEA says that to achieve its Efficient World Scenario would require investment in energy efficiency, currently about $270 billion a year, to double between 2017 and 2025 and then double again between 2025 to 2040. The European Commission estimate that to achieve its energy and climate goals requires an additional investment of €170 billion per annum.

So how is Europe approaching the need to steer more investment into clean energy and energy efficiency, as well as wider sustainability objectives? In 2016 the EC convened the High Level Expert Group (HLEG) on Sustainable Finance to provide advice on how to 'steer the flow of capital towards sustainable investment; identify steps that financial institutions and supervisors should take to protect the financial system from sustainability risks; and deploy those policies on a pan-European scale'. The HLEG met from December 2016 to December 2017 and its report made the following recommendations:

- Introduce a common sustainable finance taxonomy to ensure market consistency and clarity, starting with climate change
- Clarify investor duties to extend time horizons and bring greater focus on ESG factors
- Upgrade Europe's disclosure rules to make climate change risks and opportunities fully transparent
- Empower and connect Europe's citizens with sustainable finance issues.
- Develop official European sustainable finance standards, starting with one on green bonds
- Establish a 'Sustainable Infrastructure Europe' facility to expand the size and quality of the EU pipeline of sustainable assets
- Reform governance and leadership of companies to build sustainable finance competencies
- Enlarge the role and capabilities of the European Supervisory Authorities to promote sustainable finance as part of their mandates

The report was followed quickly by the Commission publishing an Action Plan on Sustainable Finance in March 2018. This included:

- Establishing a common language for sustainable finance, i.e. a unified EU classification system – or taxonomy – to define what is sustainable and identify areas where sustainable investment can make the biggest impact
- Creating EU labels for green financial products on the basis of this EU classification system
- Clarifying the duty of asset managers and institutional investors to take sustainability into account in the investment process and enhance disclosure requirements
- Requiring insurance and investment firms to advise clients on the basis of their preferences on sustainability
- Incorporating sustainability in prudential requirements
- Enhancing transparency in corporate reporting

The Commission also published three legislative proposals covering the taxonomy, disclosure and duties and benchmarks. Then in July 2018 the Commission convened the Technical Expert Group (TEG) to assist the Commission in developing:

- an EU classification system – the taxonomy – to determine whether an economic activity is environmentally sustainable

- an EU Green Bond Standard
- benchmarks for low-carbon investment strategies
- guidance to improve corporate disclosure of climate-related information.

The TEG will report on its taxonomy proposals by June 2019. On energy efficiency, the latest iteration of the Energy Efficiency Financial Institutions Group (EEFIG), supported by the EC and UN Environment, will feed directly into the work of the TEG on the taxonomy.

The Commission is moving quickly to put in place a framework that will help steer investment into sustainable activities. This first phase is focused on climate change mitigation and adaptation but future phases will also start to examine other aspects of sustainability including; healthy natural habitats, water resource conservation and management, waste minimisation, pollution prevention and control, agricultural and fisheries productivity, access to food, access to basic infrastructure and access to essential services.

To achieve improved levels of sustainability we need to increase investment flowing into sustainable projects, assets and sectors. The investment needs can only be met from the private sector. The EC is moving quickly and Europe is leading the world in building the enablers that will direct more capital into sustainable finance. Ultimately however success will be measured by changes of direction and increases in the flow of capital into more sustainable activities.

19.3 Making an impact. 1 May 2019

'Every investment is an impact investment'

Amy Clarke, Tribe Impact Capital

I have been thinking a lot about impact investing since speaking at the King's Impact Investing Society conference at the end of January. There still seems to be a lot of debate about definitions but it seems clear that impact investing is any investment which is aimed at achieving a positive impact on some societal problem as well as a financial return, personally I think of it as investing to have a positive impact on sustainability. Then the question of how to benchmark and measure that impact arises. The Sustainable Development Goals (SDGs) are a good roadmap to all the areas where we need to improve sustainability – across environmental, social and economic spheres – and can form the basis of measurement. Impact investing aims to have a positive impact on key sustainability problems as well as make a return, it is not philanthropy. At the King's conference Amy Clarke, the founder of Tribe said, "every investment is an impact investment" and that is correct – every investment has multiple impacts in the areas covered by the SDGs, some good, some bad, some intentional and some unintended. Impact investing is about focusing on making a positive impact as well as a financial return.

The question, that for so long has not been asked, and which impact investors ask, is what is the impact of this investment on the non-financial factors such as the environment, gender inequality, access to basic services or whatever areas the investment affects. Taking a systems' view, we need to ask what is the totality of all the impacts of the investment? An impact investment should be positive in its impact on at least some of these factors. Important questions include; what is the base line for comparison, what are the targets and how do we measure progress? The SDGs are a set of global targets covering all aspects, economic, environmental and social and provide an overall context. Various initiatives to define and measure impacts now exist and are beginning to be applied more often. The **Impact Management Project**, which grew out of a project by Bridges Fund Management is one emerging global impact measurement tool.

Of course financial investors are not the only decision makers who have impact. Managers of organisations make decisions every day, small and large that have multi-dimensional impacts – whether they be decisions on which mode of travel to take or decisions to build a new factory or develop a new product. A systems-based approach to investment appraisal

should cover the non-financial impacts, both good and bad. To what extent and how do organisations that have environmental goals factor this into every decision? Appraisal of capital investment and the way it is taught and practiced is almost entirely focused on the financial aspect and yet we know that other non-financial factors can be more strategic and therefore important.

Consumers make purchase decisions every-day that have impacts – often impacts in distant and remote parts of the world in some part of the long supply chains, impacts that can be negative in various aspects when viewed against the lens of the SDGs. Systems that bring greater transparency of the impacts to consumers have emerged but we need a lot more of them such that consumers can factor them into their decisions. How can we measure and communicate the wider impact of relatively small purchase decisions to consumers?

Impact investing is growing in volume and this is a really positive trend but we also need to think about, and talk about impact managing and impact consuming. Every investment decision, every management decision and every purchase decision has multiple impacts.

EnergyPro works to identify, develop and implement impact investment opportunities, particularly in support of the energy transition but also in other dimensions of sustainability. We also work with organisations to help them make more impactful decisions.

If we can help you in these areas let us know.

Presenting at the King's Impact Investing Society

20 Space, science fiction and aviation

Growing up I wanted to be an astronaut. It was the mid to late 1960s and the space race was in full flight. Nothing was more exciting than following the Apollo programme through to its conclusions. However, becoming an astronaut didn't seem like a viable career for a British kid so over time my career aspirations went through environmentalist, engineer, architect, to energy specialist and then energy efficiency. Space exploration and travel is still a passion though. Some people find this contrary to energy efficiency and environmentalism but I believe it is hard wired into the human species to explore, otherwise we would still be in the trees or even the ocean. I don't think we can or should stop it – just like every other activity we should undertake it in the most efficient and environmentally friendly way we can, and we need to research and develop ever better ways of doing that. Space and science fiction go together and science fiction can teach us many things as well as act as a mirror to what we are doing here and now. Aviation like space represents a dream as old as humanity. For me the history of aviation is a history of the dream of flight and centuries and decades of solving a problem. Like space travel it shows what we can achieve when we set our minds to it. It also shows the power of applied science. As an experience flight, especially when you fly yourself, is unbeatable. The blogs in this section reflect on space, science fiction and aviation.

20.1 Energy matters on the edge of the solar system. 26 Sept 2013

In the words of the immortal Monty Python – "and now for something completely different" – some energy related thoughts on the amazing Voyager 1 spacecraft which it was recently reported has now "left the solar system".

Voyager 1 was launched on 5th September 1977 with the aim of flying by Jupiter and Saturn, which it did so in 1979 and 1980 respectively. The photographs of the two gas giant planets were stunning and much better quality than those from the earlier Pioneer 10 and 11 probes.

Jupiter's Great Red Spot (three Earth's would fit within it)

Saturn with moons, Tethys and Dione with shadows and rings

I remember the great excitement of first seeing these photos. Voyager 1's sister ship, Voyager 2 also flew by Jupiter and Saturn and then went on to fly past Uranus and Neptune. Pluto is the only planet we haven't visited yet but all being well the New Horizons probe will get there in July 2015. As was widely reported it has now been confirmed that Voyager 1 passed through the heliopause and entered interstellar space in August 2012 although it turns out

that defining the real edge of the solar system is harder than you would think. So far Voyager 1 has travelled about 125 Astronomical Units, i.e. 125 times the average distance from the Earth to the sun, or about 18,699,733,875 kilometres.

One fascinating energy aspect of the Voyager mission was the "gravity assist" technique used to accelerate the vehicle and change course and accelerate by using the gravity of Jupiter and then Saturn. Essentially the course selected ensured that the vehicle would be accelerated by the planet's angular momentum. Without this technique it would have been impossible to get to Saturn. The fly by at Jupiter resulted in Voyager 1 being accelerated by roughly 35,700 miles per hour, an energy boost of about 25 MWh by my calculations. (Usually kinetic energy is measured in Joules but I have converted it to MWh as we can relate to MWh better than Joules). Of course we know that energy is always conserved so Jupiter lost the same amount of rotational energy but of course the planet is so massive, 317 times the mass of the Earth, that any effect on Jupiter won't ever be noticed.

The energy to keep Voyager functioning comes from three RTGs, radioisotope thermal generators, each of which uses 4.5 kilogrammes of radioactive plutonium 238 (238Pu) in the form of plutonium oxide which originally emitted 2.4 kW of heat which was converted to about 157W electricity by thermocouples – no moving parts, very simple and still working after 36 years. The output halves every 87 years as the radioactive material decays. The original 470W electrical output of the three RTGs combined is about half the rating of a domestic toaster. Interplanetary probes in the inner solar system, out to Mars, can use solar arrays but at Jupiter the sun is between 600 and 800 million kilometres away and the light level is only about 50W/m2 compared to 1,400W/m2 at Earth. Solar arrays would have to be enormous to generate sufficient power to run the spacecraft. As the radioactive plutonium in the RTGs decays so does the electrical power output. NASA have a sequence of switching things off and estimate there will be enough power to run some instruments up to the mid-2020s – nearly fifty years after launch. Although it is not widely known as an earth-bound energy generation technology several companies are developing thermocouples (not linked to using radioisotopes) to use different low temperature heat sources to generate power, **for example O-flexx**. If they can make them cheap enough and they can operate at low enough temperatures there will be a market in utilising waste heat sources to generate power.

The fact that we are still receiving information from Voyager is a testament to the brilliance of radio engineering, an area of technology I always struggle with. Here we have a probe that is 18 billion kilometres away, its radio transmitter emits radio waves with a power output of 23W, (compared to a mobile phone that typically emits c.3W), through a 3.7m parabolic dish antenna. By the time it gets to earth after a 17 hour trip the radio wave has a power of one tenth of a billion-billionth watt and somehow this tiny signal is picked up by the Deep Space Network's giant receivers and turned into useful information – there is no other word for that than amazing.

At the other end of the scale when it comes to radio waves is the enormous amount of energy put out by Jupiter. Strangely Jupiter emits more energy than it receives from the sun and the total emission in radio, near Infra-Red, Ultra Violet and X-ray is estimated at 100TW – about 100 times the total US electrical generating capacity.

In summary there are many amazing things about Voyager, its mission and the outer solar system. The technology of Voyager by today's standards is incredibly primitive, data is stored on a tape recorder of sorts with 69 kilobytes (yes – kilobytes) capacity. The navigation required to thread accurately through to Jupiter, Saturn and beyond is incredible. The mere fact that we have sent an emissary out that far speaks volumes for man's vision, ingenuity and our innate drive to explore.

Finally, one of the most awesome photos taken by Voyager was the famous "pale blue dot" photo – a shot of Earth taken from 6 billion kilometres away which shows the Earth as simply that, a pale blue dot in the vastness of space.

The Pale Blue dot

Carl Sagan, the great astronomer, who had been instrumental in getting NASA to command Voyager 1 to take this photograph later wrote about it:

"From this distant vantage point, the Earth might not seem of any particular interest. But for us, it's different. Consider again that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there – on a mote of dust suspended in a sunbeam.

The Earth is a very small stage in a vast cosmic arena. Think of the rivers of blood spilled by all those generals and emperors so that in glory and triumph they could become the momentary masters of a fraction of a dot. Think of the endless cruelties visited by the inhabitants of one corner of this pixel on the scarcely distinguishable inhabitants of some other corner. How frequent their misunderstandings, how eager they are to kill one another, how fervent their hatreds. Our posturings, our imagined self-importance, the delusion that we have some privileged position in the universe, are challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity – in all this vastness – there is no hint that help will come from elsewhere to save us from ourselves.

The Earth is the only world known, so far, to harbor life. There is nowhere else, at least in the near future, to which our species could migrate. Visit, yes. Settle, not yet. Like it or not, for the moment, the Earth is where we make our stand. It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another and to preserve and cherish the pale blue dot, the only home we've ever known."

Carl Sagan, Pale Blue Dot: A Vision of the Human Future in Space, 1997

It is worth taking the big picture view sometimes.

For those of you who don't know my other great interest in life is space exploration and space travel. Normal service will be resumed on the next blog post.

20.2 Remembering the Battle of Britain. 18 Aug 2015

Friday 10th July was the 75th anniversary of the start of the Battle of Britain, a pivotal moment in history that changed the course of World War 2 and consequently the world. I was lucky enough to see some of the fly-by in London of four Spitfires and two Hurricanes accompanied by four state of the art Royal Air Force Typhoons. The 18th August was named "The Hardest Day" as both sides lost more aircraft combined than on any other day of the battle. The story of the Battle of Britain has been told many times, famously in the 1969 film which used 100 real aircraft in stunning aerial warfare sequences. Like much of WW2 history, the more you learn about the Battle of Britain the more amazing the story. The average age of RAF fighter pilots was about 20 and many went into combat with less than 10 hours flying experience on type and then flew three, four or more sorties a day. Without getting too carried away in patriotic fervor it is true that Britain and the rest of the world owes the RAF pilots of the Battle of Britain a debt, and not only to the pilots, but also to their leaders and also to the Spitfire and the Hurricane and the people who designed, built and maintained them. As Churchill said; "never in the field of human combat has so much been owed by so many to so few".

Having been moved to write something on the Battle of Britain I was struggling for an energy related theme. I first thought about the Rolls Royce Merlin engine that powered Spitfires and Hurricanes. A great piece of engineering at the time it produced 977 kW (at 9,200 feet in III specification) from 27 litres displacement with a weight of 744 kg. As a measure of technology improvement in the intervening years, and referring back to my **Formula 1 blog**, these numbers should be compared to the numbers for the Mercedes F1 W06 hybrid power unit which produces 671 kW from 1.6 litres and a dry weight of 145 kg – 11 times the output per litre and 3.5 times the output per kg. As well as the Merlin, the use of 100 octane gasoline, a relatively new development in 1940, was another factor that helped give the RAF air superiority.

Spitfire and Hurricane, Battle of Britain Memorial Flight

Then I thought about how the struggle for oil drove several WW2 strategic directions and battles. There is a view that the German invasion of Russia was driven by the need to secure oil. The war in the Pacific was essentially about Japan looking for resources after the US embargoed oil exports to Japan. Romania's oil was a critical resource for the Germans and the oil refineries in Ploesti were the target for a famous 1943 American bombing raid – Operation Tidal Wave. (I once flew myself over Ploesti and the same oil refineries which was exciting.) The Germans, lacking domestic oil, developed the Fischer-Tropsch process to make oil from coal, which continues to be used and developed to this day. General

Patton's tanks famously ran out of gasoline in their rapid charge across Europe in 1944, highlighting the importance of fuel supply chains. Another less known energy story from WW2, and one that is relevant to today, is how Britain boosted domestic oil production from 750 barrels in 1938 to 845,000 barrels in 1943 – much of it from wells drilled secretly in Sherwood Forest.

I even thought about making an analogy to a new battle of Britain, the battle around energy dependency – something we need to take more seriously.

But in the end I decided we should just simply take a few minutes to remember the Few.

Of the nearly 3,000 RAF aircrew who fought in the Battle of Britain 544 lost their lives and of the remainder a further 814 died before the end of the War. The Battle of Britain Monument on the Victoria Embankment, London, records the names of the 2,936 flyers from the 15 nations who flew for Britain in the Battle. Of course we should also remember the Luftwaffe pilots who were lost.

"The gratitude of every home in our island, in our Empire and indeed throughout the world, except in the abodes of the guilty, goes out to the British airmen, who, undaunted by odds, unwearied in their constant challenge and mortal danger, are turning the tide of the world war by their prowess and devotion. Never in the field of human conflict was so much owed by so many to so few."

Winston Churchill

20.3 Remembering Apollo 1 fifty years on. 27 Jan 2017

Fifty years ago today the American space programme had its first tragedy – the fire in Apollo 1 that killed Virgil 'Gus' Grissom, Ed White and Roger Chaffee. The fire occurred during a test on the launch pad in preparation for a launch that was scheduled to occur on 21st February 1967. During the hours leading up to the fire there were numerous communications problems which led Gus Grissom the flight commander, who had previously been critical of many problems in the spacecraft and had labeled it a lemon, to say "How are we going to get to the moon if we can't talk between two or three buildings". Some time after that a call of "fire" was heard followed by "fire in the cockpit". The crew did not make it out, despite their own frantic efforts and those of the ground crew battling through toxic smoke. This was mainly down to a complex, three-way, inward opening hatch.

The result of the fire was a 21 month delay in the Apollo programme during which the spacecraft design was greatly improved. As well as the hatch being re-designed to be quick acting and opening outwards, design and manufacturing processes were improved and everything in the vehicle was fire-proofed as far as possible. Procedures were changed, including ground tests being carried out with an atmosphere of air in the capsule instead of the highly flammable pure oxygen used in Apollo 1. In the rush to land on the moon before the end of the 1960s management and workers had become sloppy – the Apollo 1 capsule contained damaged wires and changes had not been well documented. Although the actual ignition source of the fire was never discovered the lowering of standards to make the deadline was a major contributory factor. That is something we should all learn from.

If the fire had not happened Gus Grissom may have been the first man to walk on the moon but it is more likely there would have been a disaster later in the programme, either on the ground or in space, which would probably have stopped the whole project. As it was, three astronauts died horribly but the programme recovered from the tragedy by deeply questioning technologies and procedures and re-doubling its efforts. In October 1968 Apollo 7 tested the revised Command and Service Modules in earth orbit, in December 1968 Apollo 8 orbited the moon, in March 1969 Apollo 9 tested the Lunar Module in earth orbit, in May 1969 Apollo 10 did a complete rehearsal for landing on the moon, and in July 1969 Apollo 11 landed on the moon – a mere two and half years after the Apollo 1 fire. In the modern age

where it seems to take forever to do simple things and where we seem to have lost the spirit of exploration, the recovery from the Apollo 7 fire and the subsequent successes of Apollo appears nothing short of miraculous.

"If we die we want people to accept it. We are in a risky business, and we hope that if anything happens to us, it will not delay the program. The conquest
of space is worth the risk of life. Our God-given curiosity will force us to go there ourselves because in the final analysis, only man can fully evaluate the moon in terms understandable to other men."

Gus Grissom

The Apollo 1 crew

RIP

Virgil I. Grissom, 3rd April 1926 to 27th January 1967

Edward H. White, 14th November 1930 to 27th January 1967

Roger B. Chaffee, 15th February 1935 to 27th January 1967

20.4 2001: Fifty Years On. 18 April 2018

Fifty years ago, on 2nd April 1968, Stanley Kubrick's film "*2001 A Space Odyssey*" was released in cinemas. Although I didn't get to see the movie for another five years or so I first heard about it at about that time from my primary school teacher Mrs. Wright who told our class all about it, (she was an unusual and exceptional teacher). A year later I purchased an Arrow paperback edition from our school's paperback book club, a copy I still have, and was hooked.

As regular readers will know one of my great interests is space exploration and "*2001*" helped cement that interest which was originally sparked by the regular space flights of the late sixties culminating in the moon landings between 1969 and 1972. The screenplay of "*2001*" was developed by Arthur C. Clarke and based on one of his short stories called "*The Sentinel*". It explores powerful themes of exploration, evolution, human existence, life in the universe, and the rise of artificial intelligence. It remains for me the ultimate science fiction film (and book).

Deeply controversial on release, "*2001*" broke with convention with little dialogue. It shows a future where space travel is routine and run by familiar corporations such as Pan Am, (a once successful and pioneering US airline for younger readers), and Hilton – a future we may yet get to through the efforts of Elon Musk, Jeff Bezos and other space tourism pioneers. It is often said that HAL 9000, the AI running the Discovery spaceship on its mission to Jupiter, is the most human character. HAL is programmed with incompatible objectives and finally commits an insane act of murder to resolve his inner conflict. Although talked about as a warning of the dangers of AI, HAL also represents the danger of contradictory programming in the human brain.

Astronaut Dave Bowman's journey through the star gate is a wild trip, apparently often enjoyed under the effect of hallucinogenic drugs in the 1960s & 70s, and ends with his intelligence effectively being downloaded into the universe itself.

The visual effects required new technologies to be developed and of course all were shot on film without any aid of computers. The sets and the spacecraft are amazing and the use of classical music, particularly Richard Strauss's "*Thus Spake Zarathusa*" is awe inspiring. "*2001*" which truly is the master piece of two geniuses, Stanley Kubrick and Arthur C. Clarke, remains as inspiring and relevant as it was fifty years ago.

Normal energy related service will be resumed soon.

20.5 Green aviation. 10 Sept 2018

Those who know me will know of my life long-love of aviation. I wanted to be a test pilot even before wanting to be an astronaut but ended up getting into energy. My under-graduate dissertation combined my two interests as it was on the use of hydrogen as an aviation fuel, an idea that was being heavily promoted in the late 1970s by Lockheed and others with a proposal to build hydrogen fuelled Tristars ferrying between the US, Europe and the Middle East. (This document is now online ***here***). I gave up flying myself a few years ago and still miss it. As everyone knows aviation is a major problem in terms of emissions, with 500 million tonnes CO2 a year expected to triple by 2050, and I do sometimes struggle to square the desire to minimise emissions and environmental impact and the need and desire to travel, especially with the amount of air travel I have done in the last five years.

To start with I don't think we can ever (or should try) suppress the basic human desire to travel. I actually think this is a reflection of the exploration drive, without which we would still be the arboreal primates or even the ocean dwelling mammals we are descended from. Likewise we should not constrain space exploration, in fact we should be doing more, it is just a fundamental human drive. Given that, plus all the conventional economic trends (i.e. increasing wealth leads to increasing travel), we will continue to see a growth in air travel with an increased environmental impact – if we don't change the technology. The question is how to change the technology and how quickly can we do it, especially in the safety driven culture and regulatory environment of aviation.

A decade ago the emphasis was on bio-fuels and much capital was invested in biofuel production and trialling them in aircraft. Safety is of course critical in aviation and I always said I would rather not fly in a bio-fuelled aircraft for the first five years of its use (the same would apply to electric planes) – although that would have been different if I had become a test pilot! Clearly bio- and synthetic fuels will have a major role but the ultimate dream is electric power. Even a decade ago the idea of electric aircraft was science fiction but since then the advances in battery technology, coupled with the work of entrepreneurs and larger companies, has made the dream of electric aviation seem much closer.

A recent article in AirSpaceMag.com described some of the developments including Eviation's nine passenger regional commuter plane that is supposed to fly in 2019 (which has the odd name of Alice). It shouldn't be a surprise, as we have seen the same thing in electric cars, but the choice of electric propulsion leads to significant changes in the way the rest of the aircraft is designed, both in terms of structure and layout. A lot of the structure of aircraft is designed to cope with the stresses of relatively heavy, vibrating engines. Electric motors are lighter but of course there is the huge weight of batteries which will account for 60% of Alices's total weight. For comparison fuel makes up c.48% of the weight of a fully laden Boeing 747. The range of the Alice is estimated at 650 miles at 275mph.

Interestingly enough the projected operating costs are low enough that the cost to passengers could be reduced by 30-60% compared to a conventional aircraft, savings being made in fuel and maintenance. Bonny Simi, President of JetBlue Technology Ventures, is quoted in the article as saying on short trips regional turboprops have an Available Seat Mile (ASM) cost of $0.15 to $0.20 with spikes above $0.40. Larger capacity, long haul jets have

ASMs in the range of $0.08 to $0.12 as they fly higher where jets are more efficient and proportionately less time is spent in take-offs and climb. Simi goes onto say "Forecasts for electric aircraft [flying] 300 to 700 miles estimate 10 to 12 cents" ($0.10 to $0.12 per ASM). If that sort of cost advantage can actually be delivered the economic driver is clear.

As everyone knows battery technology is improving rapidly and costs are falling. There is, however, a long way to go before larger aircraft could be electric. The "magic number" where long-distance flight can become viable is cited at 1,000 Wh/kg of battery weight whereas existing batteries are in the range of 270-300 Wh/kg. The battery in a Tesla S stores 85 kWh and weighs 540 kg – a specific energy of 157 Wh/kg. The target 1,000 Wh/kg for viable aircraft does not seem to take into account possible improvements in drag reduction (and possibly further advances in light weight structures). Professor Viswanathan from Carnegie Mellon University asserts that a battery producing 400-500 Wh/kg could propel an airplane 200 to 400 miles on a single charge.

EasyJet has set a target to begin operating electric routes within 10 years and Norway has proposed making all flights less than 1.5 hours all electric by 2040. EasyJet has partnered with Wright Electric who are working on an aircraft that could carry 120 people on flights of 300 miles or less. Although these targets are exciting we should never forget both the hype cycle and the length of time (& huge amount of money) it takes to get new aircraft certified for public operations. There is a long way, and lots of capital, between announcements and glossy websites and computer generated images and a flying, certified aircraft. As I highlighted in my under-graduate dissertation, it is not only the aircraft where you need to innovate and invest, the ground infrastructure would need to change considerably. When Terminal 5 was constructed it was designed with higher capacity ground power connections as the A-380 was coming into service, imagine the extra power capacity needed at airports for electric aircraft re-charging, as well as the operations impact because of the required charging time.

At the larger, long-range end of the spectrum the direction of travel is towards hybrids. In 2008 Boeing introduced the concept SUGAR (Subsonic Ultra-Green Aircraft Research) Volt which has not been built. NASA is also working on hybrid concepts. At the Glenn Research Center the focus is on concepts that could carry 150 people long distances. As well as propulsion systems designs concepts include the highly efficient blended wing designs, a big departure from the tube designs we are familiar with. (I think it was low cost aviation pioneer Freddy Laker who said he was in the "aluminium tubes" business.) Blended wing designs can save 50% of fuel usage and NASA is moving towards funding a flying large-scale X-plane by 2021. In July 2018 at the Farnborough Air Show the UK Business Secretary Greg Clark announced a £343 million government and industry R&D drive including £58m for electric flight.

Aviation has always been incredibly innovative. 33 years separated the Wright Flyer and the DC-3, the first really effective air transport aircraft, thirty seven years separated the DC-3 and the Boeing 747 which significantly reduced cost and enabled the boom in international travel, forty years separate the Boeing 747 and the Boeing 787 which has a c.50% lower fuel burn. With all the research on innovations in aircraft design, engine design, electric propulsion and batteries it is clear that aircraft can continue to become much more efficient and ultimately much cleaner for the environment than they are today. The race is on between reducing emissions through higher efficiency and new propulsion technologies and increasing demand for air travel.

20.6 The lessons from Apollo 11 fifty years on. 16 July 2019

Even for those with no interest in space exploration it must be hard to avoid the fact that this month is the 50th anniversary of Apollo 11 making the first landing on the moon. As regular readers know I have a strong interest in space and particularly the Apollo programme and so as in previous years I have to mark the anniversary in some small way.

Only Eleven Percent

Whichever way you look at it, Apollo 11 – and the entire Apollo programme – was an incredible achievement, the result of eight years of dedicated, focused effort from up to 400,000 people, marshalled and directed by a government agency co-ordinating hundreds of contractors and sub-contractors. What can we learn from Apollo half a century on?

First of all there is the importance of a clear objective. President John F. Kennedy set out the objective in his speech to Congress on 25th May 1961, at which point the US had the grand total of 15 minutes of crewed sub-orbital space flight experience: "*First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth.*" This crystal clear objective came to be shortened as "*man, moon, decade*" and served as the touchstone for the programme and of course was achieved on 24th July 1969 when Apollo 11 splashed down in the Pacific and Neil Armstrong, Buzz Aldrin and Michael Collins were safely recovered onto the aircraft carrier USS Hornet.

Another lesson is the value of leadership taking bold steps. Throughout the Apollo programme political and programme leaders, exhibited boldness of a level which seems near impossible today. Douglas Brinkley in "American Moonshot" describes John F. Kennedy's philosophy of courage as being "*life is short, bold steps forward are immortal, so act.*" The whole idea of landing on the moon inside a decade was so bold, especially so early in the development of space technology, that even many NASA managers were shocked by the commitment. The technology did not exist, even the method of getting to the moon (Lunar Orbital Rendezvous) was not decided until July 1962 – it was another three and half years before the ability to actually rendezvous in space at all was demonstrated by Gemini VI and VII. NASA's decision to send Apollo 8 into lunar orbit in December 1968, driven partly by intelligence that the Soviet Union was planning a manned lunar flyby and by delays in the Lunar Module was incredibly bold. Apollo 8 was only the second manned Apollo flight and only the third launch of the monstrous Saturn V. The idea of sending Apollo 8 to the moon started in August 1968 with a final decision in November, after Apollo 7 had met its objectives in Earth orbit. In the four months before the mission the flight plan had to be developed, software written and the crew and Mission Control trained for a new mission.

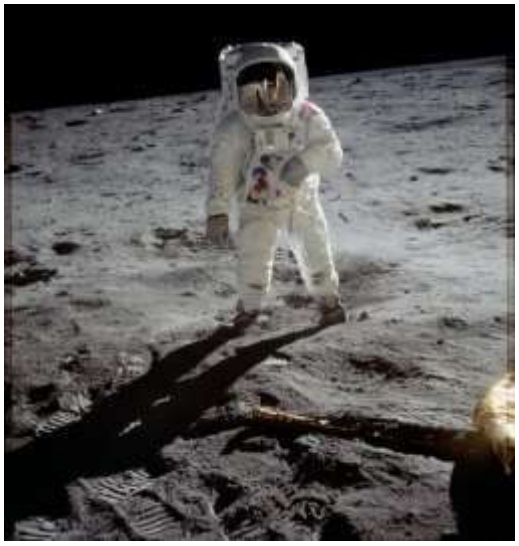
Another lesson from Apollo is that exploration is hardwired into human DNA. Although the timing of the Apollo programme was driven by Cold War rivalries the idea of going to the moon and beyond is a centuries old dream. The advances in technology, many of which we are benefitting from today, and the scientific harvest were immensely valuable, but we explore because it is in our nature. Otherwise we would still be living in trees, or the ocean. Although we clearly need to address problems on earth we cannot suppress the desire to explore the solar system and beyond.

The power of purpose in organisations is now beginning to be recognised. Apollo – and space exploration – gave many people a higher purpose, one for which they were prepared to make great personal sacrifices. Admittedly there was no idea of life-work balance back then and many individuals and families paid a very high price but it was a choice made for a higher purpose. Some people of course, including astronauts and workers gave their lives.

In summary we can learn a lot from Apollo. We certainly need clear objectives to solve our environmental and social problems and we need bold leadership, something that appears lacking today – at least amongst politicians. Of course we also need the long-term financial commitments that underpinned Apollo – as JFK said in a less well known part of his speech to Congress, "I am asking the Congress and the country to accept a firm commitment to a new course of action, a course which will last many years and carry very heavy costs". Yes, the programme was expensive, although tiny compared to defence spending, but its yield in terms of new technology, science, STEM education and the inspiration of generations of scientists and engineers was huge and continues to this day.

Having studied every detail of the Apollo programme I could find for more than fifty years I still find it incredible and the more I learn the more amazing it is. Even if you are not that interested in space I highly recommend reading at least one of the books or seeing at least

one of the films commemorating the Apollo 11 anniversary. I recommend; "American Moonshot" by Douglas Brinkley, "*Apollo 11 The Inside Story*" by David Whitehouse and "*Chasing the Moon*" by Robert Stone and Alan Andres, which is also a documentary shown on PBS and the BBC. If you only do one thing see "Apollo 11" which tells the whole story of Apollo 11 in archive footage and includes some previous unseen 70mm film that was locked away for years and forgotten. Watch it and be amazed.



Buzz Aldrin, Apollo 11. 20th July 1969

20.7 If we can land a man on the moon…. 30th Aug 2019

I have recently read many of the Apollo 11 50th anniversary related books and some of them even had new information I didn't know even after spending my whole life studying the Apollo programme. That is one of the good things about Apollo, it was so big, there are always new stories to read. However, I digress. I was once again struck by the eloquence of John F. Kennedy's two oft quoted speeches on space; the address to Congress on 25 May 1961 and the "*We choose to go to the moon*" speech at Rice University on 12 September 1962, and how they could form the basis of a speech that a hypothetical future US president (or other national leader) could use to address climate change.

Some examples from the address to Congress:

"These are extraordinary times. And we face an extraordinary challenge."

"No role in history could be more difficult or more important."

"There is no single simple policy which meets this challenge. Experience has taught us that no one nation has the power or the wisdom to solve all the problems of the world or manage its revolutionary tides — that extending our commitments does not always increase our security — that any initiative carries with it the risk of a temporary defeat — that nuclear weapons cannot prevent subversion — that no free people can be kept free without will and energy of their own — and that no two nations or situations are exactly alike.

Yet there is much we can do and must do. The proposals I bring before you are numerous and varied. They arise from the host of special opportunities and dangers which have become increasingly clear in recent months. Taken together, I believe that they can mark another step forward in our effort as a people. I am here to ask the help of this Congress and the nation in approving these necessary measures."

"All that I have said makes it clear that we are engaged in a world-wide struggle"

"I believe we possess all the resources and talents necessary. But the facts of the matter are that we have never made the national decisions or marshalled the national resources required for such leadership. We have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfilment."

"No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish."

"A second real asset is that we are not alone. We have friends and allies all over the world who share our devotion to freedom."

And from the Rice University speech:

"William Bradford, speaking in 1630 of the founding of the Plymouth Bay Colony, said that all great and honorable actions are accompanied with great difficulties, and both must be enterprised and overcome with answerable courage."

"We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too."

It is easy to see how these phrases could be co-opted to cover climate change, even if that can only be a dream itself until the current Administration is consigned to history and the better sides of America become dominant again.

The other phrase that always comes up in discussing Apollo is "if we can land a man on the moon why can't we…….. (complete with your preferred problem)". The phrase, the first recorded use of which apparently was in 1962 even before the US had flown John Glenn into orbit, is still in use. In my last blog I did hint at the inspiration Apollo could provide to solving climate change. Although I have never thought a single centrally led programme was the right approach there is a need for inspired leadership as shown by JFK. Political and corporate leadership is still needed, even though we have entered the age when many of the solutions such as renewable energy are actually economic compared to the incumbent technologies and so markets will drive change. We need leadership to drive rapid change.

In one of the best 50th anniversary books, "*One Giant Leap*", Charles Fishman addresses how Apollo changed the world. He specifically writes about what lessons Apollo has for dealing with complex social and economic problems such as homelessness, environmental problems or even climate change, an important topic for debate as back in the 1960s and 70s NASA's programme management approach was once seen as a solution to these kinds of problems. He says something that I think is true:

"If we want to tackle climate change, we can. It can't be solved with "a moonshot," in the sense that Apollo was solved with a series of brilliant technical, engineering, and management efforts. But it can be solved with a moonshot in the sense of rallying Americans" (and I would add people in all countries) "to a purpose, to a mission, to something that takes incredible effort. With leadership and clarity of purpose. We just need to be asked".

The blue marble. Apollo 17. December 1972

20.8 Man must eplore and this is exploration at its greatest….26th Feb 2021

After the hugely exciting landing of *Perseverance* on Mars I had some Twitter exchanges which questioned why we would spend 'huge resources' landing a rover on Mars. My response to this is that humans are explorers, exploration is baked into our DNA. If it wasn't we would still be living in the trees. When standing on the moon in 1971, Dave Scott, the Commander of Apollo 15, the first of the science focused Apollo missions, said "*man must explore and this is exploration at its greatest*" and *Perseverance*is the latest in the journey. As to the huge resources spent, the cost to develop the rover and get to Mars was about $2.4 billion over nine years, about $300 million a year and it will cost the same to keep it operational on Mars. Compared to many other things that is tiny and well worth it. In 2019 Americans spent $96 *billion* on their pets. The entire 2021 NASA budget is $23.2 billion, and that covers everything, robotic exploration and human spaceflight. The entire world's governmental space budget is c.$75 billion. For comparison, the Tokyo Olympics are set to cost $15 billion, Hinkley Point C is expected to cost more than £20 billion, and the UK's 'test and trace' system appears to have cost a staggering, and really hard to justify, £22 billion in a year.

I know some people say we should not be spending money on space while we are combatting climate change and other environmental problems but I don't see it that way. Exploring is a basic human need, it is in our spirit as well as our DNA. Space gives us new perspectives, the Apollo 8 photo of earth rising over the moon, and the Apollo 17 'blue marble' photo have been highly influential in raising environmental consciousness. Although not as important as the positive effect it can have on our spirits, space also brings new science and technology – although 'spin off' alone is not a necessary reason to justify the expense. We just can't stop exploring while we solve the big problems, just like we can't stop making music or art, or having competitive sports – it is part of what makes us human. Of course we need to spend more on solving the problems and moving towards net zero and a regenerative economy. We can and must do that, but we also need to keep doing the other things that make us human.

Perseverance was named in a school student competition that attracted more than 28,000 proposals. A seventh-grade student, Alexander Mather, from Virginia submitted the winning entry. In his winning essay he wrote:

> *Curiosity. Insight. Spirit. Opportunity. If you think about it, all of these names of past Mars rovers are qualities we possess as humans. We are always curious, and seek opportunity. We have the spirit and insight to explore the Moon, Mars, and beyond. But, if rovers are to be the qualities of us as a race, we missed the most important thing. Perseverance. We as humans evolved as creatures who could learn to adapt to any situation, no matter how harsh. We are a species of*

explorers, and we will meet many setbacks on the way to Mars. However, we can persevere. We, not as a nation but as humans, will not give up. The human race will always persevere into the future.

Wise words indeed.

Mars, taken by Perseverance

21 Miscellaneous

The thing about being a writer, is that sometimes you just have to write stuff down when it enters your head. The advantage of a blog is that it gives you an outlet for that even if the subject is outside the normal theme of the blog. This section covers some miscellaneous subjects including Formula 1 and David Bowie, two other great interests of mine, plus rewilding, (a subject of great importance which is still under-appreciated), and infra-tech.

21.1 Learning from Formula 1. 18 May 2015

As regular readers will know I have a great interest in space exploration but today I am writing about another passion that many people may think doesn't fit with my commitment to energy efficiency and some may not approve of – Formula 1.

Formula 1 is fascinating for a number of reasons. First of all it is still a sporting competition in which you are reminded that you never know what is going to happen next in life. Despite predictions that the new rules in 2014 would remove excitement the opposite was true and the Lewis Hamilton versus Nico Rosberg story had it all, excitement, rivalry and skullduggery Secondly F1 is based on cutting edge, innovative technology (more of which later) and demonstrates what we can do when we try hard. Like space exploration, it demands the highest standards and attention to detail in everything from design and construction through to the all important execution from the whole team, not just the driver. And of course as we were reminded of in October 2014 with the Jules Bianchi crash there is still, despite great improvements in safety, the ever-present element of danger. Anyway I am an avowed F1 fan and a big fan of the 2014 World Drivers' Champion Lewis Hamilton who is an incredibly talented driver and exhibited great skill and fortitude in coming from behind many times during the 2014 season.

What are the links between Formula 1 and energy efficiency?

It may be surprising to some but there are some links between Formula 1 and energy efficiency. First of all in 2014 the sport, driven by the large car manufacturers, adopted strict fuel efficiency requirements – a reduction of fuel use of 35% over the previous V8 engines, a maximum fuel load of 100kg and a maximum fuel flow rate of 100 kg/hour. The resulting hybrid power units – they can no longer be called engines – combine 1.6 litre V6 turbo-charged internal combustion engines (ICE), two Energy Recovery Systems (ERS) and an Energy Storage (ES) unit i.e. a battery. The ERS consists of a Motor Generator Unit-Kinetic (MGU-K) which harvests energy that would normally be wasted in braking and a Motor Generator Unit-Heat (MGU-H) which collects energy from the exhaust. The ICE produces 600 hp (485 kW) and the ERS can produce an additional 150 hp (112 kW), giving a total output similar to the old V8 engines. The integration of the ICE, the ERS and ES is a complex task that can affect strategy. Various other rule changes reduced the all important down force from the car's aerodynamics and banned actively using the exhaust to improve aerodynamics, making the cars harder to drive.

The new power units brought with them a highly controversial change in the noise levels and tone of F1 cars at full throttle, instead of the piercing high pitch scream the new sound has been described as like a sewing machine (probably not the best description as the noise level is still 138 dB) – judge for yourself ***here***. The positive view is that spectators can now hear other sounds. At the end of the day all noise, and heat, from any process represents energy being wasted.

The Mercedes team and the W05 Hybrid car (both the car and engine were designed and manufactured in the UK) dominated the Championship in 2014 and a major factor in their success seems to have been the use of integrated design principles. I have written before about the principles of integrated design and the significant advantages that true integrated design can bring in terms of energy and material efficiency. Examples abound – from the *Empire State Building retrofit* to the excellent work carried out in Ireland by

the *Sustainable Energy Authority of Ireland* (SEAI) in applying integrated design in industry. We need to further promote integrated design in buildings and other areas such as vehicles and there are several examples of integrated design in the 2014 Mercedes F1 car and its 2015 successor.

The compressor and the turbo of the MGU-H are packaged at opposite ends of the internal combustion with the compressor at the cooler front, and the turbo at the hotter back. This meant having a shaft, spinning at c.120,000 rpm between the two passing through the V of the engine – it is a very demanding engineering task to design and build such a shaft without flexing and apparently it took two years to perfect. One consequence of the layout was that the compressor could be larger. The resulting reduction in pipework reduces turbo-lag. Another consequence was lower cooling requirements for the inter-cooler which meant smaller radiators and hence smaller side pods – less frontal area means less drag. Other teams had rear mounted compressors which had to be smaller to fit within the overall packaging of the car.

Another example of integrated design was that even the fuel and lubricants were developed by PETRONAS in conjunction with the development of the power unit. Never before have fuel and lubricants been developed in such close co-operation with the design of the power unit.

One of the regulation changes affecting down force was a reduction in the width of the front wings – which in 2014 could only reach half away across the tyre instead of right across as in previous years. Mercedes used an innovative solution, instead of a conventional V shape for the suspension lower wishbone they used a single arm with a forked arm. This acts as a wing and generates downforce which allowed a bigger gap between the nose and the wing, which allows more airflow through the underfloor and to the rear. In order to do this, however, meant designing one arm that could do the work of two – a clear example of integrated design.

The rapid rate of technological development in Formula 1 is illustrated by the progress made on the KERS. In 2007 the first development system weighed 107 kg and achieved an energy efficiency of 39 per cent. By 2009 the weight had been brought down to 25.3 kg and the efficiency increased to 70 per cent. By 2012 the weight was less than 24 kg and the efficiency up to 80 per cent. The technological advances of Formula 1 do impact on ordinary vehicles and the ***MGU-H technology*** may yet appear in road cars, helping to further improve fuel efficiency.

Another link between Formula 1 and energy efficiency is the importance of large amounts of data, and real time data collection. Modern F1 cars have more than 150 sensors on-board that are feeding information back to the garage and the technical team at headquarters in real time. The telemetry is used to optimize strategy, run simulations and provide feedback to the driver. It is also used to help optimize the car's on-going development programme. The increasing availability of real time data from buildings allows us to manage energy more effectively as well as model their performance and design better buildings.

The data collection feeds into an enormous effort to understand the interaction of numerous variables including; those which can be influenced by the design and the set-up of the car e.g. down force, brake balance etc; external physical factors such as track conditions – temperature and surface type – wind speed and direction, the effects of following other cars (which disrupts the air flow); and human factors – how the car is driven and how fast pit stops are for example. In building and industrial process energy use we are dealing with a similar interaction of design/set-up, external factors and human factors and just beginning to have the data and the computing power to create a better understanding of how to optimize energy use in real-time.

At the end of the day we are all utterly dependent on engineering and Formula 1 is an example of engineering at its best. We need to celebrate great engineering more.

I mentioned the high performance and quality standards of F1 at the beginning. The constant striving for improvement and the highest standards required from all team members

is an example all organizations should learn from, whether they are involved in energy efficiency or not. All too often in many areas of life and business we put up with sloppy performance (I may return to this subject in future posts – the sloppy performance of banks is particularly driving me crazy at the moment). We need more absolute, "unreasonable" insistence on high standards in all areas of business from the board room down to the shop floor.

To sum up, Formula 1 – like it not – is an expression of much of what makes us human, our basic competitiveness which is a positive force (but of course can turn negative), our incredible technological ingenuity, the power of team-work and the importance of demanding high standards. The 2015 F1 season has started well for Lewis Hamilton and Mercedes, although Ferrari seem to have narrowed the performance gap and remain a real threat for the rest of the year, as does Lewis Hamilton's team mate Nico Rosberg. I look forward to watching the rest of the season and particularly seeing my first-ever live Formula 1 race, the Monaco Grand Prix at the end of May.

Mercedes AMG Petronas F1 W12

21.2 RIP David Bowie 1947 – 2016. 12 Jan 2016

It would be impossible for me not to comment on the terribly sad death of David Bowie. As for many of my generation he was, and remains, a big part of my life and is by a very long way my favourite musician of all time. His influence on music, art and culture cannot be under-estimated. Perhaps it can only really be appreciated by those of us who were there and watched the 1972 performance of "Starman" on Top of the Pops on black and white TV, under the dis-approving parental gaze. The world changed at that moment.

In 1976 I was lucky enough to win tickets to see the world premier of his first film, "*The Man Who Fell to Earth*". Apart from the excitement of attending a star studded (minus Bowie) world premier I will never forget the first shot of him on the big screen in Leicester Square or the impact of the movie. I still have the ticket and the movie poster, bought for the then not inconsiderable sum of 50p.

I first saw him live on the "white light" Isolar II tour in June 1978. A friend and I managed to get to the front row centre stage, no more than a couple of metres away from Bowie. Subsequent concerts in stadia, The Glass Spiders tour in June 1987 at Wembley, and the Sound+Vision tour in August 1990, were great but could never beat being in the front row of the New Bingley Hall County Showground in Stafford.

So what was/is the appeal of Bowie? For those who know of my interest in space it will not be a surprise that the space and science-fiction nature of "*Ziggy Stardust & the Spiders from Mars*" was the original draw for me. It soon went far beyond that as his lyrics always seemed to have great meaning about life, love and the universe. As the cliché goes he always innovated and it seems hard to believe that fans, me included, who loved the sci-fi rock of "*Ziggy Stardust*" could also like what Bowie called the plastic soul of "*Young Americans*", the indefinable "*Station to Station*", the techno "*Low*", and the dance music of "*Let's*

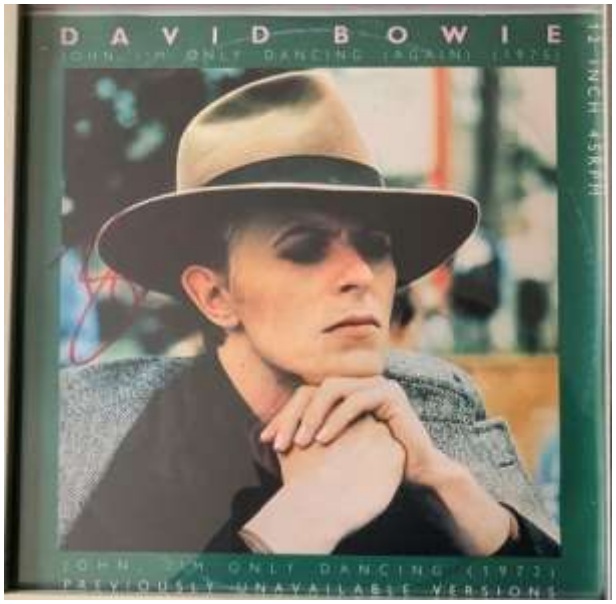
Dance". There was always that period of adjustment to the new style when a new album came out but with the exception of a few albums they all came good in the end. Even the low points had their moments of brilliance.

As well as the changes in style he was always at the cutting edge of musical experimentation and technology, and then later video and the internet. In a 2000 interview with Jeremy Paxman he talked about the power of the internet to disintermediate and break down the barrier between the artist and the consumer. It is hard to remember the primitive nature of the internet in 2000 but Paxman's reaction and look of skepticism expresses it well. Now of course, 16 years later, we take disintermediation and "prosuming" as the norm, and the kind of music and video technology that used to cost a fortune is now available in apps that cost pennies or are even free – meaning anyone can create professional quality music, video and art.

Without a doubt David Bowie was a creative genius, but perhaps more importantly one who was able to channel that creativity into action without worrying about the barriers or what people will think. We are not all musical, (I know I am not) but we are all more creative than we think, but we allow lots of barriers to get in the way of creating so Bowie's life should inspire us to always act on the creative drive. His music, film, art and effect on culture will live on forever. As he said in "*Quicksand*":

"I'm not a prophet or a stone age man

Just a mortal with the potential of a superman."



John, I'm Only Dancing (Again) (1975)

21.3 Rewilding and agriculture. 17 April 2019

Although there is still a lot to do to deliver the transition to a cleaner, low carbon, more flexible energy system, it does sometimes feel that the seismic plates in energy have shifted and that the outcome is inevitable. That should not be taken to mean we can relax – not only is there a lot to do to deliver existing and new technologies, business models and regulation – we still have to combat the resistance of the old guard who as in any paradigm shift spread confusion and fight to hang onto their positions. However the other dimensions of improving sustainability cannot be ignored. Earlier in the year we saw the report on how "*rapidly declining insect populations could threaten the collapse of nature*" which reminded me of the book "*Wilding*" which I read recently.

'Wilding', which I highly recommend, tells the story of Knepp Castle Estate in West Sussex which since 2001 has switched from traditional intensive (and unprofitable) agriculture to rewilding which has resulted in an incredible increase in biodiversity. The approach is to establish a functioning ecosystem and let nature get on with it – rather than target specific goals or species. Knepp has seen great increases in bio-diversity and become a breeding ground for several species that were absent or in severe decline including, purple emperor butterflies, turtle doves, nightingales and 13 out of the 17 UK resident species of bats.

Rewilding Britain define rewilding as follows:

Rewilding is the large-scale restoration of ecosystems where nature can take care of itself. It seeks to reinstate natural processes and, where appropriate, missing species – allowing them to shape the landscape and the habitats within.

Rewilding encourages a balance between people and the rest of nature where each can thrive. It provides opportunities for communities to diversify and create nature-based economies; for living systems to provide the ecological functions on which we all depend; and for people to re-connect with wild nature.

https://www.rewildingbritain.org.uk/rewilding/

Attaining greater sustainability requires ensuring we have food supplies as well as protecting the environment, objectives that can clearly be in opposition to each other. The food production system is essential infrastructure, although it is not usually characterised as such. As in other areas of infrastructure we are seeing a shift towards digitisation, we are also seeing a shift towards production of food in controlled environments. Like producing buildings, producing food in a controlled environment rather than out on site makes a lot of sense and the ability to control environments, possibly in an urban location, can raise productivity as well as reduce resource input for production and transportation.

The idea of the environment created by large-scale farming as being somehow natural, an idea we all grew up with, is clearly wrong – the agricultural environment is as man-made as the inner city and maybe it is largely incompatible with truly protecting nature. The combination of food production in a controlled environment and rewilding provides a clear direction of travel. We need to greatly ramp up food production in controlled environments, out of the field and into the converted warehouse, and then rewild former agricultural land.

Our vision should be healthy food for all produced in controlled and efficient environments enabling large areas of the land and seas to be rewilded.

22 Book reviews

I really should do more book reviews as I read voraciously. My book collection has more than 2,500 books spanning all of my interests in life as well as fiction. Here are the book reviews I have published on the blog, all of which are linked to my professional interests.

22.1 Book review – Power Play - a science fiction book about energy efficiency by Ben Bova. 6 June 2013

As my friends know one of my other big interests in life other than energy is space exploration and although I don't read as much as I used to I am still a fan of 'hard science fiction ('a category of science fiction characterized by an emphasis on scientific or technical detail, or on scientific accuracy, or on both' according to Wikipedia). We can learn a lot from science fiction and of course many of the technologies and gadgets we take for granted today actually first appeared in yesterday's science fiction by Arthur C. Clarke, Robert Heinlein and many others.

On my recent trip to the USA I read' *Power Play*' by Ben Bova. I am a huge fan of Ben Bova whose '*Grand Tour*' series describes an exciting future where we explore the solar system and find life in surprisingly many places. Anyway, '*Power Play*' is extremely unusual – probably even unique – a science fiction story about the problems of commercializing a new energy efficiency technology. The technology in question is Magneto-Hydro Dynamics, MHD, which is actually a more efficient way of generating electricity rather than an end-use efficiency technology, but we know there are large efficiency opportunities in the power generation system just as there are in end use applications such as buildings, industry and transport and we need to focus on improving efficiency in all areas.

Anyway. '*Power Play*' deals with the interaction of the power industry with power politics and paints a dismal, (but probably realistic), view of US (and not just the US) politics, with one character saying, 'It's the old game, tell the voters you're giving them what they want, when in reality you're giving the special interests what they want'. Needless to say the bad guys try to stop the development of MHD, a technology which can improve the efficiency of generation by 50% and, in what one character admits is an exaggeration, offers the potential to cut electricity prices in half. The plot moves with the usual Bova pace and attention to detail and without giving it away, of course the good guys triumph in the end.

MHD is an intriguing technology that has links to rocket technology and in theory could offer high efficiency with no moving parts. The principle is that a when a high temperature, fast moving, (supersonic) plasma passes through a magnetic field it a generates an induced voltage. This is exactly the same as in a normal mechanical dynamo except the stream of plasma, which results from combustion, replaces the metal rotating conductor.

MHD is not a new idea, it first emerged in the late 1930s, resurfaced in the 1960s and then gained widespread publicity and a lot of government funding in various countries in the late 1970s and 1980s, as a response to the energy crises. It was seen as a way of burning coal, including high-sulphur coals, efficiently and cleanly although it was also considered as a way of generating power from nuclear power. Numerous experimental systems were built and in the 1970s Russian MHD systems actually delivered power to the grid.

Like many other technologies, especially in the energy field, the promise and predictions turned out to be optimistic and today we see nothing about MHD. In practice the technological problems are very tough in a number of areas. Firstly there is the problem of containing a high temperature plasma, akin to that in a rocket engine or found during re-entry from space. Chamber walls and electrodes are prone to extreme erosion due to the high temperature and nature of the plasma.

Secondly there is a need to seed the plasma, typically with potassium, to increase its charge, and the seed material needs to be recovered and re-used or disposed of. For maximum

efficiency the magnetic coils should be super-conducting to reduce parasitic loads so as in Tokamak fusion reactor designs you end up with very high temperatures close to a containment vessel close to very cold temperatures – not impossible of course- just difficult from a materials perspective. To achieve the high efficiencies talked about by Ben Bova, probably as high as 60%, the MHD generator needs to be combined with a steam turbine system utilizing the heat of the MHD exhaust, effectively a combined cycle. Without that the maximum achieved efficiency of MHD alone is about 22%. The other problem in a carbon constrained world of course is CO2 emissions. Ben Bova – who has included the effects of climate change in several novels – skips over this with a quick reference to Carbon Capture & Storage.

The other factor that inhibits any development of MHD is that conventional generators are getting much more efficient. The average efficiency of all coal fired power stations in the world is c.33% but modern stations can reach an efficiency of 45%, with a target of 50% in sight in the next decade. With these efficiencies the relative advantage of MHD, which is far more complex and risky, is greatly reduced even if it could achieve 60% efficiency. The extra cost and complexity just isn't worth it.

So, MHD remains a technology that has never been fully developed and one for which both the technology and the economics would seem to be challenging at best. It seems set to remain in the realms of science fiction – but don't let that put you off '*Power Play*' and the many other fine Ben Bova stories.

22.2 Book review – Children of Light. How Electricity Changed Britain Forever by Gavin Weightman. 29 July 2013

I recently read a great book for anyone interested in the history of energy in the UK; *Children of Light. How Electricity Changed Britain Forever*, by Gavin Weightman. (**http://www.amazon.co.uk/Children-Light-Electricity-Changed-ebook/dp/B004IK8M7G**). With electricity and a potential crisis in electricity supply in the UK in the newspapers nearly every day it is important to put the issue in context and that means understanding the history of the electricity industry. Children of Light is an excellent account of that history from its beginnings in the 1870s right through to privatization in the 1980s. As well as being informative the book is highly enjoyable, providing a great perspective on the mix of technology, companies and individuals who changed the UK by developing the electricity industry.

It was good to find out that one of the first public electricity systems in the world was in Goldalming in Surrey (apparently there is a plaque in the town marking this), even though it wasn't really the first in the UK it was a good year ahead of the more famous Pearl Street in New York in 1882 which normally gets the credit for being first in the world, (Edison had better PR!). Godalming's electricity was provided by a water wheel on the river. It was also good to be reminded that the main selling point of electricity was that it was cheaper for lighting than gas – the cost was £195 per annum to light the streets of the town compared to £200 from the gas company. All the switches from one energy source to another historically have been because the cost of providing energy services from the new source is cheaper – something we ignore at our peril.

The influence of great engineers and entrepreneurs, some of whose names are still familiar today like Merz and McLellan, Siemens and Edison is well described, as well as some names that will only be familiar to older readers (me included) such as Swan, Crompton, Armstrong, Thomson-Houston and Ferranti. The Anglo-German nature of Siemens was news to me – William Siemens represented his brother's firm, (Werner Siemens), and lived most of his life in the UK, and ended up being knighted. The influence of American entrepreneurs on the London Underground was also fascinating. The Central line was built with "international finance and American technology" from General Electric (trains), Sprague (lift motors), Thomson-Houston (electrical distribution gear) and Babcock & Wilcox (boilers). The development of the Underground was also driven by American Charles T. Yerkes, who had

served jail time in the US for taking funds from the Philadelphia town treasury with the help of the Treasurer. Yerkes was a great promoter, and generally "colourful" character, and went on to make a fortune in Chicago street railways. Eventually he was forced out of Chicago and based himself, along with his entourage, including his second wife, a seventeen year old girl and a former lover, in London's Claridge's Hotel. He then proceeded to play Monopoly with the existing proposals for new tube lines and the companies running the District and Metropolitan lines. He brought in American investment and technology and in a short period effected the electrification of the District and Metropolitan lines, and the building of the first sections of the Bakerloo, the Piccadilly and the Northern lines.

A really interesting part of the history is the municipal ownership of electricity suppliers. In 1926 there were 572 "authorized undertakings" with 438 generating stations – two thirds owned by municipalities – and this level of local ownership continued until nationalization in 1947 when some 600 companies were taken into the British Electricity Authority and fifteen area boards. Maybe with the dissatisfaction with existing suppliers and the move towards community energy we are going back to having locally owned suppliers.

Other snippets from the book that stood out for me include:

- battles over planning for pylons, particularly in areas of outstanding natural beauty like the South Downs or the Lake District – shades of wind farm planning battles
- complaints about prices going up (despite public ownership)
- the need for pre-payment meters in poorer areas
- the ability to rent electrical appliances – this spread the cost and helped build demand as more people could then afford electricity consuming goods
- Ferranti's invention in 1929 of the electric fire with a parabolic reflector, I remember them as being very common into the 1970s – we certainly had one throughout the 1970s.

Anyway the book is well worth reading for anyone interested in the energy industry and how we got to where we are today. I recommend it.

22.3 Book review – Healthy Buildings by Joseph G. Allen & John D. Macomber. 3 July 2020

I don't often write book reviews these days but every so often a book comes along that is so important or moving that I feel the need. '***Healthy Buildings'*** is one of those and it should become the go to reference for anyone maintaining, refurbishing, designing, owning or just working in buildings – so that is just about everybody. Clearly in the light of COVID-19 it is a very timely book.

It starts with very personal introductions explaining how the authors got to where they are and the work that led to this book. I liked this approach as it helps to frame the 'why', why is the subject important and why do they care enough about it to write a book, which as I know is a huge commitment on top of your day job. Throughout the book is highly informative, extensively referenced and yet easy to read. I really like the style of the book when explaining scientific concepts, captured in the phrase; "environmental media, which is the annoying public health way of saying air, water, or dust".

A lot of the issues discussed have been known about for a long while, but either hidden away, dealt with peripherally or separately in silos, which is part of the problem we face. This book brings them all together in an integrated way and presents enough hard evidence on the value of addressing health in building design, refurbishment and operation to convince even the most hard-nosed real estate investor. It is interesting how much evidence there is that is either not known about or has been systematically ignored, something that the authors bring out using the story of a C-suite executive from company selling air filters asking if there was any evidence of the health effects of PM2.5. There is a huge evidence base but surprisingly enough, a senior executive from a company that has an interest in being on top

of that particular subject didn't know about it. That is a sad commentary on the 'captains of industry' that we have in the built environment sector.

The book brings home the clear message that our collective health is not something that comes solely from random events, or is managed or influenced solely by medical professionals, but instead is highly affected by the buildings we inhabit for 90% of the time and hence by building designers, owners and operators. It also makes the overwhelming case on the effects on productivity of higher levels of ventilation. The 3/30/300 rule quoted in the book is a good ready reckoner, at least for office buildings: 3 units of cost on utilities, 30 on rent and 300 on staff, so a small gain in productivity is worth far more than the usual energy savings. All of this fits with the thinking about multiple, strategic non-energy benefits of energy efficiency which I have often talked about. The strategic (and financial) value of improved productivity far outweighs energy savings and we need to be selling productivity improvements that as a side benefit can bring energy savings. There is a twist to this, making a building healthier, for instance by increasing ventilation rates, will increase energy use but this could be very worthwhile from productivity gains. It also of course improves the returns from any energy efficiency measure e.g. heat recovery and it can improve the case for onsite-generation and/or storage, so we need to factor all these things into better business cases for holistic projects that incorporate health related benefits, productivity benefits and energy efficiency benefits. We need to think about the energy baseline we are comparing to – the current situation or the new situation with increased ventilation.

The book once again reminds us of the importance of language. Indoor Air Quality (IAQ) is a known concept but actually IEQ, Indoor Environmental Quality, may be a better metric as it covers all aspects of the indoor environment not just air quality. It also reminds us that design codes or building regulations are minimum performance standards and may be far from the ideal. Who really wants to perform at the minimum level? But we design and operate buildings at those levels, or even below, all the time.

As well as a treasure trove of evidence and tools that can be used to sell healthy buildings to decision makers, as well as operationalise healthy buildings in real life situations, the book offers suggestions and tools for doing just that. As I have said before, capturing and valuing all the benefits of building upgrades is critical for making the business case stack up, and the health and productivity benefits are ones that are the largest and yet the most often ignored. Like energy efficiency there is massive potential for cost-effective improvement in the health impact of buildings and exploiting that potential is critical for addressing massive health problems in all societies, just like exploiting energy efficiency is for addressing the climate problem. This issue seems to be being neglected in a lot of the 'build back better' conversations which seem too focused on the real and important energy efficiency benefits. Health benefits may get better traction with governments, especially in the COVID world we now inhabit.

I am sure this is a book that I will come back to time and time again. We are now taking inspiration from it as we develop new ideas and service offerings about integrated health and energy retrofits.

23 Science

The subject of science and its role in society has been put into sharp relief by the Covid pandemic. Interestingly this blog from 2017 refers to the anti-vaxxers, thinking no doubt of the MMR debate, if debate is the right word. The Covid vaccines are an amazing product of science and technology but I am afraid that anti-vax, anti-science view points are in the ascendancy around the world, and that is deeply worrying. We need to constantly remind ourselves, and everyone else, of the real nature of science and its importance to our societies and our survival. We need to be spending much more money on science and more on science education at all levels.

23.1 The Long March for Science. 24 April 2017

The marches for science in many cities around the world this weekend were good to see. We often seem to be entering a world of anti-science, especially amongst the religious right in the US and the current administration. Groups like the anti-vaccination brigade and those who want to teach creation alongside evolution are bad signs of the growing power of anti-science. At the same time we are increasingly dependent on technology, much of which flows from a deep scientific understanding of the universe and how it works, at least in the little backwater that we inhabit. It is weird that the anti-science people still want benefits from science including clean water, cheaper and healthier food, medical treatment (apart from the ones they disagree with), electricity, the internet and mobile phones.

The great physicist Richard Feynman wrote an essay called "*The Value of Science*". He talks about three values. Firstly the obvious one is the technology that flows from science. Technology is not always driven by science but the two things are increasingly inter-dependent. Science has allowed us to develop medicines that have eliminated diseases like polio and smallpox, it helped developed anaesthesia, it enables us to understand and harness electricity, it allowed us to develop micro-processors etc. etc. The list goes on and on. Feynman's second value is the inspiration and enjoyment that comes from exploring the universe. Even if we personally cannot directly take part or fully comprehend much of the science it is inspiring to read and think about. Who cannot be at least a little inspired by scientists being able to decode **DNA**, or listening to the sound of radio signals received from **pulsars** by Jodrell Bank, or this picture of earth taken by the Cassini probe around Saturn? (The arrow marks earth).

View of the earth from Saturn, taken by Cassini

The third value that Feynman identified is that science always deals with ignorance, doubt and uncertainty. He said:

"Now, we scientists… take it for granted that it is perfectly consistent to be unsure, that it is possible to live and not know. But I don't know whether everyone realizes this is true. Our freedom to doubt was born out of a struggle against authority in the early days of science. It was a very deep and strong struggle: permitting us to question – to doubt – to not be sure. I think that it is important that we do not forget this struggle and thus perhaps lose what we have gained. Herein lies a responsibility to society."

This is subtle but important. It is about our freedom to doubt authority. Scientists like Galileo challenged authority and science continues to do that to this day. The element of doubt Feynman refers to is so vital because the really dangerous people in the world are the anti-science people with no doubts.

Science is amazing. It is also part of what makes us human. Only a science based approach can make everyone wealthy and healthy and clean up the environment, which is what we need to do as quickly as possible. We should be massively increasing spending on science and science education not cutting it.

24 Personal

Sometimes I just have to write blogs about personal matters, sometimes linked to energy but sometimes not. This section contains a few examples including one written on the death of my best friend, Scott White. They may give some insight into my life but in any event writing them was helpful to me, and in the case of the blogs about Scott and 9/11, cathartic.

24.1 My remarks on accepting the ACEEE Champion of Energy Efficiency Award 2017 in Denver. 22 Aug 2017

I was honored to be presented with an ACEEE Champion of Energy Efficiency Award in Denver, Colorado on 17th August. Here are my remarks on accepting the Award at the ACEEE Industry Event.

Thank you very much for this award. It is a great honour to be given an award by the ACEEE as most of my work is outside the US and I am a big fan of the work of ACEEE. When I flew over for this I wasn't expecting to have to make an acceptance speech so I was very surprised when I read in the programme "presentations by award winners". When I asked Ethan for advice, he suggested talking about how I got into energy efficiency and something about the industry.

Well, it may not surprise you that when I was asked, "what do you want to be when you grow up?" as a child I did not say, I want to go into energy efficiency. I actually wanted to be an astronaut but growing up in UK in the 1970s that didn't seem a viable career move. Then in 1974 in the U.K. we had something called the three day week. This meant that industry only got electricity three days a week, TV finished early, households had rolling power cuts, and even the pubs closed early. This was all due to a strike by coal miners, but it came on the back of the first oil crisis and the two combined seemed to foretell some dystopian future where energy was in short supply. I decided then that energy was a really important area to work on and particularly energy efficiency and renewable energy, which back then was called alternative energy. When I left school I took one of the first ever degrees focused on energy. Then after working a year as an energy auditor I was invited to do a PhD about the potential for energy efficiency in British industry. I have to tell you I had no intention of doing a PhD, but this was a unique opportunity as it was based in industry. Furthermore one of the industries I focused on was brewing. So I spent much of my PhD in breweries and in those days workers in breweries could drink at lunch time – something long gone because of Health and Safety rules. So all in all it was a hard PhD to turn down. It is worth noting that brewing has always been central to energy efficiency and thermodynamics – John Prescott Joule who did the early work on thermodynamics was the son of a wealthy brewer and his early work was all about saving money on energy costs – only later did he work on the theory.

So that is how I got into energy efficiency. I suppose the other question is why did I stay with it so long. There is a lot of talk of barriers in energy efficiency and I suppose I have banged my head against every one of them over the years. I was probably too pig headed or too stupid to stop banging my head against barriers. There is also a more subtle and important explanation and that is about purpose. I think that improving energy and resource efficiency or productivity is the key challenge of our times and a worthy purpose to pursue. We know that we need to generate much more wealth, that is the only way to resolve problems of poverty and ignorance, here in the US, in Europe and in every corner of the world. Fundamentally we have to make everyone rich. In the past of course, and the not too distant past when I was a student, the prevailing truth was that increasing GDP meant increasing energy usage. Since the industrial revolution, wealth creation has been based on extracting more and more resources with all of the negative impacts that brings. It is clear now that despite the views of some people in Washington that model is bankrupt.

Incidentally I read yesterday that in Washington the administration is following a BAY policy – Business As Yesterday. Despite the views of the current administration it is clear that the next mega-wave of wealth creation is about increasing the efficiency of energy and resource use – decoupling GDP growth and energy and resource use – something we have started to see in energy use in Europe and the USA. Energy efficiency is clearly at the heart of that change.

What keeps energy efficiency interesting as a career is seeing how far can we go? When you have worked on the problem as long as I have you get a historical perspective. In 1976 Amory Lovins published "*Energy strategy: the road not taken*" in which he described "soft energy paths" and in the UK in 1979 Gerald Leach published "*A low energy strategy for the UK*". Both of these were considered wildly optimistic at the time and widely panned by analysts, the energy industry and government agencies. History shows that they turned out to be more accurate than any official government or energy industry scenario. As I said in the title of a blog; "*Surprise, you are living in a low energy future*". What is more, we achieved that low energy future without really trying, except perhaps for a ten year period starting in the mid-to late 1970s.

Being an optimist I think that the six powerful drivers of change; policy, economics, technology, the interest of institutional capital, new business models and market infrastructure will continue to drive advancements in energy efficiency, and over the next 30 to 40 years we will achieve a much more efficient future than we think possible. At the end of the day our level of energy efficiency is simply a matter of choice. Given all the global and local pressures choosing anything other than a very low energy future makes no sense. In fact when we consider the global environment a famous phrase from the space programme comes to mind, "*failure is not an option*".

I want to finish with one more space related quote. When Apollo 11 was coming back from the moon the crew held a final in-flight press conference where they talked about the meaning of the moon landing. Michael Collins the Command Module Pilot, likened Apollo 11 to a submarine's periscope – all you could see was the capsule and the crew but underneath that was a huge support structure that made it all possible. I often think that our careers are like that – all you see is the individual's achievements but in fact they are supported by many, many people, some remembered, some forgotten – family, friends, teachers, mentors, bosses, team members, clients and many, many more. I would like to thank all those people who have contributed to my career, past, present and future.

Thank you again to the ACEEE for their great work and thank you very much for this award.

24.2 Bye, bye Miss American pie. 9 Nov 2016

As a life-long Americophile I can't let the election of Donald Trump as President of the USA go by without comment. Before I do that it is worth explaining that my affection for America came originally from following the space programme, (landing a man on the moon was America at its best), but soon grew into something much wider. The bottom line is that America was founded on some great principles and ideals, admittedly principles and ideals that are often not lived up to, but nevertheless they are important and have had global significance. They were formed in the 18th century by giants like Thomas Jefferson, Benjamin Franklin and James Madison. These men were people of their age and need to be viewed as such, but that was an age that welcomed rationality and knowledge – the Age of Enlightenment – a world we now seem to be rapidly moving away from. I have long followed American politics with all its craziness closely, I stayed up to the early hours of the morning to watch Richard Nixon's resignation speech in August 1974 – I don't think many British 15 year old school boys did that. I have always argued that whatever dimension you look at, people, culture, technology, science, geography, whatever you want, America has the best and the worst in the world, and everything in-between. It is the land of extremes. The US often gets criticized because of the worst end of the spectrum. Unfortunately we now seem to be entering an era when some of the worst elements have the upper hand.

So what is going on in the US (and I am afraid in many other countries)? There is clearly anger and backlash at the mainstream politicians for not addressing problems that worry many people. Globalisation has brought enormous benefits but the problems of adjustment to de-industrialisation have not been properly addressed. Over the last ten to twenty years most of the increase in wealth has been concentrated in the hands of a few, whereas from WW2 on until the 1980s most of it benefited the working and middle class. Immigration, or rather mass migration, has caused and will continue to cause massive social, ethical and practical problems in the US and Europe. The perception (real or not) that immigration is uncontrolled is a huge issue and leads to xenophobia which can be exploited.

"Making America Great Again" is code for all these things as well as extreme views harking back to some imagined past when America really was the top dog and there were no problems in America. (Dumbest quote of the campaign: "there was no racism in America before Obama"). The reality is that America is still great but the world has changed and like everywhere it has a number of significant problems on the home front and internationally. The likelihood of a Trump presidency really solving these problems is extremely unlikely – the very few policies promoted during the campaign show little understanding of the issues.

The scariest aspects of a Trump presidency, and current trends in general, include:

- The rise of fact free debate and belief in crazy conspiracy theories
- The rise of being able to repeat a lie multiple times and have it become a "truth" – despite evidence to the contrary
- The rise of not trusting experts – "I know more about ISIS than the generals". Really – how can that be?
- The links to Russia and comments about NATO are really worrying. I hope we never see it happen but the Baltics are really at risk
- The rise of a bullying and misogynistic culture – remember that culture in any organization comes from the top
- The rise of the idea that business is an "I win – you lose" game
- The idea that Mike Pence may become President

Hillary Clinton was clearly not a good candidate. Given her well known long-standing ambition to be President you would have thought she would have been more careful over things like emails. Using a home server was a seriously bad decision even though the actual security implications were probably very small. It shows a high degree of arrogance. It was interesting that we never got to see RNC emails or Trump's tax returns – and now probably we never will. We will see what comes out of the Trump University case and other actions. The reality of a woman President will have to wait – probably for a long time. President Obama has done a good job in most areas but I don't agree with all of his foreign policy shifts. He took office in the middle of the worst financial crisis since the 1930s but somehow that has been forgotten. The healthcare reform, for all of its problems, was a great achievement and if (when) it is rolled back people may look back fondly on the benefits they had for a few years.

In a number of his science fiction books set in the 2050s or beyond Arthur C. Clarke referred back to a global "time of troubles" between the 2010s and the 2040s before a return to rationality and global prosperity and peace. It seems as if he may have been right.

The expression "*You can always count on Americans to do the right thing – after they've tried everything else*" is attributed to Winston Churchill, although as with many sayings there is doubt he actually said it. Anyway it seems as if we may have to wait a long time while they are trying everything else – and hope the consequences aren't catastrophic.

24.3 A weaver of magic – Scott White. 31 May 2018

Only Eleven Percent

My favourite author Arthur C. Clarke once said that "*any sufficiently advanced technology is indistinguishable from magic*" and today I want to write about some technology that fits that description, and more importantly about the person who created that magic. Of course Arthur meant that technology is only magic to those who don't understand it, not that it cannot be explained. The huge array of "magical" technology we have available today is due to humanity's creativity and genius at deciphering the universe and working out how to apply that knowledge.

Scott White and the author in Lovell's restaurant, Lake Forest, Illinois

Scott & I combining our interests of space, good food and good wine at Lovells of Lake Forest, (owned by the son of Apollo 13 Commander Jim Lovell but now unfortunately closed).

On 10th May *Nature* published a paper with the title: "*Rapid energy-efficient manufacturing of polymers and composites via frontal polymerization*" by a team from the Beckman Institute at the University of Illinois. Unless you have an extremely good understanding of advanced chemistry and materials science I don't recommend reading the paper itself but the technology described is incredible. Essentially it concerns a new way of curing polymers that only requires a quick touch from a small heat source to send a wave of polymerisation through the material. The significance of this in the real world is in the manufacturing of high performance polymers and composites, materials that are finding growing use in aircraft, automobiles and other applications due to their excellent mechanical and thermal performance and low weight, a characteristic that helps reduce fuel use.

In our normal world of energy efficiency we are used to talking about savings of 10-30%, maybe 50-70+% in really impressive cases. Manufacturing composites is energy intensive and uses large ovens, one US producer reports that curing just one component of a commercial airliner can use 96,000 kWh, equivalent to the *annual* usage of nine average US homes. The new technique uses **10 orders of magnitude less energy** and can cut production time by two orders of magnitude. That is what you call real energy savings.

The reason I am writing about something that is far outside my expertise is that the lead researcher of this technology was my best friend for many years, Scott White. Scott passed away on 28th May, taken tragically young by a rare cancer. Scott accomplished many amazing things in his career – he was the driving force behind the first ever self-healing materials back in 2001, an advance that was reported in the press globally and led to creating a company to exploit the technology, Autonomic Materials Inc. Essentially the whole field of self-healing materials sprung from his research.

I first met Scott in 1979 when I was a student working in the US for a summer selling ice cream. We were brought together "by chance" because I spotted his parent's Morris Minor on their drive. For anyone who does not know a Morris Minor is a classic 1950s British car and needless to say they are very rare in the US, back then I owned one in the UK. As a result of that car I struck up a conversation with Scott and his parents and that was the start of a rare

and life-long friendship. In the words of another favourite author of mine and Scott's, Richard Bach, there is "nothing by chance".

Scott was many things, a true magician in many ways; the advances in materials science he pioneered have already and will continue to change the world for the better, he was an excellent cook, guitarist, teacher, athlete, parent and friend amongst many other things. His impact will live on but he will be sorely missed.

For a very brief description of Scott's career see **here**.

For more information on frontal polymerization see **here**.

24.4 Some thoughts on the energy transition. 19 Sept 2018

On the 13th September I was asked to give some thoughts on the energy transition to a gathering at Opus Corporate Finance. Here is an edited version of my remarks.

Thank you to Opus for giving me the opportunity to give some of my views on the energy transition. I started work in energy efficiency in 1980 and although we didn't use the term back then I have been actively involved in the energy transition ever since. We say energy transition these days as short-hand to cover the shift away from centralised, primarily fossil fuel energy sources to more decentralised, cleaner and more flexible energy sources, and all the other things associated with that. We should always remember that there have been other energy transitions; from wood & biomass to coal, from coal to oil, from oil to gas. Those transitions were always driven fundamentally by economics but in the early stages of this transition the driver was perhaps more environmental in nature. Now however we have reached the point where economics are taking over, and that is accelerating the rate of change.

Energy transitions take place over long timescales, fifty to a hundred years. An example of that is electrification. A good pub quiz question is where was the world's first public electricity system? Perhaps surprisingly it was in Godalming in 1881 and it used hydro power from the river Wey driving a Siemens alternator to provide lighting. That was 50 years after Faraday, in the Royal Institution on Albermarle St, carried out his experiments on electricity. (If you have never been go to the Royal Institution and see Faraday's actual lab). Fifty years from scientific breakthrough to first commercial innovation is not good for VC funds but in the energy sector it is not unusual. As an aside, interestingly enough the Godalming station shut down in 1894 because it couldn't compete with gas lighting – I am sure at that point many people wrote off electricity as a wacky, expensive, unreliable, alternative energy source that would never compete.

As fifty years is too long to think about, and as you probably saw on the news it is the tenth anniversary of the collapse of Lehmans it is worth reminding ourselves what has happened in the last ten years of the UK's energy transition. Ten years ago in the UK there were no solar feed-in tariffs and 22 MW of solar PV, feed-in tariffs were introduced in 2010, and now we have 12.8 GW of solar generating capacity – almost a 90% CAGR. That is an amazing change in the context of energy transitions. Ten years ago the total renewable capacity was about 2.4 GW and now it is 18.3 GW. Ten years ago there was no storage industry other than pumped storage, now people are talking about a possible 8 to 12 GW in the next few years. Ten years ago the Tesla Roadster had just come out and other than that your choice of EV was limited to a G-Wiz which quite frankly wasn't much of a choice.

If we have to date the start of this energy transition in the UK it would be the introduction of the Non-Fossil Fuel Obligation in 1990 which led to the first wave of wind farms being installed. Back then you could have held a meeting of the entire UK wind industry in the back room of a pub. Since then we have gone from a 4 MW installation at Delabole to 8.5 GW of capacity and wind supplying c.15%+ of electricity with the latest off-shore wind farm having 659 MW capacity alone. We have seen costs of wind and solar fall dramatically, even in off-shore wind where they have fallen further and faster than many of us believed possible even five years ago. The output of renewables has trebled since 2010 and fossil fuel use for generation

has fallen by 44%. In 1990 coal was still generating 72% of UK electricity and now we celebrate days without coal.

One of the constant factors of energy transitions is that the establishment and the energy sector itself consistently gets it wrong – in the same year as the Godalming electricity system was installed, 1881, the Chief Engineer of the Post Office, one of the top technical brains in the country, said "Electric lighting is a completely idiotic idea". I suspect he had shares in some coal gas lighting company – they were an important element of the stock exchange of the day and shares fell sharply once electricity started to take market share.

When in 1911, Winston Churchill, as First Lord of the Admiralty, began to switch the navy's battleships from coal to oil power, he did so in the face of withering scepticism from the establishment. One of his predecessors had stated that "*the substitution of oil for coal is impossible, because oil does not exist in this world in sufficient quantities*". Government and energy industry forecasts in the UK and globally have been proven to be unreliable, in fact worse than unreliable, they have been terrible.

Of course talking about the government making mistakes inevitably leads us to nuclear power. Political power and electrical power have always been closely linked and there is no closer link than in nuclear power. Politicians are like magpies, they are drawn to bright shiny objects and the latest one is Small Modular Reactors, SMRs. To anyone promoting SMRs I always quote Admiral Rickover, the pioneer of nuclear power in the US Navy who said:

"An academic reactor plant almost always has the following basic characteristics: (1) It is simple. (2) It is small. (3) It is cheap. (4) It is light. (5) It can be built very quickly. (6) It is very flexible in purpose. (7) Very little development will be required. It will use off-the-shelf components. (8) The reactor is in the study phase. It is not being built now.

On the other hand, a practical reactor can be distinguished by the following characteristics: (1) It is being built now. (2) It is behind schedule. (3) It requires an immense amount of development on apparently trivial items. (4) It is very expensive. (5) It takes a long time to build because of its engineering development problems. (6) It is large. (7) It is heavy. (8) It is complicated."

SMRs fit firmly into the category of academic reactors and are just the latest bright shiny thing that has attracted the interests of politicians but won't deliver on the promise. Hinckley Point fits the description of a practical reactor.

Especially given Brexit we should not forget that this is a global transition and that in emerging economies the problems and opportunities are on a scale that dwarf the UK's. My company, EnergyPro, has a JV with EESL, the Indian publicly owned ESCO and we have deployed £60m of capital in the UK over the last year. But this week I have had meetings with an Indian delegation accompanying the Minister of Power discussing various programmes in India including the national plan to install 250 million smart meters, all pre-pay and all payable by mobile phone, in the next few years using the Meter Asset Provider model. This is a huge opportunity for providers and funders of meters. India also faces a massive issue in meeting demand for cooling. If Room Air Conditioners are adopted at the same rate as they were adopted in China India would need 300 500MW power stations just to meet the incremental demand of the Room Air Conditioners. That clearly cannot happen, so India has a national cooling strategy and we are using UK expertise and technology to provide trigeneration solutions. Other innovative UK cooling technology providers such as Dearman are active in India. Wearing a UK export hat the opportunity to provide technical and financial expertise is huge.

To finish up, let's look forward ten years, out to say 2020. Some of the key trends which I expect to accelerate include:

- at the macro level the decoupling between GDP and energy use will accelerate. The firm link between GDP and energy use used to be axiomatic but in the UK, the US and elsewhere a decoupling is occurring.

- demand for energy will be cut faster than expected, and demand for fuel will start to be impacted by EVs. We will see peak oil, but that means a peak in demand and not the old idea of a supply constraint.
- renewables will be cheaper than fossil fuels in most situations – and subsidy free models will make money.
- the old model for running a grid that there is Base load and then you add in more flexible sources as demand increases is dead. You will have a situation where the really valuable element is flexibility is flexibility itself which can be provided through, storage, demand response, local generation and energy efficiency.
- all that means adding intelligence to dumb assets to make them better performing, more profitable and greener. This merging of infrastructure and technology – Infratech – is behind a lot of the energy transition and still has so much more potential. There are a lot of dumb assets out there – and I don't mean the one in the White House.
- prosuming – the idea of both consuming and producing energy will spread further in the industrial, commercial and residential sectors. It will be harder and harder to draw a line between the electricity industry and buildings, industry and homes. It will be one inter-connected system, multi-directional and increasingly distributed
- there will be a move away from single technology solutions – end users just want service and actually don't care about energy itself so we will see hybrid solutions – CHP, batteries, solar etc. coming together in new energy as a service business models
- digitisation will enable new services and business models, and allow energy companies and regulators to really measure the effects of energy efficiency and demand response programmes in time and location. We are working with a US company called OpenEE which is enabling pay for performance models for energy efficiency programmes and making efficiency a reliable, distributed energy resource just like a generator. This, along with standardisation of projects and performance insurance, will transform energy efficiency from being the forgotten sister of energy policy and investment into a major growth sector.
- finally electrification of ground based transport is inevitable – it is just a matter of how quickly it happens, twenty five years or fifty years. In the meantime easily available technologies like higher efficiency engines and CNG for trucks will have an interim role to play but ultimately electrification will beat all other solutions.

In conclusion, the energy transition has now entered its major growth and consolidation phase, everything that has happened over the last two to three decades has just been the appetiser. The pressures from end users and capital wanting better, more efficient, greener solutions, plus technological change, are now all acting to accelerate the transition even further into the mainstream. These developments will challenge all of the fundamental assumptions behind our energy institutions, markets, business models, regulators, and industrial structures and we will have to change them all.

So, having participated in the first thirty years of this energy transition, I am hoping to see the next thirty years and in thirty years I think we will look back and be amazed how far we have come. I hope to work with some or all of you soon to help make some of that future happen.

24.5 Witnessing the energy transition. 30 Jan 2019

The end of January (30th) brings another significant birthday, (one that I have trouble believing), and those events are an excuse for some retrospective thinking as well as consideration of the future. I thought I would briefly review "my life in energy", trying to explain some of the influences on me, set against the unfolding energy transition, so please indulge me.

In the 1960s I really liked visiting North Wales. Snowdonia, the castles and the Ffestiniog Railway all combine to make North Wales a special place. One year we visited the Ffestiniog

pumped storage hydro scheme. The scale of the engineering and the vision to dig tunnels and caverns out of the mountainside, as well as the storage aspect was fascinating. It is an amazing piece of engineering and epitomises the central planning of the nationalised electricity industry of that time. It also made the energy industry exciting.

The author at Ffestiniog pumped storage hydro power station, circa 1967

The 1970s were dominated by the two oil crises of 1973/74 and 1979. Although of course the 1973/74 oil crisis was caused by the OPEC embargo in response to the Arab-Israeli war rather than any physical shortage of oil, it did mark a seismic shift of power from consumer nations to the producers and a change in the way that we viewed energy. In the UK it rolled into the three day week caused by the coal miners' industrial action and regular power cuts which really brought home what life without electricity would be like – even in the relatively simple world of the 1970s. As well as missing favourite TV shows, which of course were not at that time available at any other time or on any other media (hard to imagine now), doing homework by candle light made me realise what it must have been like for previous generations or people in countries without access to electricity. This period also saw the environmental movement gaining momentum. The three day week definitely influenced my choice of degree course, an inter-disciplinary degree called Science of Resources with a focus on energy, once I had convinced myself that the aeronautical industry was in a terminal decline and that being an astronaut was fairly unlikely. In the summer of 1979 I was in the US when people lined up for gas and gas hit the heady heights of 86 cents a gallon, 25% up from the year before.

In the 1980s I started work doing energy audits and then a PhD looking at the potential for energy efficiency in British industry with a focus on sectors that my PhD supervisor christened the boozy industries – brewing, distilling, malting and dairies. I spent much time visiting sites including most of the breweries in the country – a tough gig for a PhD student. The UK brewing industry led the world in developing an annual energy benchmarking exercise, one that I think is still going, probably represents the longest time series data on the energy consumption of an industrial sector anywhere in the world.

The 1990s started with the world changing collapse of the Soviet Union and the fall of the Berlin wall, as well as the privatisation of the electricity and gas industries in the UK. The two combined to change my life, privatisation led to energy prices falling sharply and everyone taking their eye off the ball of efficiency by the mid-1990s but the fall of the Soviet empire led to opportunities in Central & Eastern Europe. I spent a fascinating four years working in Romania at a time when the rate of change was visible. Amongst other things I designed EU assistance programmes, advised the Ministry of Industries Agency for Energy Conservation, co-founded an ESCO which is still going, and sponsored two orphans. The early 1990s also saw the introduction of the Non-Fossil Fuel Obligation and the emergence of the then tiny wind industry. Delabole, with its ten 400kW turbines, opened in November 1991.

The 2000s were my introduction to energy services, firstly through Enron (which actually was a great place to work) and then RWE. My brewing industry PhD proved useful when we gained Guinness as a client, first at Park Royal with Enron & then Park Royal, Dublin and Dundalk breweries with RWE. We took Park Royal from being the least efficient brewery to the most efficient but it sadly had to close due to restructuring within Diageo and concentration of production in Dublin. In that period I learnt to like drinking Guinness, a skill I have now lost. The Guinness and Sainsburys deals that we developed with Enron and then delivered through RWE were really ground breaking and some of the things we worked on, like demand response on commercial refrigerators, only came to pass much later. We also applied integrated design and right sizing principles. In the late 2000s my focus switched to finance – first doing equity research in new energy and clean tech and then corporate finance. It felt like a big change of direction but given that Enron operated more like an investment bank I now see the decade more as a gradual shift towards finance. In 2012 I founded EnergyPro with the purpose of bringing more capital to energy and resource efficiency, something we are doing through advisory work, asset management and fund raising. Looking forward I see growth in energy services, sustainable infrastructure and the intersection of technology and infrastructure – infratech. More and more of our activity will be linked to the Sustainable Development Goals which form a clear set of targets for society, organisations and individuals.

It has been interesting to witness and fulfilling to participate in the energy transition and I look forward to continuing to do that. Energy transitions take a long time but it is worth taking a look back occasionally and see how much change there has been. We still have a long way to go but I am reminded of Arthur C. Clarke's quote: "we tend to over-estimate what we can achieve in the short-term but under-estimate what we can achieve in the long-term".

24.6 Remembering 9/11. 10th Sept 2021

It feels important to mark the 20th anniversary of the tragedy of 9/11. As they are for many other people I imagine, my memories of that day are still vivid, and it is easy to answer the 'where were you when it happened?' question. I couldn't claim any personal connections to the event, fortunately, but I do remember it had a serious impact on me and it took about two years to process it properly. I felt an attachment to the World Trade Center and remember in the 1970s the publicity around its construction, and my excitement when I visited it for the first time in 1978, as well as being just as excited on subsequent visits to the observation deck in 1983 one crystal clear evening just as it got dark, and in 2001.

On the day itself I was in the Guinness Park Royal brewery at a start-up meeting of the Enron-Diageo Utility Alliance Agreement, an innovative 15 year utility outsourcing deal that had taken about a year to develop and implement. Apart from the main order of business we discussed the celebration dinner planned for that evening. After the meeting I switched my phone back on to get a message from my wife who when I called her back, told me a plane had flown into the WTC. I assumed it was a light aircraft, mentioned it to the teams that were in the meeting and then left. Of course we didn't have the access to instant news we have today on our phones. Strangely there was a TV in the meeting room but we didn't think of switching it on. The potential scale of the event only hit me when I got in the car to go back to Enron House. The driver had the radio on and we listened to the commentary, trying to work it out. The real impact hit me when I walked into the massive trading floor style office and there was a deathly silence and images of the towers' destruction were playing on the big TV screens. Many of the Enron staff were Americans and many had relatives and friends in New York. Some were crying.

There was uncertainty about what to do and whether everyone should go home. Enron House overlooked the garden of Buckingham Palace and there were fears that London may also be targeted. We cancelled the celebration dinner with Guinness of course. After a few hours everyone was sent home and I remember listening to the news service on my phone

and relaying information to fellow train passengers. Once home I tried to call my American friends, who were nowhere near New York, but couldn't get through.

Even now it is hard to contemplate the scale and impact of that day. For good and bad it has shaped the world we live in and in many ways we live with the consequences everyday. But on the 20th anniversary we should all take some time to remember the 2,977 people who were killed at the World Trade Center, the Pentagon and in Shanksville, Pennsylvania, as well as the many more that were injured, those who suffered (and still suffer) long-term health problems, the rescuers, as well as all their families and the survivors who are still affected by it.

Memorial at Ground Zero in 2003

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