Implementing the efficiency first principle in the UK

Jan Rosenow
The Regulatory Assistance Project
Rue de la Science 23
1040 Brussels
Belgium
jrosenow@raponline.org

Richard Cowart
The Regulatory Assistance Project
Rue de la Science 23
1040 Brussels
Belgium
rcowart@raponline.org

Keywords

energy supply and demand, energy efficiency policy

Abstract

The principle of "Efficiency First" has been adopted by the European Union (EU) in the various parts of the Clean Energy for All Europeans package. It is a principle applied to policymaking, planning, and investment in the energy sector. Put simply, it prioritises investments in customer-side efficiency resources (including end-use energy efficiency and demand response) whenever they would cost less or deliver more value than investing in energy infrastructure, fuels, and supply alone.

Efficiency First has gained traction at the EU level since the launch of the Energy Union Communication in February 2015 and the publication of the Clean Energy for All legislation package. But it is also finding purchase in some European countries such as Germany, where it has become a leading energy policy principle that now underpins Germany's *Energiewende* or energy transition.

What is unclear so far though is how the Efficiency First principle should be applied across the energy system and what the implementation would look like. In this paper, we identify key areas where we see opportunities for the Efficiency First principle to play an important role. We use the United Kingdom as a case study, as there are many existing policy areas that demonstrate how Efficiency First could be applied. In particular, we assess the potential for Efficiency First in the context of policy decisions that will be made over the next years, including the design of a new able-to-pay energy efficiency programme, energy network regulation (RIIO), infrastructure spending, revisions of the capacity mechanism, and the levy control framework.

Introduction

The UK's energy policy is at crossroads. Ambitious carbon targets, an ageing energy infrastructure, rising fuel poverty, and a legacy of fossil fuel investment warrant bold political decisions to ensure the UK transitions to a low-carbon energy system. Because of the long-term nature of investment in energy infrastructure, decisions made over the next five to ten years will shape the evolution of the energy system. Getting those choices right is key for ensuring a sustainable, affordable, and secure energy future. The principle of Efficiency First (E1st) that we explore in this paper delivers on all three.

Efficiency First means more than just strong, dedicated energy efficiency policy, it is a principle applied to policymaking, planning, and investment in the energy sector. Put simply, it *prioritises investments in efficiency resources whenever they would cost less or deliver more value than investing in energy infrastructure, fuels, and supply.*

At first look, this is purely a common-sense policy. Of course, public policy should promote end-use efficiency whenever saving energy costs less or delivers greater value than conventional supply-side options. Doesn't it happen automatically? Unfortunately, no. On the demand side, investments in efficient solutions are impeded by numerous market barriers to individual action. On the supply side, industry traditions, business models, and regulatory practices have always favoured, and continue to favour, fossil-fuel-based energy infrastructure and sales over lower sales and energy saving technologies. The evidence across decades of experience shows that investments in efficiency are not automatic and, to make matter worse, many policies and decision rules now interfere with the delivery of efficiency and demand response resources in the economy, generally, and across energy markets, in particular.

The principle of Efficiency First or "Energy Efficiency First" has emerged to some extent in the United States (under other names), where approaches such as integrated resource planning and "all cost-effective efficiency" standards have existed in at least some states for a long time (Cowart 2014; Rosenow et al. 2016). E1st has gained traction at the EU level since the launch of the Energy Union Communication in February 2015 (EC 2015) and the publication of the Clean Energy for All Europeans (CE4ALL) legislation package. But it is also finding purchase in some European countries such as Germany, where it has become a leading energy policy principle that now underpins Germany's *Energiewende* (BMWI 2016a) or energy transition. In 2016, the German government concluded a consultation on how to implement E1st through its Green Paper on Energy Efficiency (BMWI 2016b). E1st likewise offers a promising approach to UK energy policy that is consistent with reaching the 2050 climate goals at least cost. We recommend that the UK follow suit and adopt it.

Following the adoption of E1st as a high-level conceptual principle, it needs to be considered in all energy policy areas. Both Germany (Rosenow and Jahn 2016) and the EU (European Climate Foundation 2016; Rosenow et al. 2016) are investigating where and how the E1st principle should be applied across the energy system. We recommend that the UK government carry out a systematic review of where the E1st principle should be applied and prepare a plan for enactment. Adopting a "hard look" policy to examine and invest in E1st is the first and most important step the government can take. It is pivotal to unlocking the huge reservoir of low-cost, low-carbon savings that sits untapped in every part of the United Kingdom despite significant improvements in energy efficiency over the past few decades (Rosenow et al. 2018).

In this paper, we identify key areas where we see potential for E1st to deliver low-carbon outcomes at a lower cost whilst also delivering a wide range of benefits associated with energy efficiency improvements. This paper explains the concept of E1st and shows how it can be applied in the UK context, providing a number of examples. In particular, we focus on E1st in the context of policy decisions that will be made over the next years, including the design of a new able-to-pay energy efficiency programme, energy network regulation (RIIO), infrastructure spending, revisions of the capacity mechanism, and the levy control framework.

Defining Efficiency First

The E1st principle focuses on customer-based, or demand-side, efficiency resources, recognising that these resources are essential to securing systemwide efficiency. Yet demand-side resources have often been overlooked or ignored and still face multiple barriers to inclusion in planning and deployment. The initial definition of this principle was set out by the Regulatory Assistance Project (RAP) in Cowart (2014) and also Bayer (2015). Achieving E1st requires a commitment to:

1. mobilising end-use energy efficiency as the UK's "first fuel;"
2. overcoming deep-seated market barriers to end-use energy efficiency and demand response; and
3. reversing historic preferences for supply-side resource investments across the UK policy landscape.

Why is E1st so important? Meeting the demand for energy services more efficiently and more flexibly on the demand side will avoid costly investments in energy infrastructure and fuel and is essential to the cost-effective, timely decarbonisation of the economy. In addition to many benefits for the energy system, investment in demand-side alternatives can also improve air quality and health and increase energy security.

It is easy to see the reasons to avoid the wasteful consumption of fossil fuels, with their unwelcome emissions and energy security costs. But it is also important to maximise the efficient use of renewable, non-emitting resources, as we seek to rapidly reduce the UK's carbon emissions. Wasting high-value renewable resources on inefficient end-use consumption is both an economic burden and a drag on the pace of decarbonisation. Customer-based efficiency and demand response resources are an essential foundation to achieving all of the other key objectives of the UK's energy policy – the often-cited trilemma of security, sustainability, and affordability.

While the case for better use of demand-side resources in the energy system is compelling, it is also clear that they are often overlooked in favour of supply-side resources and considered to be an entirely separate category. E1st is an approach that tries to overcome this, so that demand-side resources are considered systematically in energy system decision making.

Applying the Efficiency First principle to the UK context

The good news is that smart policies can help overcome these barriers to greater use of demand-side resources. E1st recognises that energy efficiency is a distributed resource and, as a result, cuts across many policy areas, including those relating to buildings, appliances, climate policies, and the internal energy market. The following four steps can serve as a map for applying E1st across these various policy areas:

- **Planning**: Recognise the value of efficiency, including its multiple benefits to the energy system, consumers, and society, and the use of consistent demand projections in planning.
- **Targeted energy efficiency policies and programmes**: Ensure strong minimum requirements for new and existing buildings, appliances, and labelling that ramp up over time. In addition to standards for new buildings and equipment, the UK's vast array of existing stock must be upgraded and retrofitted to save energy. This requires specialised targets, programmes, and measures that will deliver deeper savings over time. Stable sources of funding are essential to overcome barriers and leverage private finance. This kind of targeted support for energy efficiency is necessary to ensure that energy efficiency is a deliverable resource on a par with supply-side infrastructure.
- **Infrastructure decision rules:** Ensure that investments in energy infrastructure are not undertaken without first assessing how to meet energy service needs at the lowest total societal cost, taking into account all cost-effective demand-side resources, beginning with demand reductions. Helping customers reduce demand can often be cheaper than building new infrastructure to serve increased energy consumption.

- **Compliance and review**: Provide clear, high-quality monitoring and verification standards, along with an effective compliance framework and a periodic review structure to allow for course corrections over time. Global experience has proven that active oversight and continuous programme improvements are needed to uncover and deliver on demand-side potential in almost every market.

The following sections provide an overview of how this framework applies to concrete areas of UK policy.

PLANNING

Energy sector planning occurs on many levels within the UK, both in policy development and in network planning. It is essential that demand-side resources be properly assessed at these levels of planning, and, in particular, that the reductions efficiency and demand response policies could deliver on system demands be consistently taken into account.

The following are recommendations for some of the policy planning processes underway or under review. Some aspects related to network planning are dealt with in the section on infrastructure decision rules below.

The Clean Growth Strategy

In 2017, the UK government published the Clean Growth Strategy, setting out the policy framework to achieve future carbon budgets. The Clean Growth Strategy contains several energy efficiency policy objectives including the ambition to upgrade as many UK homes to an Energy Performance Certificate of 'C' by 2035 "where practical, cost-effective and affordable" (HM government 2017, p. 13). In addition, the Committee on Climate Change (2015) has recommended a carbon budget covering the period from 2028 to 2032 and set out the trajectories required for energy efficiency in order to meet the targets.

However, the level of ambition and the carbon budgets are currently not met by the existing policy framework. The Committee on Climate Change specifically mentioned energy efficiency in buildings as one of four priority areas that will need to be addressed, and the Committee's analysis shows that current efforts are not sufficient. This means that existing policies need to be extended and new policies implemented. Future policies need to be designed in such a way that the policy package will achieve those trajectories and close the gap between current run rates for efficiency measures and the required levels. Analysis by RAP and Association for the Conservation of Energy (Guertler and Rosenow 2016) showed that there is a considerable mitigation gap in the buildings sector that needs to be closed through reforming existing and introducing new policies.

This means that the UK government has to expand its planning from high-level targets and policy objectives to specific policy initiatives delivering on those targets and objectives.

Testing and piloting

Past energy efficiency schemes, such as the Green Deal, struggled partly due to a lack of testing and piloting (Rosenow and Eyre 2016). The assumptions made at the policy design stage were never tested with consumers and turned out to be overly optimistic. In order to design effective instruments, future energy efficiency policy needs to be based on the best available evidence of how consumers are likely to respond. This is essential to ensuring that energy efficiency is a deliverable resource that can make the E1st principle viable.

TARGETED ENERGY EFFICIENCY POLICIES AND PROGRAMMES

The UK has a long track record of targeted energy efficiency policies and programmes going back several decades now (Mallaburn and Eyre 2014; Rosenow 2012). On a temperature-corrected basis, total UK household energy use decreased by 19 percent between 2002 and 2016, despite a 12 percent increase in the number of households and a 10 percent increase in population (Department for Business, Energy & Industrial Strategy (BEIS) 2016). Per-household energy consumption fell by 37 percent between 1970 and 2015, with most of this decrease (29 percent) occurring since 2004 (BEIS 2016a). Energy efficiency improvements in individual households have offset the 46 percent increase in the number of households, the 5.6 °C increase in average internal temperatures, and the rapid growth in appliance ownership over this period, with the result that total household energy consumption has increased by only 7 percent in 45 years.

Although rising energy prices and the 2008 recession contributed to recent trends, the bulk of the reduction in per-household energy consumption can be attributed to public policies to improved energy efficiency. Of particular importance have been the major home insulation programmes funded by successive "supplier obligations" such as the Carbon Emissions Reduction Target (CERT-2008–2012) and the Energy Company Obligation (ECO-2013 onwards) (Committee on Climate Change 2017; CEBR 2011; DECC 2015; Odyssee 2017; Rosenow 2012). These imposed energy and carbon saving targets on electricity and gas suppliers and allowed them to recover the costs through a levy on household energy bills. Also important were the requirement for condensing boilers within the UK Building Regulations and the progressive tightening of EU standards on the energy efficiency of electrical appliances (CEBR 2011). Evaluations of these policies have shown them to be highly cost-effective, both in terms of the cost savings to participating households and in terms of broader societal welfare (Lees 2006; Lees 2008; Rosenow and Galvin 2013). This experience supports the argument that market forces alone cannot deliver all cost-effective investment in residential buildings, owing to multiple and overlapping market failures. Instead, policy intervention can be used to improve economic efficiency.

However, the introduction of the Green Deal (an on-bill financing mechanism) and the reorientation of the Energy Company Obligation (ECO) towards more expensive energy efficiency measures resulted in a sharp drop in the installation rates of energy efficiency measures. By mid-2015, the average delivery rate for loft insulation had dropped by 90 percent, cavity wall insulation was down by 60 percent, and solid wall insulation had not increased compared with 2012. It is now widely accepted that the Green Deal failed for a variety of reasons including a very high interest rate, a complex customer journey and its limited focus on non-financial barriers to energy efficiency retrofits (Rosenow and Eyre 2016). The recent report by the National Audit Office (NAO 2017) confirms this view. The level of reduction in energy demand is therefore expected to slow down in coming years if no additional policies are being put into place.

Going forward, the ECO will be focused on households in fuel poverty, an area that has traditionally been supported by dedicated grant programmes. For the first time in more than two decades, there is currently no energy efficiency programme for the able-to-pay market, even though most of the properties requiring energy efficiency measures are within this segment. Buildings comprise a huge fraction of the nation's infrastructure, and their energy demands impose major economic and environmental costs on the nation. We all pay those costs. In the authors' view, a policy to bar public spending on efficiency in buildings for able-to-pay households makes no more sense than a national policy not to pay for sidewalks, parks, and roads in middle-class neighborhoods. In order for the UK to meet its carbon targets, this acute policy void needs to be filled.

The following represent opportunities to strengthen targeted energy efficiency policies in the UK.

Expanding the Energy Company Obligation to the able-to-pay sector

The UK was the first country in Europe to adopt an energy efficiency obligation in 1994 and has achieved significant energy savings using this instrument (Rosenow 2012). A recent global review of around 50 energy efficiency obligations (called Energy Efficiency Resource Standards in the US or White Certificate Schemes in some EU Member States) shows that they deliver energy savings at costs well below the cost of supplied energy in most sectors and most locations (Rosenow et al. 2018f). International experience shows that energy efficiency obligations such as ECO work best where they target a wide range of consumers so that almost everyone benefits directly from the programme.

However, the next phase of ECO, after a one-year transition phase, will focus entirely on fuel-poor households. The vast majority of households are not in fuel poverty (BEIS 2018), including some on low incomes. This means that ECO would be funded by more than 85 percent of households without any benefit to low-income households not in fuel poverty. The ECO targets should be increased to also include households not in fuel poverty, delivering benefits both to those on low incomes but not in fuel poverty and the able-to-pay sector. This was the case for more than 20 years and has largely proven to be effective.

Stamp duty rebate programme

The selling and purchasing of a home are critical trigger points for making refurbishments to a property. Buying a property is associated with paying a property transfer tax called Stamp Duty Land Tax in the UK, which can amount to significant costs to the purchaser. The Stamp Duty Land Tax could be used to create incentives for time-of-sale upgrades to homes and commercial properties by providing Stamp Duty rebates for qualified energy efficiency upgrades to properties that are installed shortly before or soon after the time of sale. Analysis of the potential of such a programme suggests that a 25 percent rebate could potentially fund more than 300,000 retrofits per year depending on take-up (Jahn and Rosenow 2017).

Carbon Revenue Recycling

Leveraging carbon revenues to drive carbon reductions via efficiency upgrades is an approach that is increasingly getting traction across Europe. Public commitments have been made by more than 17 countries in the EU to return part of the carbon revenues from the EU Emissions Trading System auctions to climate and energy efficiency programmes (Wiese et al. 2018). Current forecasts for the UK suggest that, over the next six years, carbon revenues from the Climate Change Levy and the EU Emissions Trading System[1] will generate more than £15 billion (€16.8 billion) of income (based on Office of Budget Responsibility 2018 and Wiese et al. 2018). On average, this equates to more than £2.5 billion that could be reinvested in energy efficiency.

Since the purpose of carbon charges is to drive decarbonisation at the lowest cost to the nation, and since investing in energy efficiency is, in large measure, the lowest-cost pathway to carbon reduction, it is critical that government leverage the power of carbon revenue, also due to the economic signals provided by carbon prices. Analysis based on UK experience with efficiency programmes reveals that investing carbon revenue in efficiency provides nine times more carbon reduction than does simply raising energy prices through higher carbon charges (Lees and Bayer 2016).

Energy efficiency Feed-in-Tariff

Most EU countries have adopted feed-in tariffs for renewable energy. The same approach can also be used for efficiency through energy efficiency feed-in tariffs (EE FiTs). EE FiTs establish a price that will be paid for energy savings and let the market determine the quantity of savings that will be delivered. Whilst no country has used EE FiTs as its core policy mechanism to support energy efficiency, there are many examples of related concepts that can be drawn upon such as "standard offer" efficiency programmes, capacity markets, and tradable white certificates (Neme and Cowart 2013). Payments would be based on demonstrated demand reductions or installation receipts confirming that certain energy efficiency improvements have been implemented. EE FiTs would work well under the new electricity market structure following the Electricity Market Reform, as they are consistent with those incentives for electricity generation (Eyre 2013).

INFRASTRUCTURE DECISION RULES

Every year large sums of money are being spent on upgrading old and building new energy infrastructure. Often it takes several decades until those investments have amortised, which means that spending decisions need to be carefully considered. If misdirected, this can result in locking in carbon-intensive technologies for the long-term, leading to much greater costs later on. Efficiency needs to be a core part of the infrastructure decision-making process, but currently there is limited scope for it to be recognised.

Energy consumers are increasingly recognised as not just passive "load" on energy grids, but as potentially active partners, responders, or "prosumers" in energy service networks. Commercial buildings, homes, and industrial facilities can play an important role in reducing energy consumption and energy peak demands, thus reducing the volume of investments needed in generation, transmission, and distribution infrastructure. But decisions relating to energy infrastructure have tradition-

1. It is currently unclear whether the UK will continue to participate in the EU Emissions Trading System after the vote to leave the EU in June 2016.

ally been made – and continue to be made – without consideration of the potential for lower-cost demand-side alternatives. It is also important to note that the rules governing investment in energy efficiency are different from those governing investment in public infrastructure; and these differences often disadvantage energy efficiency over more traditional infrastructure choices (Amon and Holmes 2016).

Prioritizing E1st requires a change to regulatory rules expressed in the RIIO (Revenue = Investment + Innovation + Outputs) price control regime that today allows tariffed recovery of network costs. Amendments need to ensure that demand-side resources can compete against pipes and wires investments in meeting the UK's energy service needs and that these "non-wires" and "non-pipes" solutions will be deployed and paid for when they are less expensive than supply. Experience in North America has demonstrated that a disciplined approach to demand-side analysis can deliver extensive savings against traditional infrastructure plans. For examples, see Cowart (2014). Incorporating E1st into the decisions governing investment in energy infrastructure requires identification of the many points at which these decisions are made and of the actors involved. There is also ample opportunity to introduce E1st principles into some of the many rules and regulations governing how investment decisions in energy infrastructure are made. A few of these areas are listed below.

Introducing an energy efficiency performance incentive metric in network regulation

In the past, regulation of electricity, gas, and heat networks in the UK was driven by a "predict-and-provide mentality" (Strbac 2010). In recognition of this, Ofgem changed the old RPI-X price formula (retail price inflation, minus expected efficiency improvements) to the RIIO framework. One of RIIO's objectives is to encourage network companies to "play a full role in delivering a low carbon economy and wider environmental objectives" (Ofgem 2013). RIIO fundamentally changed the previous price formula in that it recognises operational costs (opex) in a similar fashion to capital costs (capex). This approach has been coined "totex," or total expenditure, and is intended to result in network companies shifting their focus from capital investment to outcomes (which could in theory include energy efficiency improvements). The move to a totex regime was first suggested by Ofgem in March 2008, when the energy regulator launched its RPI-X@20 review. From this comprehensive review of the previous regulatory regime, which had endured since privatisation in 1989, emerged the RIIO (revenue = incentives + innovation + outputs) model.

Demand-side management, including demand response and energy efficiency, can also receive support under the Network Innovation Competitions for gas and electricity, which replaced the Low Carbon Networks (LCN) Fund. This mechanism provides up to £90 million (€100.8 million) of funding per annum for demonstration projects. In practice, however, the majority of proposals and approved projects focus on more efficient management of the supply infrastructure (Ofgem 2015, 2016). Another avenue for supporting demand-side management is the Network Innovation Allowance, which aims to fund small-scale innovation projects. Its value is 0.5 to 1 percent of network companies' allowed revenues, based on how well thought-through their innovation plans are. There are some demand-side management projects that have received support under this mechanism (see http://www.smarternetworks.org/) but, similar to the Network Innovation Competitions, the projects are dominated by supply-side projects. While many of the pilot projects deliver benefits to consumers and increase the efficiency of energy supply, there are lost opportunities for cost reduction through demand-side focused innovation at scale. Finally, the Innovation Roll-out Mechanism is a mechanism through which companies can apply for additional funding to roll out a proven innovation, provided the company meets defined criteria, including that it cannot fund the rollout itself. Demand-side resources can be included.

In principle, network companies can already undertake demand-side measures and recover the costs through the basic price control framework or through the different incentives and innovation rollout mechanism. However, in reality, network companies have not yet engaged at scale in delivering demand-side solutions and it is unlikely to happen without further incentives and regulations.

Thankfully, the regulator took a serious look at the role network companies can (and should) play in delivering end-use energy efficiency. At a high level, Ofgem (2018) committed itself to creating a level playing field for demand-side and supply-side resources. This marks an important step in the right direction. In its response to the consultation on the next phase of RIIO, the regulator states (ibid, p. 24): "Where energy efficiency, alongside other supply-side options, has the potential to defer or mitigate the need for network investment, then there should be no barriers to network companies pursuing this solution." However, although a useful starting point, it is not clear yet what this will mean specifically for network companies and for RIIO. Ofgem will develop more specific methodologies for RIIO-2 to fill this gap.

Reforming the Levy Control Framework

The Levy Control Framework (LCF) is an agreement between HM Treasury and the Department of Energy and Climate Change (DECC) originally established in March 2011 as a means of controlling expenditure under levy-funded energy programmes. The purpose of the LCF is to put a cap on the energy bill impacts of policy interventions. Energy efficiency obligations are currently not included under the cap but reported on alongside the LCF. LCF counts only the direct bill adders from energy efficiency mandates; it does not count the bill savings. Bill savings come in at least two types: lower bills incurred by program participants and energy system savings enjoyed by everyone, participants and non-participants alike. Energy system savings accrue to everyone receiving service connected to the wholesale power market due to lower clearing prices, lower reliability costs, lower renewable energy costs, fewer transmission and distribution upgrade costs, and so forth. For a more accurate representation of bill impacts, both types of savings need to be counted in addition to the costs.

Reforming the capacity market

The UK's capacity market is a mechanism designed to ensure that sufficient future capacity will be available to meet the recently adopted reliability standard. Capacity providers can bid in auctions to receive capacity payments, which are based on the auction clearing price. It is widely accepted that demand response and energy efficiency can provide additional capacity requirements, often at much lower cost than some conventional supply-side alternatives. However, the current design of the capacity market does not reflect the true value of demand response and efficiency – only 1 percent of total capacity in the second auction was awarded to demand response (National Grid 2015). This is largely because the auction market rules discriminate against demand response (and energy efficiency). The first barrier is the different treatment of demand-side resources: In the four-year-ahead auction, new generation assets are eligible for capacity contracts extending over more than a decade and up to 15 years, while demand response investments are given only a one-year capacity contract (PA Consulting 2016). Since demand response providers must incur the transaction costs of finding and enrolling demand response customers and installing demand response and energy efficiency technologies, while the benefits of energy efficiency and demand response will accrue over several years, the capacity market rules make demand response programs unprofitable for the majority of potential demand response providers. The second barrier is the minimum capacity size in the capacity market. Currently, the minimum capacity size is 2 MW. This is significantly more than in other established capacity markets such as that of PJM and ISO-New England in the U.S., where the minimum size is 100 kW (Neme and Cowart 2014).

There is ample experience in other markets to demonstrate that demand response is capable of delivering as much as 10 percent of all capacity requirements at a far lower cost than new generation and at least as reliably (Hurley et al. 2013). Including efficiency also lowers the costs of providing capacity across the entire market, delivering savings in the billions of dollars, as evidence from the U.S. shows (ACEEE 2016). Restructuring the capacity mechanism so that it puts efficiency and demand response on a level playing field is key to achieving future capacity needs and decarbonisation at least cost. Experience from the Electricity Demand Reduction pilot and elsewhere should be applied to a redesign of the UK's capacity market, so that it puts demand-side resources on an equal footing with supply-side solutions.

Consider efficiency resources as a key part of the UK's infrastructure

Historically, buildings have not been considered part of the nation's infrastructure. This means that energy efficiency improvements could not be funded through the government's infrastructure investments. The UK's National Infrastructure Plan contains commitments for (largely private) investment in infrastructure projects. Of the total £256 billion to be spent on energy infrastructure projects, no funds have been allocated to efficiency (BEIS 2016b). Instead, the investment is almost entirely focused on supply-side projects such as nuclear, offshore wind, and gas power generation, transmission and distribution upgrades, and oil and gas production. There is a need to recognise energy efficiency as an infrastructure priority and allocate funds to it. Independent analyses show that when compared to infrastructure projects like the first phase of High Speed 2, a major high-speed railway under construction in the UK, and the rollout of smart meters, efficiency provides comparable monetary benefits (Frontier Economics 2015). This is true even without quantifying many of the social benefits of energy efficiency measures such as health and wellbeing improvements.

There is unique opportunity to define energy efficiency as an infrastructure priority: The government has set up the National Infrastructure Commission to analyse the UK's long-term economic infrastructure needs, outline a strategic vision over a 30-year time horizon and set out recommendations for how identified needs should begin to be met. This is done through publication of a National Infrastructure Assessment once per parliament. The current National Infrastructure Assessment was published in 2018, following a consultation process in 2016. Feeding into this assessment, the National Needs Assessment Executive Group (chaired by the Institute for Civil Engineers) has set out its own vision for the UK's infrastructure and concludes that energy efficiency is a key component in delivering the UK's infrastructure needs (National Needs Assessment Executive Group 2016). The Infrastructure Transitions Research Consortium (ITRC 2016) provided evidence that fed into the National Needs Assessment, which estimates that electricity demand can be reduced by 40 percent compared to unconstrained demand, plus an electrification strategy by 2050. Without an electrification strategy, ITRC suggest a potential of 15 percent by 2050. For gas, the reduction potential is around 57 to 67 percent, depending on whether electrification is part of the strategy.

In the National Infrastructure Assessment published in 2018 the National Infrastructure Commission (2018) highlights energy efficiency as a key element of the future energy system. It also recommends that Government should set a target of 21,000 energy efficiency measures a week by 2020. However, the report falls short of defining energy efficiency as a national infrastructure priority, which would reinforce its critical importance for meeting the challenges of the low-carbon transition. When considering the infrastructure needs in future assessments, the National Infrastructure Commission should capture the full suite of benefits of energy efficiency.

COMPLIANCE, REVIEW, AND PROGRAMME IMPROVEMENTS

Over time, energy efficiency policies require a compliance framework to ensure delivery, periodic review to allow for course corrections, and, more importantly, increased ambition as confidence grows. Tracking progress is an essential part of the compliance and review process and relies on clear and accurate monitoring and verification of claimed savings. Unlike supply-side energy resources and energy network infrastructure, energy efficiency and demand response resources are profoundly distributed. Moreover, measuring how much efficiency or demand response has been delivered requires detailed assessments of the situation with and without the activity in question. Such assessments require sufficient data and skilful analysis. Fortunately, there is a deep body of experience globally on how to do this well. For example, the U.S. Environmental Protection Agency has developed measurement and verification guidance for demand-side energy efficiency which is available in draft (EPA 2015). Regulators, system operators, and delivery agencies across the globe now routinely measure and verify conformance with efficiency and demand response initiatives involving the equivalent of several billions of pounds sterling annually.

The following are recommendations for improvements to the compliance and review framework as the government considers new energy efficiency policies.

Establish clearer monitoring and verification rules

In its report evaluating the Green Deal and the Energy Company Obligation, the National Audit Office (NAO 2016) has pointed out that the government did not set clear success criteria for the Green Deal that would have enabled DECC to track progress against target metrics. It was partly a result of the Green Deal being a novel policy mechanism with uncertainties around how much it would deliver. This meant, however, that the government could not monitor the scheme's progress against expectations. Future energy efficiency policies need to be designed in such a way that a clear target trajectory is established, a metric for measuring progress is defined, and delivery is monitored against those target metrics.

It is also widely recognised that the actual impact of low-carbon technologies is often lower than predicted by models alone, a phenomenon which has been coined the "performance gap." Despite this awareness, in many instances estimates of both energy savings and renewable energy generation in domestic buildings continue to rely on engineering models and building energy simulations rather than approaches that are based on measured parameters. Recent analysis suggests that many low-carbon technologies deployed in the UK, including energy efficiency measures, might deliver lower than expected savings (McElroy and Rosenow 2018). The UK government has taken important steps for some energy efficiency measures to derive more realistic energy savings estimates, mainly through the National Energy Efficiency Data-Framework (NEED), and additional energy efficiency measures should be monitored going forward.

Periodic reviews

Periodic reviews of energy efficiency policies, targets, and measures are essential to secure progress and increase ambition for energy efficiency over time. Equally important, BEIS and Ofgem will need good data on the results of efficiency and demand response programs to consider how flaws can be repaired, how over-compensation and under-delivery can be remedied, and how programmes can be expanded into new areas and deeper savings can be delivered. Experience with successful programmes in many jurisdictions demonstrates that, as confidence in savings estimates improves, ambition levels and resulting savings levels will rise.

Conclusion

The United Kingdom, like the rest of Europe, now faces a double-barrelled economic challenge: meeting the imperative of dramatic reductions in carbon emissions, while also stimulating economic growth to combat a softening economy, and the need to drive up domestic employment. During times of low interest rates and slowing growth rates, investing in infrastructure can provide a crucial boost to national economies. Investing in energy efficiency across the nation's building stock and business enterprises offers the additional advantage of immediately lower energy bills and a lower trajectory of energy spending across many years to come. Making better use of our renewable investments, reducing fuel import costs, and meeting carbon reduction goals at lower costs to households and businesses are additional benefits.

This paper demonstrates that there is ample opportunity for the implementation of E1st in the UK to achieve this. It requires a set of intelligent policies and regulations to make that happen but luckily there is a lot of experience from around the world that can be built on.

Bibliography

American Council for an Energy-Efficiency Economy (ACEEE) (2016): Energy efficiency lowers costs in recent PJM capacity auction. Retrieved from: http://aceee.org/blog/2016/06/energy-efficiency-lowers-costs-recent.

Amon, A., Holmes, I. (2016): Energy Efficiency as Infrastructure, Leaping the Investment Gap, London: E3G.

Bayer, E. (2015): Efficiency First: Key Points for the Energy Union Communication. Montpelier, VT: The Regulatory Assistance Project. Retrieved from: http://www.raponline.org/document/download/id/7507.

Department for Business, Energy & Industrial Strategy (BEIS) (2018): Annual Fuel Poverty Statistics, 2018. Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/719106/Fuel_Poverty_Statistics_Report_2018.pdf.

BEIS (2016a): Energy Consumption in the UK 2016. Retrieved from: https://www.gov.uk/government/statistics/energy-consumption-in-the-uk.

BEIS (2016b): National Infrastructure Pipeline 2016. Retrieved from: https://www.gov.uk/government/publications/national-infrastructure-pipeline-2016.

German Federal Ministry for Economic Affairs and Energy (BMWI) (2016a): Was bedeutet eigentlich "Efficiency First"? Retrieved from: https://www.bmwi-energiewende.de/EWD/Redaktion/Newsletter/2016/23/Meldung/direkt-erklaert.html.

BMWI (2016b): Green Paper on Energy Efficiency. Retrieved from: https://www.bmwi.de/Redaktion/EN/Artikel/Energy/green-paper-on-energy-efficiency.html.

Committee on Climate Change (2017): Energy prices and bills – impacts of meeting carbon budgets. Retrieved from: https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/.

Committee on Climate Change (2015): The fifth carbon budget – The next step towards a low-carbon economy. Retrieved from: https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/.

Centre for Economics and Business Research (CEBR) (2011): British Gas Home Energy Report 2011. An assessment of the drivers of domestic natural gas consumption. London: Centre for Economics and Business Research.

Cowart, R. (2014): Unlocking the Promise of the Energy Union: "Efficiency First" is Key. Montpelier, VT: The Regulatory Assistance Project. Retrieved from: http://www.raponline.org/document/download/id/7401.

Department of Energy and Climate Change (DECC) (2015). Energy Consumption in the UK (2015). Chapter 3: Domestic energy consumption in the UK between 1970 and 2014.

European Commission (2016a): Commission proposes new rules for consumer centred clean energy transition. Retrieved from: https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition.

European Commission (2015): A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy. COM/2015/080 final. Retrieved from: https://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF.

U.S. Environmental Protection Agency (2015): Evaluation Measurement and Verification (EM&V) Guidance for Demand-Side Energy Efficiency (EE). Draft for public input. Retrieved from: http://www.epa.gov/sites/production/files/2015-08/documents/cpp_emv_guidance_for_demand-side_ee_-_080315.pdf.

European Climate Foundation (2016): Efficiency First: A New Paradigm for the European Energy System. Retrieved from: https://europeanclimate.org/efficiency-first-a-new-paradigm-for-the-european-energy-system/.

Eyre, N. (2013): Energy saving in energy market reform – The feed-in tariffs option. Energy Policy 52 (0), pp. 190–198.

Frontier Economics (2015): Energy efficiency: An infrastructure priority. Retrieved from: http://www.frontier-economics.com/publications/energy-efficiency-an-infrastructure-priority/.

Guertler, P., Rosenow, J. (2016): Buildings and the 5th Carbon Budget. Report funded by the European Climate Foundation. Retrieved from: http://www.ukace.org/wp-content/uploads/2016/09/ACE-RAP-report-2016-09-Buildings-and-the-5th-Carbon-Budget.pdf.

Hurley, D., Peterson, P., and Whited, M. (2013): Demand Response as a Power System Resource: Program Designs, Performance and Lessons Learned in the United States. Regulatory Assistance Project. Retrieved from: http://www.raponline.org/document/download/id/6597.

Infrastructure Transitions Research Consortium (ITRC) (2016): National Needs Assessment (NNA) – ITRC Interim Report: Analysis of Strategic Options for the NNA.

HM Government (2017): The Clean Growth Strategy. Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf.

Jahn, A., Rosenow, J. (2017): Property Transfer Tax reform – a revenue-neutral financing mechanism for energy efficiency? In: Proceedings of eceee Summer Study 2017, pp. 1351–1358.

Lees, E., Bayer, E. (2016): Toolkit for Energy Efficiency Obligations. Retrieved from: www.raponline.org/document/download/id/8029/.

Lees, E., 2006. Evaluation of the Energy Efficiency Commitment 2002–05, Eoin Lees Energy, Wantage.

Lees, E., 2008. Evaluation of the Energy Efficiency Commitment 2005–08, Eoin Lees Energy, Wantage.

Mallaburn, P.S., Eyre, N. (2013): Lessons from energy efficiency policy and programmes in the UK from 1973 to 2013. Energy Efficiency, 7 (1), pp. 23–41.

McElroy, D., Rosenow, J. (2018): Policy implications for the performance gap of low-carbon building technologies. Building Research & Information 47 (5), pp. 611–623.

National Audit Office (2016): Green Deal and Energy Company Obligation. Retrieved from: https://www.nao.org.uk/wp-content/uploads/2016/04/Green-Deal-and-Energy-Company-Obligation.pdf.

National Infrastructure Commission (2018): National Infrastructure Assessment. Retrieved from: https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf.

National Needs Assessment Executive Group (2016): National Needs Assessment – A Vision for UK Infrastructure. Retrieved from: https://www.ice.org.uk/getattachment/media-and-policy/policy/national-needs-assessment-a-vision-for-uk-infrastr/National-Needs-Assessment-PDF-(1).pdf.aspx.

National Grid (2015). Final Auction Results T-4 Capacity Market Auction for 2019/20. Retrieved from: https://www.emrdeliverybody.com/Capacity%20Markets%20Document%20Library/T-4%20Final%20Results%202015.pdf.

Neme, C., Cowart, R. (2014): Participation in Electricity Capacity Markets – The US Experience. Regulatory Assistance Project Retrieved from: www.raponline.org/document/download/id/7303/.

Neme, C., Cowart, R. (2013): Energy efficiency feed-in-tariffs: key policy and design considerations. Proceedings of the eceee Summer Study, pp. 305–315.

Odyssee (2017): Odyssee decomposition facility. Retrieved from: http://www.indicators.odyssee-mure.eu/decomposition.html.

Ofgem (2018): RIIO-2 framework decision. Retrieved from: https://www.ofgem.gov.uk/publications-and-updates/riio-2-framework-decision.

Ofgem (2016): Electricity Network Innovation Competition: 2016 funding decision. Retrieved from: https://www.ofgem.gov.uk/publications-and-updates/electricity-network-innovation-competition-2016-funding-decision.

Ofgem (2015): First Tier Low Carbon Network Fund Registration Log. Retrieved from: https://www.ofgem.gov.uk/publications-and-updates/first-tier-low-carbon-network-fund-registration-log.

Ofgem (2013): Price controls explained. Retrieved from: https://www.ofgem.gov.uk/publications-and-updates/factsheet-price-controls-explained.

Office for Budget Responsibility (2018): October 2018 Economic and Fiscal Outlook: Fiscal Supplementary Tables. Retrieved from https://obr.uk/efo/economic-fiscal-outlook-october-2018/.

PA Consulting (2016): Aggregators – Barriers and External Impacts. Report for Ofgem. Retrieved from: https://www.ofgem.gov.uk/system/files/docs/2016/07/aggregators_barriers_and_external_impacts_a_report_by_pa_consulting_0.pdf.

Rosenow, J., Cowart, R., Thomas, S. (2018): Market-based instruments for energy efficiency: a global review. Energy Efficiency. Retrieved from: https://doi.org/10.1007/s12053-018-9766-x.

Rosenow, J., Guertler, P., Sorrell, S., Eyre, N. (2018): The remaining potential for energy savings in UK households. Energy Policy 121, pp. 542–552.

Rosenow, J., Bayer, E., Genard, Q., Toporek, M., Rososińska, B., (2016): Efficiency First: From principle to practice. Real world examples from across Europe. Retrieved from: http://www.raponline.org/wp-content/uploads/2016/11/efficiency-first-principle-practice-2016-november.pdf.

Rosenow, J., Jahn, A. (2016): Germany Adopts "Efficiency First" Principle – Let's Work to Make it a Reality. Retrieved from: http://www.raponline.org/germany-adopts-efficiency-first-principle-lets-make-it-reality/.

Rosenow, J., Eyre, N. (2016): A post mortem of the Green Deal: Austerity, Energy Efficiency, and Failure in British Energy Policy. Energy Research & Social Science 21, pp. 141–144.

Rosenow, J., Galvin, R. (2013): Evaluating the Evaluations: evidence from energy efficiency programmes in Germany and the UK. Energy & Buildings 62, pp. 450–458.

Rosenow, J. (2012): Energy Savings Obligations in the UK – A History of Change. Energy Policy 49, pp. 373–382.

Strbac, G. (2010): Cited in House of Commons Energy and Climate Change Committee (2010): The Future of Britain's Electricity Networks. Second report of session 2009-10, Volume I, HC194-1.

Wiese, C., Cowart, R., Rosenow, J. (2018): Carbon leverage: Investing Europe's carbon revenues in energy efficiency. Retrieved from: https://www.raponline.org/knowledge-center/carbon-leverage-investing-europes-carbon-revenues-in-european-energy-efficiency/.