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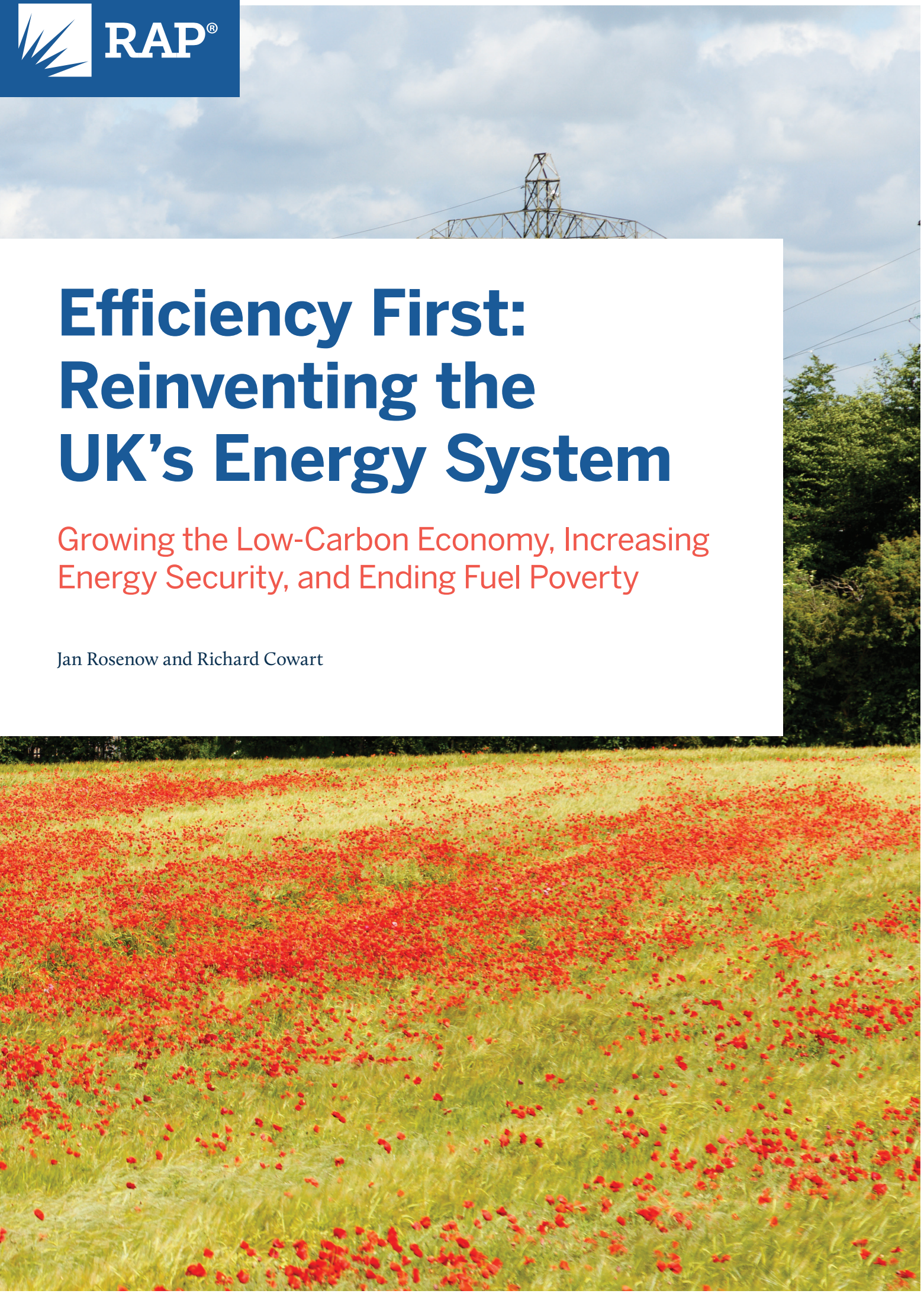

Efficiency First: Reinventing the UK's Energy System

Growing the Low-Carbon Economy, Increasing Energy Security, and Ending Fuel Poverty

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Efficiency First: Reinventing the UK's Energy System

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The UK's energy policy is at a 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 sustainable 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 trajectory along which the energy system will evolve. Getting those choices right is key for ensuring a sustainable, affordable, and secure energy future. The principle of Efficiency First that we explore in this report delivers on all three.

Efficiency First means more than just strong dedicated energy efficiency policy; it is a principle applied to policy-making, 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 a 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; and 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 savings technologies. The evidence across decades of experience is that investments in efficiency are not automatic, and that numerous 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" (E1st) or "Energy Efficiency First" has emerged in the United States (although not labelled in that way), where approaches such as Integrated Resource Planning and "all cost-effective efficiency" standards have been in existence for a long time.[1] E1st has gained traction at the European Union (EU) level since the launch of the Energy Union Communication in February 2015[2] and the publication of the Winter Package,[3] but also in some European countries such as Germany, where it has become an energy policy principle[4] and is now an underlying principle of Germany's *Energiewende.*[5] The German Government has now concluded a consultation on how to implement E1st through its Green Paper on Energy Efficiency.[6] E1st likewise offers a refreshing lens on UK energy policy, which is consistent with reaching the 2050 climate goals most economically. We recommend that the UK follow suit and adopt it.

1 Cowart, R. (2014). *Unlocking the promise of the energy union: "Efficiency First"* is key. Brussels, Belgium: The Regulatory Assistance Project. Retrieved from: http://www.raponline.org/document/download/id/7401

2 COM/2015/080 final

3 EC. (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

4 RAP. (2016). Minister for economy and energy recognizes efficiency first as a guiding principle for German Energiewende [press release]. Retrieved from: http://www.raponline.org/news/minister-for-economic-affairs-and-energy-recognizes-efficiency-first%C2%9D-as-guiding-principle-for-the-german-energiewende/

5 BMWI. (2016). *Was bedeutet eigentlich "Efficiency First"?* Retrieved from: https://www.bmwi-energiewende.de/EWD/Redaktion/Newsletter/2016/23/Meldung/direkt-erklaert.html

6 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/

Following the adoption of the E1st as a high level conceptual principle, this needs to be absorbed into all energy policy areas. Both in Germany[7] and the EU,[8] work is under way to investigate where and how the E1st principle should be applied across the energy system. We recommend the UK government carry out a systematic review of where the E1st principle should be applied and prepare an Action Plan to enact this. Adopting a "hard look" policy to examine and invest in E1st is the first and most important step the Government can take to unlock the huge reservoir of low-cost, low-carbon savings that sits untapped in every part of the UK despite significant improvements in energy efficiency over the past few decades.[9]

In this report, we identify a number of key areas where we see potential for the E1st principle to deliver low-carbon outcomes at a lower cost whilst also delivering a wide range of multiple benefits associated with energy efficiency improvements.

This policy brief (1) explains what the concept of E1st is and (2) 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, infrastructure spending, revisions of the capacity mechanism, and the levy control framework. The aim of this paper is to start a discussion around the value that E1st can bring to the UK context.

What is Efficiency First?

The E1st principle focuses on customer-based (demand-side) efficiency resources, recognising that demand-side resources are essential to securing system-wide efficiency. Yet demand-side resources have often been overlooked or ignored and still face multiple barriers to inclusion in planning and deployment.[10]

Achieving E1st requires a commitment to:

- mobilise end-use energy efficiency as the UK's "first fuel";
- overcome deep-seated market barriers to end-use energy efficiency and demand response; and
- reverse 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 more costly investments in energy infrastructure and fuel, and is essential to the cost-effective and timely decarbonisation of the economy. Moreover, investment in demand-side alternatives can carry many additional benefits besides those it brings to the energy system, such as improved air quality,[11] improved health, and increased 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 and cost-effectively decarbonise the UK economy. Wasting high-value renewable resources on inefficient end-use consumption is both economically costly 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 oft-cited trilemma of security, sustainability, and affordability.

Although 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

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

8 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/ and 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

9 Rosenow, J., Eyre, N., Sorrell, S., & Guertler, P. (Forthcoming). *Unlocking Britain's first fuel: the potential for energy savings in UK housing.* A UKERC/CIED Policy Briefing.

10 The initial statement of this principle was set out by RAP in Cowart, R. (2014). *Unlocking the promise of the energy union: "Efficiency First" is key.* Brussels, Belgium: The Regulatory Assistance Project. Retrieved from: http://www.raponline.org/document/download/id/7401. See also Bayer, E. (2015). *Efficiency First: key points for the energy union communication.* Brussels, Belgium: The Regulatory Assistance Project. Retrieved from: http://www.raponline.org/document/download/id/7507

11 Demand-side alternatives can refer to a wide range of options, including options like diesel generators, which can worsen air quality if not properly regulated. It is important to draw a clear distinction between economic resources and emergency resources that can be deployed only under well-defined system emergency conditions, and to ensure that economic demand-side alternatives are subject to proper air quality regulations to protect against unintended adverse air quality effects.

What are demand-side resources?

Broadly speaking, there are two different types of demand-side resources. **End-use energy efficiency** reduces the demand for energy while meeting demand for energy services, which in turn reduces the volume of production, transport, and consumption of electricity, gas, and other energy sources. The cost of delivering a kilowatt-hour (kWh) of energy saved is often lower than the comparable cost of delivering a kWh of energy generated,[12] and when the additional benefits of energy efficiency are quantified, including benefits to customers, the energy system, and broader societal benefits like water conservation and air quality, the value of end-use energy efficiency can far exceed that of generation. Moreover, as the UK decarbonises its energy mix, energy efficiency reduces the investment needed in new low-carbon resources.

In contrast to end-use energy efficiency, **demand response** may not reduce overall energy consumption. Rather, it alters consumption patterns to increase or reduce demand in particular locations and time periods, in response to energy prices and system conditions. Demand-response resources can be mobilised either as a behavioural or programmed response to price changes ("price-based" demand response) or as a flexibility resource that is deployed, to improve reliability and power quality, often through aggregation of a large number of individual loads (often called "incentive-based" demand response). Demand response can be a dispatchable electricity system resource or it can change the shape of the demand curve as the availability of supply, and thus the value of energy, shrinks and expands.

Although both energy efficiency and demand response produce benefits for consumers, the power system, and society, they require different drivers to implementation. End-use energy efficiency faces a range of well-documented market barriers to implementation, and thus requires a combination of targets, codes and standards, programmes, and funding to overcome the barriers and leverage private investment.[13]

Although demand response has traditionally been used as an emergency resource even in vertically integrated utility systems, its greater value as a routine system resource is better revealed in properly structured and operated power markets. This is because demand response can offer new or improved energy services to consumers at lower cost, and valuable and varied flexibility services to the power system, allowing demand response to generate revenues in all power market timeframes, including as balancing and regulation resources. Demand response will be increasingly valuable as a means of adjusting loads to the varying output of variable renewable resources, particularly wind power and photovoltaic (PV) production.

Despite the differences between end-use energy efficiency and demand response, it is important to recognise that without changes to the structure of power markets and power sector regulation, energy efficiency and demand response face barriers to inclusion in planning and deployment, some of which are common to both. And while end-use energy efficiency in particular will not be fully enabled through the electricity market design alone, electricity markets and electricity sector regulation as they are currently structured present a very real barrier to achieving cost-effective end-use energy efficiency and demand response. These barriers stem from the current rules on how network companies are regulated, how competitive power markets operate, how resource adequacy is determined, and how consumer tariffs are structured.

12 The cost of delivering a kWh of energy saved includes all costs (public funding + private finance); the cost of delivering a kWh supplied is the cost to the energy supplier of delivering a kWh to the end-use consumer.

13 There is some room for energy efficiency to participate in energy markets—primarily in forward and capacity markets, but many cost-effective energy efficiency investments will be lost without codes, standards, customer incentives, or other non-market assistance.

are considered as an entirely separate category (see text box on demand-side resources for more background). 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 Tap the UK's First Fuel

The good news is that smart policies can help overcome these barriers. 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 how to apply E1st across these various policy areas.

1. **Planning.** Recognise the value of efficiency, including its multiple benefits to the energy system, consumers, and society, and use of consistent demand projections in planning.
2. **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 buildings and equipment 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.
3. **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.
4. **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 teaches that active oversight and continuous improvement in programmes 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

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 that efficiency and demand-response policies could deliver on system demands be consistently taken into account.

The text box on the following page contains recommendations for some of the policy planning processes underway or under review.

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. On average, individual households now use 37 percent less energy than they did in 1970, with the bulk of this decrease occurring since 2004. Total household energy use decreased by 19 percent between 2000 and 2014, despite a 12-percent increase in the number of households and a 9.7-percent increase in population.[16]

Those impressive reductions in energy use have not been accidental—they have been driven by energy efficiency policies such as energy efficiency obligations on energy suppliers, regulations supporting condensing boilers, and grant programmes such as Warm Front. Research commissioned by British Gas[17] has shown that about two-thirds of the large reduction in domestic gas use has been achieved by energy efficiency improvements.

14 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/

15 Guertler, P., & Rosenow, J. (2016). *Buildings and the 5th carbon budget.* Retrieved from: http://www.ukace.org/wp-content/uploads/2016/09/ACE-RAP-report-2016-09-Buildings-and-the-5th-Carbon-Budget.pdf

E1st options in planning processes

Apply the E1st principle in the Carbon Plan, establishing a clear role for energy efficiency and demand response. By autumn 2017 a new Emissions Reduction Plan (also known as the Clean Growth Plan) is expected to be published, setting out the policy framework going forward to achieve future carbon budgets. The Committee on Climate Change has recommended a carbon budget, covering the period 2028 to 2032, and set out the trajectories required for energy efficiency to meet this.[14] The Committee specifically mentioned energy efficiency in buildings as one of four priority areas that will need to be addressed and shows that current efforts are not sufficient, which 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 The Regulatory Assistance Project (RAP) and the Association for the Conservation of Energy (ACE) shows that there is a considerable mitigation gap in the buildings sector that needs to be closed through reforming existing and introducing new policies.[15]

Testing and piloting. Past energy efficiency schemes such as the Green Deal struggled partly because of a lack of testing and piloting. The assumptions made at the policy design stage were never tested with consumers and turned out to be overly optimistic. Future energy efficiency policy needs to be based on the best available evidence of how consumers are likely to respond in order to be able to design effective instruments. This is essential to ensure that energy efficiency is a deliverable resource that can make the E1st principle viable.

However, the introduction of the Green Deal and the reorientation of the Energy Company Obligation (ECO) resulted in a sharp decrease 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 62 percent, and solid wall insulation had not increased compared with 2012. It is now widely accepted that the Green Deal failed, and the recent report by the National Audit Office[18] confirms this view. The level of reduction in energy demand is therefore expected to slow in coming years if no additional policies are put into place.

Going forward, the ECO will be focussed 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.[19] For the UK to meet its carbon targets, this acute policy void needs to be filled.

The text box on the following page represents opportunities to strengthen targeted energy efficiency policies in the UK.

16 DECC. (2015). Energy consumption in the UK (2015). London: DECC.

17 Centre for Economics and Business Research. (2011). *British Gas home energy report 2011.* An assessment of the drivers of domestic natural gas consumption. London: Centre for Economics and Business Research.

18 NAO. (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

19 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 neighbourhoods.

Opportunities to strengthen energy efficiency policies

Expand ECO to the able-to-pay sector. The next phase of ECO, after a one-year transition phase, will focus entirely on fuel-poor households. 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. The vast majority of households are not in fuel poverty,[20] including some on low incomes. This means that ECO would be funded by 83 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 proven to be effective.

Stamp Duty rebate programme. The Stamp Duty Land Tax should 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.[21]

Carbon Revenue Recycling. Leveraging carbon revenues to drive carbon reductions via efficiency upgrades is an approach that increasingly gets traction across Europe—public commitments have been made by more than ten countries in the EU to return part of the carbon revenues from the EU Emissions Trading System (ETS) auctions to climate and energy efficiency programmes.[22] 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[23] will generate more than £15 billion of income.[24] On average, this equates to £2.5 billion, which could be reinvested in energy efficiency. Because the purpose of carbon charges is to drive decarbonisation at the lowest cost to the nation, and because investing in energy efficiency is, in large measure, the lowest-cost pathway to carbon reduction, it is critical that the government leverage the power of carbon revenue,[25] in addition to the economic signals provided by carbon prices.[26]

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 there is no country that 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.[27] Payments would be based on demonstrated demand reductions and/or installation receipts confirming 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.[28]

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20 DECC. (2015). *Annual fuel poverty statistics report: 2015.* Retrieved from: https://www.gov.uk/government/statistics/annual-fuel-poverty-statistics-report-2015

21 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. Retrieved from: http://eng.janrosenow.com/uploads/4/7/1/2/4712328/6-129-17_jahn.pdf

22 Vaze, P., & Sunderland, L. (2014). *The economic case for recycling carbon tax revenues into energy efficiency.* Retrieved from: https://www.e3g.org/docs/The_case_for_recyling_carbon_tax_Feb2014_Final.pdf

23 It is currently unclear whether the UK will continue to participate in the EU ETS after the vote to leave the EU in June 2016.

24 Office for Budget Responsibility. (2016). *March 2016 economic and fiscal outlook: fiscal supplementary tables.* Retrieved from: http://budgetresponsibility.org.uk/download/economic-and-fiscal-outlook-supplementary-fiscal-tables-march-2016/

25 Cowart, R., Bayer, E., Keay-Bright, S., & Lees, E. (2015). *Carbon caps and efficiency resources: launching a "virtuous circle" for Europe.* Retrieved from: www.raponline.org/document/download/id/7515/

26 Common-sense 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. See Lees, E., & Bayer, E. (2016). *Toolkit for energy efficiency obligations.* Retrieved from: www.raponline.org/document/download/id/8029/

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

28 Eyre, N. (2013). Energy saving in energy market reform—the feed-in tariffs option. *Energy Policy* 52(0), pp. 190-198.

Infrastructure Decision Rules

Every year large sums of money are 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, investment can result in long-term lock-in into carbon-intensive technologies, 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, not just as 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.[29] But decisions relating to energy infrastructure have traditionally been made—and continue to be made—without consideration of the potential for lower-cost demand-side alternatives.[30] Prioritising E1st requires a change to regulatory rules expressed in the RIIO (Revenue = Investment + Innovation + Outputs) price control regime that today allow tariffed recovery of network costs. Reform is needed to ensure that demand-side resources can compete against pipes and wires investments in meeting the UK's energy service needs and to ensure that these "non-wires" and "non-pipes" solutions will be deployed and paid for where they are less expensive than supply.[31]

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. In 2017 and 2018, there will be an 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 in the text box on the following page.

29 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: RAP. (2014). *Unlocking the Promise of the energy union: "Efficiency First" is key.* Retrieved from: www.raponline.org/document/download/id/7401. Although this section focusses on energy efficiency, it is equally important to consider the value of demand response as a demand-side alternative to supply-side infrastructure.

30 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. See Amon, A., & Holmes, I. (2016). *Energy efficiency as infrastructure, leaping the investment gap.* London: E3G.

31 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, R. (2014). *Unlocking the promise of the energy union: "Efficiency First" is key.* Retrieved from: http://www.raponline.org/document/download/id/7401. Ibid. FN 29

E1st opportunities in rules and regulations

Introducing an energy efficiency performance incentive metric in RIIO-2. In the past, regulation of electricity, gas, and heat networks in the UK was driven by a "predict-and-provide mentality."[32] In recognition of this, Ofgem changed the old RPI-X 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."[33] 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 and is intended to result in a shift from network companies focusing on capital investment toward outcomes.[34]

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 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.[35] Another avenue for supporting demand-side management is the Network Innovation Allowance (NIA), which aims to fund small-scale innovation projects. Its value is 0.5 percent 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,[36] but similar to the Network Innovation Competitions, the projects are dominated by supply-side projects. Although 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 focussed innovation at scale. Finally, the Innovation Roll-out Mechanism (IRM) is a mechanism to enable companies to apply for additional funding to roll out a proven innovation that meets defined criteria, including where 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 IRM. 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. Over the next years, Ofgem will develop the RIIO-2 framework, which commences in 2021 for gas and electricity transmission and gas distribution and for electricity distribution in 2023. Building on the current incentive structure in RIIO, additional incentives and/or primary and secondary deliverables could be introduced that provide an impetus for energy efficiency investment by the network companies.

Reforming the Levy Control Framework. The Levy Control Framework (LCF) is an agreement between HM Treasury and DECC originally established in March 2011 as a means of controlling expenditure under levy-funded energy programmes. LCF has as its purpose putting a cap on the energy bill impacts of policy interventions. energy efficiency obligations are currently not included under the cap but are reported on alongside the LCF. LCF counts only the direct bill adders from energy efficiency mandates, but it does not count the bill savings. Bill savings come in at least two types: the lower bills incurred by programme 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

32 Strbac 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.

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

34 The move to a total expenditure, or 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.

35 See, for example, 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 and 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

36 Energy Networks Association. (undated) *Energy Storage and Demand Response.* Retrieved from: http://www.smarternetworks.org/ProjectList.aspx?TechnologyID=7

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 one percent of total capacity in the second auction was awarded to demand response.[37] 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, whereas demand-response investments are given only a one-year capacity contract.[38] Because demand-response providers must incur the transaction costs of finding and enrolling demand-response customers and installing demand-response and energy efficiency technologies, although 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 megawatts (MW). This is significantly more than in other established capacity markets, such as PJM and ISO-NE in the United States, where the minimum size is 100 kW.[39]

There is ample experience in other markets to demonstrate that demand response is capable of delivering as much as ten percent of all capacity requirements at a far lower cost than new generation and at least as reliably.[40] Including efficiency also lowers the costs of providing capacity across the entire market—delivering savings in the billions of dollars, as evidence from the United States shows.[41] 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 investment. 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.[42] Instead, the investment is almost entirely focussed 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

37 Nationalgrid. (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

38 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

39 Neme, C., & Cowart, R. (2014). *Participation in electricity capacity markets—the US experience.* Montpelier, VT: The Regulatory Assistance Project. Retrieved from: www.raponline.org/document/download/id/7303/

40 Hurley, D., Peterson, P., & Whited, M. (2013). *Demand response as a power system resource: program designs, performance and lessons learned in the United States.* Montpelier, VT: The Regulatory Assistance Project. Retrieved from: http://www.raponline.org/document/download/id/6597

41 ACEEE. (2016). *Energy efficiency lowers costs in recent PJM capacity auction.* Retrieved from: http://aceee.org/blog/2016/06/energy-efficiency-lowers-costs-recent

42 HM Treasury and Infrastructure and Projects Authority. (2016). *National Infrastructure Plan 2016.* Retrieved from: https://www.gov.uk/government/publications/national-infrastructure-pipeline-2016

compared to infrastructure projects like the first phase of HS2 and the rollout of smart meters, efficiency provides very comparable monetary benefits,[43] and this is even without quantifying many of the social benefits of energy efficiency measures such as health and wellbeing improvements. There is a unique opportunity to define energy efficiency as an infrastructure priority: the government has set up the National Infrastructure Commission (NIC) 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 the publication of a National Infrastructure Assessment once per parliamentary term. The current National Infrastructure Assessment is ongoing following a consultation process in 2016 and will be published in 2018. 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.[44] The Infrastructure Transitions Research Consortium (ITRC)[45] 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 suggests a potential of 15 percent by 2050. For gas, the reduction potential is around 57 percent to 67 percent, depending on whether or not electrification is part of the strategy. When considering the infrastructure needs, the NIC should capture the full suite of multiple benefits of energy efficiency.

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

44 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

45 ITRC. (2016). *National needs assessment (NNA)—ITRC Interim Report: analysis of strategic options for the NNA.*

46 For example, the US Environmental Protection Agency has developed measurement and verification guidance for demand-side energy efficiency that is available in draft: EPA. (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

Recommendations for compliance and review framework

Establish clearer Measurement & Verification rules. In its recent report evaluating the Green Deal and the Energy Company Obligation, the National Audit Office[47] 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.

Review. Periodic review of energy efficiency policies, targets, and measures is 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 increase.

Compliance, Review, and Programme Improvements

Energy efficiency policies require a compliance framework to ensure delivery, and periodic review to allow for course corrections—and more importantly, as confidence grows, increased ambition—over time. Tracking progress is an essential part of the compliance and review process, and it 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.[46] 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 annually.

The following text box includes recommendations for improvements to the compliance and review framework as DECC considers new energy efficiency policies.

Delivering Efficiency First

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.

We document in this paper 12 reforms that could be taken to deliver on that promise. Those 12 reforms are summarised in the table below. There may well be others, for example, related to giving local authorities the right powers to oversee integrated approaches to delivery of energy efficiency and heat decarbonisation programmes, which we recommend the government consider as part of the assessment proposed.

47 NAO. (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

Efficiency First Recommendations for the UK

Recommendation	Who?	When?
Develop new energy efficiency incentives for RIIO-2	Ofgem	2017-2021
Expand ECO to the able-to-pay sector	BEIS	2018
Introduce Stamp Duty rebate programme	HMRC	2017
Introduce carbon revenue recycling	HMRC	2018
Introduce EE feed-in tariff	BEIS	2018
Reform the Levy Control Framework	BEIS	2018
Reform the capacity market	BEIS	2018
Consider efficiency resources as a key part of the UK's infrastructure	NIC	2017-2018
Establish clearer M&V rules	BEIS	2017
Periodic review	BEIS	2017 and then every two years

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