

Energy Efficiency – A Personal View

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Context

This paper expands on a presentation originally given to a meeting of staff and students from the EPSRC funded Energy, Resilience and the Built Environment Centre for Doctoral Training (ERBE) and invited guests on 7th November 2019 in London.

1. Introduction

Energy efficiency is one of those “good things” we all think we should do and be encouraged to do. It saves money; it extends the life of limited natural resources; and it helps reduce carbon emissions. The last reason in particular is of paramount importance today as we work to develop ways to achieve the Government’s target of net zero emissions in our economy by 2050 [1]. We know that our use of fossil fuels over the last couple of centuries has not been as efficient as it could have been. We also know how damaging the use of fossil fuels has been. Use of fossil fuels will continue to damage our environment for generations to come because around 40% of the CO₂ emitted into the atmosphere in the current decade is likely still to be there in 100 years’ time [2].

The facts that burning fossil fuels creates CO₂, and that CO₂ “blanket” around our global atmosphere traps heat, thereby leading to rises in average global surface temperatures, are not new. We knew this as long ago as 1896 when the UK was mining over 200 million tonnes of coal per year [3], oil was a niche fuel and gas was used mainly for lighting. The Swedish Nobel Prize winning physical chemist, Svante Arrhenius, estimated that at then current consumption rates of fossil fuels there would be enough CO₂ emitted to atmosphere to drive a 5-6°C rise in average global surface temperatures [4]. Bear in mind that a 5°C drop from the average we have enjoyed in the current warm, inter-glacial, period drives an Ice Age. At the height of the last Ice Age, Europe was covered in 3-4 km of ice for thousands of years [5]. A 5-6°C rise in average global surface temperatures would make life on earth as we know it impossible. We are seeing real impacts today at just over 1°C rise [6]. So, not only do we need to decarbonise our energy supplies – and the UK electricity supply industry has done a good job so far for our electricity supplies – we have to make every kWh count in use and that means doing more on energy efficiency, more on decarbonising and more on reducing our need for heat and transport.

Unfortunately, doing the right thing so far as energy efficiency is concerned doesn’t happen naturally. For the vast majority of us, whether we are behaving as individuals in our homes or as

managers in industry, commerce and services, it's not top of mind. We have other, most would say more important or better, things to do with our time and money. Buy that next car; keep production going even if it means keeping plant ticking over between shifts; build as many houses as possible as cheaply as possible – never mind the heating and lighting efficiencies, or the build quality. In other words, natural human behaviours and biases, aided and abetted by the way the free market works, distracts or prevents us from investing time, money and skills into energy efficiency rather than something else which the market, or our peers, are influencing us to do or buy.

So, how can we address the lack of sufficient interest in energy efficiency not just now but through the generations, ever since bulk energy supplies have become generally available? My career experience leads me to think there is only one answer - through well designed, implemented and enforced Government intervention in the market. Having a single option is both good and bad. It's good in so far as everyone will operate on the same playing field and, if they respond to the signals, will achieve energy efficiency improvements. It's bad in so far that if the Government of the day isn't sufficiently interested in energy efficiency, as a key part of energy and climate change mitigation policy, or thinks philosophically that intervention in the market is somehow wrong, very little, too little in relation to the scale of the challenge, will get done. The market will continue to be driven by the normal market drivers. Externalities like the environment, energy efficiency and social needs will be ignored or demoted in the policy pecking order.

Fortunately, Governments since the 1970s/80s have seen fit to intervene to some extent to signal the importance of energy efficiency though whether they have intervened enough and effectively is certainly a matter for debate. Some would say, in the light of the overwhelming evidence, that the debate is over: more should have been done, and time for action at scale was yesterday. However, on the positive side, it should be remembered that on 27th September 1988, the then Prime Minister, Margaret Thatcher, gave a speech to the Royal Society [7, 8] in which she stated:

“For generations, we have assumed that the efforts of mankind would leave the fundamental equilibrium of the world's systems and atmosphere stable. But it is possible that with all these enormous changes (population, agricultural, use of fossil fuels) concentrated into such a short period of time, we have unwittingly begun a massive experiment with the system of this planet itself.”

In saying this, she was echoing a statement made thirty years earlier by Revelle & Suess [9]:

“Human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future. Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years.”

By the time Mrs Thatcher gave her speech to the Royal Society, there was a growing body of evidence that atmospheric greenhouse gases, of which carbon dioxide was the main one, were rising and, in turn, were causing rises in average global surface temperatures. Furthermore, the main cause of rising carbon dioxide emissions was man's (or to be more precise, western-style man, living

and enjoying the benefits of modern developed economies) use of energy produced from fossil fuels. (It is worth bearing in mind the fact that around 2 billion people do not have access to electricity. They use very little energy and have a very low carbon footprint – but for the wrong reasons.) Why these early, top level, concerns were not translated into policies and programmes and regulation more quickly and at a much larger scale is a question worth asking. Did the Royal Society audience that evening see and hear the scientist speaking, fleetingly, only to be replaced by the politician and the looming problems she would be facing a year or so later [10]?

We know that energy efficiency is one of the ways in which we can reduce carbon emissions. Unfortunately, without well designed, consistent and long-term Government intervention in the market, investment in energy efficiency (not just capital but time and enough well trained, skilled and experienced people) will not be sufficient. So, what drives Government interest in energy efficiency – and energy generally - over and above individual Ministerial interest? The main drivers are energy supply, security and price. Here are three cases to illustrate this statement.

2. Energy shortages in war time and post-war Britain

The fuel economy of Great Britain changed dramatically between the 1930's and 1940's. The surfeit of domestic production in the 1930's became a serious deficiency by the late 1940's and long-range economic forecasts indicated that this situation was likely to not only persist but to worsen. In the Second World War, our imported energy supplies (and food and raw materials) were being disrupted by the enemy. Faced with the real prospect that our factories could be idle if access to energy were disrupted, we had to make every kWh count. Brought up on a diet of cheap, available energy, we had little if any incentive to improve the energy efficiency of manufacturing. Managers in industry, generally speaking, were not focused on improving the energy efficiency of their processes or utilities. They were focused on output. The Government therefore, under its then Ministry of Fuel and Power [11], set up a Fuel Efficiency Service in 1942 tasked to go round the country giving advice on energy efficiency measures – improving boiler efficiency, eliminating steam leaks, etc. After the War, the Committee on National Policy for the use of Fuel and Power Resources (the Ridley Committee) concluded that much could be done to reduce the energy deficit by eliminating waste, and recommended that:

“The Ministry of Fuel and Power should invite industry to set up an organisation to provide a greatly increased fuel efficiency advisory service for Industry.”

In 1953, the Fuel Efficiency Service was effectively privatised and became NIFES, the National Industrial Fuel Efficiency Service [12]. The National Coal Board agreed to provide an income of £250,000 a year for an initial period of five years, while the Gas Council and the British Electricity Authority each agreed to provide £100,000 a year for the same period. (I leave those who are interested to research how much money was being spent then on energy supplies per kW installed; and to estimate the marginal cost of a kWh produced, compared with one saved.)

In essence, that has been the story of energy efficiency – always a poor relation to energy supply. NIFES still operates today because there is still a lot to do to improve energy efficiency in the economy. Similarly, the famous book by Oliver Lyle (of Tate & Lyle), “The Efficient Use of Steam”, first published in 1923, is still available today [13, 14]. Much remains to be done.

3. The OPEC Oil Embargo.

In 1973, OPEC (the Organisation of Petroleum Exporting Countries – mainly the Middle East producers led by Saudi Arabia) increased oil prices by a factor of four overnight. For the UK, on the brink of becoming an oil exporter, this unprecedented rise in oil prices was both good and bad news.

It was seen as good news in that the price of oil rose, thereby making production of North Sea Oil not just economically viable but highly profitable for the oil companies and revenue raising for the UK via the North Sea Fiscal Regime. It was also good news in that it prompted the Government of the day to set up the UK’s first renewable energy RD&D programme in 1978 at the former Department of Energy.

However, it was bad news in that goods and services would become more expensive thereby driving inflation upwards; and there may even be energy shortages and rationing. (The miners’ strike in early 1974 forced the Conservative Government under Edward Heath to put the country on a 3-day week: energy disruption and the negative impacts were fresh in people’s minds [15]).

So, what did the Government do so far as energy use was concerned? It had plenty of information on energy supply, how many therms of gas were produced per annum, how much coal was being mined, how many kWhs were being generated, etc. But it had very little information about the demand side, how much energy was being consumed across the various industrial sectors per unit of output, what was the potential for savings and energy efficiency improvements, etc. The then Department of Industry therefore decided, in 1975, to set up the Industrial Energy Thrift Scheme (IETS) which was run by a small team at the National Physical Laboratory [16]. I was part of that team.

The IETS had two objectives: to gather data on energy use; and to provide advice on energy saving opportunities. It covered the whole of manufacturing industry with the exception of the major steel sites. Through the respective industrial sector Research Associations and NIFES, about 6000 site visits were carried out across about 30 industrial sectors over 6 years. Sector reports were published which provided sector specific consumption information and outlined what could be done to improve energy efficiency, often by 20% or more. However, without capital and grants there was little incentive for energy users to do any more than address gross energy waste and implement low cost measures and, maybe, bring forward the date of renewal of utility and process plant. The energy price driver was significant but not enough on its own to incentivise investment.

4. The establishment of the Energy Efficiency Office (EEO).

In 1986, the Department of Energy set up the Energy Efficiency Office (EEO). The EEO came about not because of energy supply, security or price concerns but because of the then Prime Minister, Margaret Thatcher's, strong interest in driving improvements in efficiency in the Civil Service. In 1980, she commissioned Sir Derek Rayner from Marks & Spencer (afterwards Lord Rayner and Chairman and Chief Executive of M&S), to set up an Efficiency Unit to look for efficiency improvements in different policy areas. About 300 so-called Rayner Scrutinies [17] were carried out in the early 1980s and one of these looked into the way energy efficiency was organised (or, more accurately, left to individual Government Departments to determine policies and priorities as they saw fit). That arrangement was neither efficient nor effective. Following acceptance of the Efficiency Unit's recommendation to establish a central point of policy formulation and execution for energy efficiency, the EEO was set up in April 1986. I joined in June 1986 to be part of the team responsible for energy efficiency technologies RD&D. The EEO was very fortunate in having an enthusiastic Secretary of State in Peter Walker. To paraphrase one of his drier (i.e. closer in the spectrum of political thinking to Mrs Thatcher, unlike Peter Walker who was more towards the "wet" end of the spectrum) Ministerial colleagues, Norman, now Lord, Tebbit, [18], he didn't sit back and wait to see what his officials were doing to promote energy efficiency. He got in his official car (not on his bike, as Lord Tebbit said his father did when he was unemployed in the 1930s and in search for work) and led the charge from the front, going round the country with his Monergy campaign to save energy – and money. The EEO ran lots of schemes ranging from raising awareness, helping to improve energy efficiency in the domestic sector, and carrying out demonstration and R&D projects which were developed and expanded in 1989 as the Energy Efficiency Best Practice Programme.

Today, energy efficiency is just as important, maybe even more so. Not only are there micro-economic arguments for investing in energy efficiency, there is also an important role for energy efficiency to play in helping to meet our climate change mitigation goals to reduce greenhouse gases emissions to net zero by 2050. Since 2004, the UK has been a net importer of energy [19]. In 2017 UK imports of energy were almost twice as large as its exports. Net imports made up 36% of UK energy needs and with Sterling trading in November 2019 at around \$1.27 (down from the \$1.40s-\$1.50s before the Referendum of 2016 on whether or not to leave the European Union), there are strong balance of payments arguments for making our kWhs go further.

It is a telling statement that whereas it took tens of millions of years to create fossil fuels worldwide, our own resources in the North Sea are in economic decline only 50 or so years after they were first discovered. There's an old saying from the north of England (Lancashire) that describes the rise and fall of wealth in families: "clogs to clogs in three generations" [20]. Unfortunately, the same appears to apply to our oil and gas energy resources. From 1975, when the first oil was brought ashore from the Argyle field in the North Sea, to 2004 when the UK became net importers of energy, just one generation has passed. Whether the nation could have made better use of that natural resource is really the subject of another discussion.

Some would argue that now, more than ever, there is a need for a central agency to drive energy efficiency for the nation. I think we need such an agency to promote interest, stimulate investment and help build a robust and effective energy efficiency goods and services industry. The former EEO was absorbed into the Department of the Environment following the machinery of Government changes in 1992 when the former Department of Energy was abolished [21]. Wind forward to 2014 and the Department of Energy and Climate Change, set up in 2008 [22], established the Energy Efficiency Deployment Office (EEDO) [23]. The EEDO was disbanded in 2015 [24] and DECC itself became part of the Department for Business, Energy and Industrial Strategy (BEIS) [25].

Today, if you look for a single point of policy in Government on energy efficiency you will not find one. If you Google the EEO you will not find that either. As I searched for any reference to the EEO, I began to imagine what it must be like to be in a totalitarian State looking for a real event that you knew happened – because you were there – only to find ... nothing.

Some in the energy world may ask - so what? You don't need a single point of policy formulation and execution for energy efficiency. Energy efficiency can easily be handled by embedding it within the policies of the responsible Departments. On the basis of my experience, I disagree. Energy efficiency embedded within the responsible Department has to fight its battle for policy priority against bigger players with more power and influence; and with the lottery of whether the Minister of the day is interested or not. Thus, for example, in the Ministry formally responsible for housing, energy efficiency and low carbon goals are not as high up on the policy and political agenda as they need to be, having regard to the major contribution to carbon emissions attributable to the residential sectors. Such targets can be dismissed as unnecessary or too expensive – as happened with the zero carbon homes policy. In 2014, the then responsible Minister, Stephen Williams, gave a speech to the Zero Carbon Hub, an organisation specially set up to help prepare the house building industry to deliver zero carbon homes [26]. He said:

“The timing of this [Zero Carbon Hub] report is impeccable, coming shortly after this government has announced it will introduce the necessary legislation to deliver zero carbon homes.”

In 2015, nine years after the Government announced the zero carbon homes goal in 2006, a Treasury paper – “Fixing the foundations: Creating a more prosperous nation” – dismissed the requirements for zero carbon buildings [27].

Left to individual Government Departments, I think there is a real risk that energy efficiency will be overlooked or demoted in the policy pecking order – with a little help from the Treasury if necessary.

I am sure there will be some who will disagree with me when I say the mood today is insufficiently supportive of effective energy efficiency policies and measures – not enough visionary policy thinking, not enough money and resources, and not enough political profile. I am sure there will be a Government spokesperson somewhere who will say something like “the Government takes energy efficiency very seriously, etc.” Whatever the spokesperson says, the fact is that energy efficiency does not enjoy today the resources, the policy priority and the Government support that it had

when the EEO was in existence 30 years ago. Without a central lead agency, without a nationally recognised leader and without adequate resources, formulation and delivery of effective energy efficiency policies and programmes are hampered. Given that intervention is such an important part of delivering energy efficiency improvements across the economy, there needs to be a visible champion for energy efficiency within Government – someone whose name can be instantly recognised as the “go to” Minister for energy efficiency. Since the days of the Energy Efficiency Office we have had none of these key ingredients in place. Furthermore, if in the future we see a shift towards a deregulatory framework, or light touch regulation with continuing inadequate resources for enforcement, we will risk missing the economic and environmental benefits investment in energy efficiency has to offer.

Conversely, if we see a new Government throwing billions at decarbonisation, without paying due attention to getting fragmented supply chains into order, and tradespeople properly trained ready to deliver high quality refurbishment packages, all we will be doing is wasting money and storing up problems for the future in the form of poorly designed, poorly implemented and under-performing refurbishment projects which will not deliver energy and carbon savings and will be expensive to rectify.

Unfortunately, the past is littered with such failures – avoidable if due attention had been paid at the design stage and on site to the detail, and if buildings and energy management systems had been properly commissioned prior to occupation. From thermal bridges acting as magnets for condensation and mould growth in electrically heated, inadequately insulated, high rise apartment blocks which the tenants cannot afford to heat; from rolls of insulation lying in lofts not properly fitted; to massive south facing windows in schools causing excessive solar gain and overheating in summer; people of my generation have seen it all. Unfortunately, these problems are not just historical. We see them today – see for example the external wall insulation cases in this reference [28].

I would like to close by proposing a challenge to LoLo/ERBE students. You represent some of the finest developing minds working and researching energy and the built environment. You are part of the future for the building professions and the industry. Over the years of LoLo, I have seen your work and I know how keen and enthusiastic you and your teachers are. I know you will warm to the challenge I am about to outline. It’s all about getting to net zero by 2050. It’s a real challenge. It is highly topical. And it’s central to our national goal, announced by the previous Prime Minister, Theresa May, to be net zero carbon by 2050 [1] – assuming that goal isn’t abandoned and assuming we will have a United Kingdom to help deliver it. The Minister who signed the legislation, the Rt Hon Chris Skidmore, was referred to as the Interim Minister of State for Energy and Clean Growth [29]. Let us hope that the word “interim” does not also apply to the policy goal. As is to be expected, the Treasury is keen to assess the costs of this important policy measure in more detail than the £1tn estimate made public a few days after the Prime Minister’s announcement by the previous Chancellor, Philip Hammond. The Chancellor, Sajid Javid, announced the “Net Zero Review” on the 2nd November to assess how the UK can maximise economic growth opportunities from its transformation to a green economy [30]. The Chancellor added:

“This review is a vital next step in delivering that commitment, ensuring that we can end our contribution to global warming, while supporting growth and balancing costs, to avoid placing unfair burdens on families or businesses.”

How “unfair burdens” will be defined in relation to the burdens which will surely arise if atmospheric greenhouse gas concentrations are permitted to increase is unclear.

It’s worth reading through the terms of reference document [31], noting in particular what the review will not cover (e.g. “the costs of adapting to the impacts of climate change”). The point here is that whilst it is important to carry out estimates of what achieving the net zero goal is likely to cost it is also important to carry out an estimate of the costs of not taking action. Making a comparison of the costs of taking mitigation action or not taking action, including adaptation, puts the costs into perspective. The costs of not taking action is not zero. According to the review of the Economics of Climate Change carried out by Lord Stern in 2006 [32], the costs of taking action are significantly smaller than the costs of adaptation. That is why the costs of adapting to the impacts of climate change becomes so important to assess alongside the costs of, and resources required for, mitigation action – which, I acknowledge, will be significant.

5. The challenge

We know how important it is to decarbonise our housing stock if we are to stand any chance of getting close to the net zero goal announced in June this year by the then Prime Minister, Theresa May [33]. We know that most dwellings already built and occupied will be here in 2050. We also know that new dwellings, although much better designed than those built to previous Building Regulations standards, are a long way off PassivHaus standards. It’s worth taking a look at the PassivHaus Trust website [34]. The Trust make clear that it’s not just about design. It’s also about building with meticulous attention to detail and rigorous design and construction according to principles developed by the Passivhaus Institut in Germany. Passivhaus standards can be certified through an exacting quality assurance process. People will have differing views as to whether our housebuilding industry could build tens of thousands of dwellings each year to PassivHaus standards and get the necessary certification. It must be of some concern that it is hard to know whether dwellings designed to current Building Regulations standards have actually been built to deliver those standards in operation. Based on evidence about the performance gap derived from post-occupancy research we can be pretty sure that most if not all buildings will not be performing as designed and that the gap could be considerable.

So, the challenge is to estimate the cost ranges of plausible pathways for our national housing stock to be refurbished to net zero carbon by 2050, having regard to a whole host of factors and givens. I suggest some here, for example:

- i. the different types of existing dwellings;
- ii. their locations (urban, outskirts of towns and cities, semi-rural and rural);

- iii. whether co-location of residential and commercial buildings into whole energy zones (where “whole energy” includes local generation, load management, load time shifts, and storage) could offer complementary energy demand profiles which would reduce carbon emissions in that zone;
- iv. their typical A-G ratings;
- v. emerging low carbon technologies and heating systems, including controls;
- vi. dwelling design and refurbishment packages;
- vii. whether there are some dwelling types that cannot be refurbished within reasonable economic yardsticks and if so, how many of those exist where demolition and replacement by new dwellings that meet net zero standards is the only option;
- viii. demographics, occupant behaviours and propensity to let status quo rule;
- ix. tenure types, for example in relation to the design of policies and measures for homeowners, landlords, managed dwellings;
- x. how many dwellings are in flood plains; and whether investment in low carbon, or adaptation, measures makes economic sense;
- xi. the fragmented, disorganised and variable performance of the supply chain and its components;
- xii. the nature of energy supply, its carbon intensity, and how it is evolving to include more decentralised, local and micro-generation;
- xiii. storage, including the possible role of electric vehicles as electricity storage devices;
- xiv. the role of Government decarbonisation policies – what policies and programmes would need to be in place to enable and promote action to achieve net zero by 2050;
- xv. the role of energy efficiency measures in relation to the building fabric, the need to avoid summertime overheating, impact on aesthetic appearance;
- xvi. indoor air quality;
- xvii. whether you or your own relatives would agree to going ahead with a low carbon refurbishment, and;
- xviii. anything else you think is relevant.

Bear in mind that there will be uncertainties and unknowns for which you will need to make plausible assumptions, which in turn will be reflected in the cost estimate ranges you come up with.

To those students and staff who are here tonight, I invite you to take this idea back to your colleagues. Talk to your supervisors. Is it a challenge worth putting some time and effort into – formally as part of your training or informally as a useful think piece? If, like me, you think it is worth spending some time on, consider what work needs to be done first to refine the problem definition, and to take my outline and create a research proposition that can be undertaken in a short timeframe. What I’m thinking of here are a few teams working for a few days ideally over about a week or so – because if you were asked this question by a Government Minister, or the MD of a housebuilder looking to expand into mass refurbishment, you’d be lucky to get a week to come up with a reasonably reliable response. Two weeks would probably give you a more robust response

with the added bonus of identifying “show-stoppers” and whether new legislation would be required. Compare your methodologies, assumptions and results. Devise and apply a sensible, pragmatic plausibility test and see if or how the goal could be achieved and, if so, by whom, by what mechanisms, and at what cost.

Remember, there is no “right answer” but there are certainly “wrong” ones. However, it can be just as valuable to come up with “wrong” ones because they will show where special effort will be required – for example, to get better data to quantify qualitative assumptions or to assign high, medium or low probabilities against some of those assumptions.

Thank you for your interest and attention.

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About the author

I graduated in 1969 from the University of Kent at Canterbury with a Second Class Honours Degree in Chemical Physics and went on to complete a PhD there into low temperature fluorescence spectroscopy of anthracene and related organic molecular crystals in 1972. In July 1973, I joined the Department of Industry's Laboratory of the Government Chemist where my first assignment was to work in a team responsible for the development of simple chemical field tests for use by the Factory Inspectorate for assessing exposure to toxic substances in factory atmospheres.

In October 1973, I was inspired by the four-fold increase in oil prices to find a way into the energy world. It sounded interesting: and how right I was. Eventually, in 1975, an opportunity came up. I volunteered to join the newly formed Department of Industry's Energy Unit located at the National Physical Laboratory where we designed, set up and managed the Industrial Energy Thrift Scheme (IETS). The IETS had two objectives: (i) to gather information on energy use and energy savings potential across manufacturing industry; and (ii) to provide advice on ways to improve energy efficiency. Over 30 industrial sectors and 6000 manufacturing units were visited during the period 1976-1980. That was the start of my career in the energy world.

In 1978, I joined the Department of Energy to work on the Government's first major programme into renewable energy resources and technologies. In June 1986, I joined the newly formed Energy Efficiency Office where I worked on RD&D programmes, culminating in being appointed Director of

the Energy Efficiency Best Practice programme in 1994. Additionally, from 1999-2001, I was part of the team which took forward the Government's climate change levy policy to conclude energy and carbon savings agreements (the climate change levy agreements) with over 30 business sectors and over 10,000 manufacturing units; and set up the Carbon Trust, an independent company limited by guarantee and funded by Government to accelerate the transition to a low carbon economy.

In 2001, I was seconded to the Carbon Trust, initially as its Technical Director and subsequently as Director with responsibility for promoting the UK's approach to climate change mitigation internationally. I left the Carbon Trust in 2011 to set up my own independent energy consultancy.

I have had the fortune to be able to work on one of the most important parts of UK energy policy - energy efficiency and renewable energy technologies - building a unique experience of the development of Government policy and programmes, working with like-minded professionals who want to contribute to the goal of a low carbon UK, and having a thoroughly worthwhile, enjoyable and rewarding career.

David Vincent,

November 2019