CREDS

# Policy for energy demand reduction

Centre for Research into Energy Demand Solutions

## 1. Introduction

Energy demand reduction has been a key part of the UK's progress to date in climate mitigation. All future scenarios compliant with the UK's international commitments and national legislation indicate that energy demand reduction will continue to be a critical component.

Despite its acknowledged importance, there are contested approaches to energy demand reduction policy. In particular, there is interest in behavioural economics (Thaler and Sunstein, 2008), that emphasises 'nudge interventions' (Halpern, 2015). Based on a broader range of research on energy use, this paper critiques that approach with respect to effectiveness in the context of major energy transitions. We argue for a more pluralist approach, using a range of disciplinary insights and pointing towards a wider and more ambitious set of policy instruments.

## 2. Background – trends in energy use and energy efficiency

It is now well-known that the UK has broken the link between economic growth and carbon emissions. Since 1970, GDP has almost tripled and $CO_2$ emissions have fallen by more than 30%, a 4-fold improvement in the carbon/GDP ratio. Much commentary on this change focusses on the decline of coal and the rise of gas and, more recently, renewable energy. But these are minor contributors to the overall effect. The dominant cause has been the change in energy intensity (the energy/GDP ratio), in which there has been a 3-fold improvement since 1970 (see Figure 1).

Since 2005, primary energy demand has fallen. Changes in trade patterns, economic structure and technology have all contributed, with technical change being the most important factor (Hardt et al, 2018; IEA, 2015). The period of most pronounced energy demand reduction, 2005-2012, coincided with the period of most active energy efficiency policy, starting with the 2003 Energy White Paper. The implementation of this in buildings and industry was through the 2004 Energy Efficiency Action Plan. In transport, progress was slower and largely driven by EU level agreements on average car emissions.

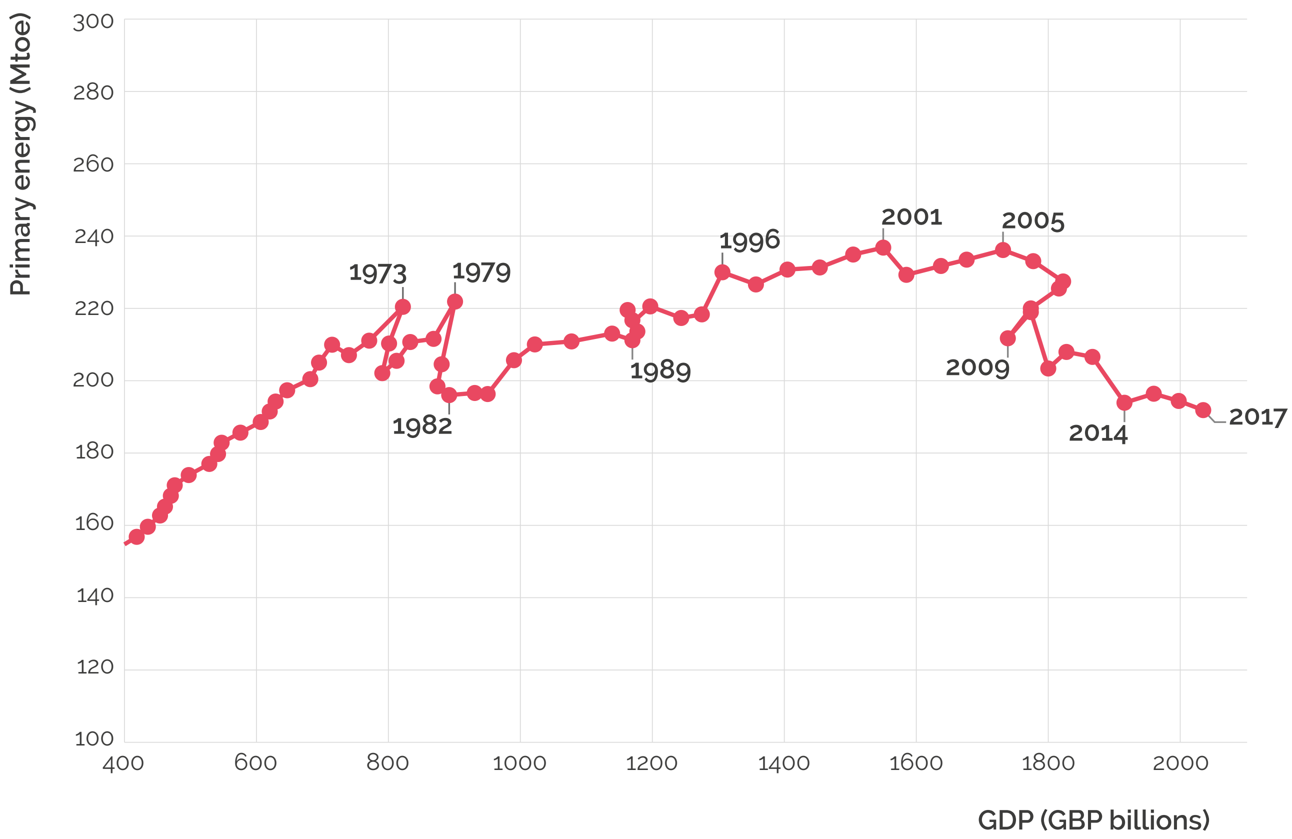


**Figure 1: Development of UK primary energy demand and GDP 1950–2017. Author calculations using official UK data.**

In 2012 there were significant cuts to a number of programmes and policies, notably energy supplier obligations (Rosenow and Eyre, 2013), business incentives and support programmes in both sectors (Mallaburn and Eyre, 2013). The trend in UK energy demand remains downwards, but has weakened, and reversed in the transport sector. It will need to revert to the trend observed between 2005 and 2012 to be consistent with any plausible and economic scenario for net zero ambition (CCC, 2019).

The ambition for future reductions in energy demand reduction is high, with ambitious targets in the Clean Growth Strategy (BEIS, 2017). However, as the strategy itself recognises, there is currently a lack of specific programmes or policy instruments to deliver these goals (Eyre and Killip, 2019). This disjuncture between ambition and policy is now exacerbated by the net zero commitment.

## 3. Approaches to thinking about demand reduction

Since 2010, there has been an increased focus in government on 'behavioural change', with behavioural insights teams institutionalised in several Government departments. In the broadest sense, this is welcome. Self-evidently, reducing demand requires individuals to do something differently, for example in what they buy, how much they travel and how they keep warm.

Although a variety of different types of intervention change behaviour, 'behaviour change' interventions are typically framed with respect to voluntary individual choices, i.e. "interventions that involve neither command-and-control regulations nor financial incentives, e.g., information provision, appeals to values and norms, engagement and restructuring choice options (so-called nudges)" (Stern, 2020). Of course, the psychological insights about the limits to rationality in decision-making that underpin behavioural economics (Kahnemann, 2011) are as valid for energy use as for other areas of behaviour. However, these insights about social norms, framing, inertia, bounded rationality and transaction costs do not automatically justify 'nudge' policies. On the contrary, the same insights can also provide a rationale for other policy approaches.

Of course, individuals have some agency. However, there is no research showing that individual, voluntary action has been more than a minor component of historical change. The potential identified by behavioural economics in controlled trials has often not been realised in real world applications, e.g. in the impact of smart meter roll out (Torriti, 2016, p172). Moreover, we know of no significant successful policy interventions in UK energy demand reduction policy that rely principally on 'nudge'.

Indeed, a recent meta-analysis (Nisa, 2020) concludes that: "taken in isolation, behavioural interventions have a very small positive effect on climate change mitigation behaviours while the intervention is in place. Once the intervention stops, there is no evidence that such interventions produce lasting positive changes". The idea that energy demand reduction can be delivered largely by 'behaviour change' is not defensible. The very features that make nudge interventions non- controversial and politically acceptable also undermine their effectiveness. Moreover, it is clear that UK energy efficiency policy has become less effective, not more, since nudge became fashionable.

Yet, in recent years, government has tended to prefer to use 'nudge theory', even on issues where its own social research professionals recognise it is ill-suited (Hampton and Adams, 2018). This has led to a limited and unhelpful framing of energy demand change – as wasteful behaviours that individuals need help in changing. A good example is the inaccurate description of our own Research Centre in the Clean Growth Strategy. CREDS role was described as "Research Councils are planning to invest around £19 million to research how people's energy choices can help them stop wasting as much energy."

The need to look more broadly than 'nudge' is amplified by the recognition that far-reaching changes in energy use are now required. Nudge interventions are effective when "easy, attractive, social and timely" (Halpern, 2015). But the energy transition cannot wait for all these factors to be favourable. Major refurbishments of buildings are costly and difficult; changing travel patterns can be challenging when land-use and transport systems are designed around the private car.

A range of disciplinary insights is required. They are available from a variety of sources, e.g. from science and technology studies (e.g. Geels, 2002); economics (e.g. Grubb, 2014), psychology (e.g. Stern et al, 2016) political science (e.g. Langlois-Bertrand et al, 2015), and sociology (e.g. Shove, 2010). The vast majority of current research findings about energy use emphasises the importance of interactions with user technology, infrastructures, institutions and wider social change.

## 4. Drivers for energy demand reduction

Analysis of energy use has typically distinguished between two factors: reducing demand for energy services (thermal comfort, illumination, mobility etc) and improving the energy efficiency with which those services are delivered (Schipper et al, 1992). Traditionally, policies to reduce energy demand have focused mainly on energy efficiency. Getting 'more for less' has an obvious attraction. Reducing demand for energy services appears less attractive when perceived as reducing individuals' utility and overall welfare. However, the benefits obtained from energy services depends upon the context: many energy service demands are wasteful in some contexts (e.g. illuminating an empty room), while others depend on structural factors (e.g. a long-distance commute because of housing shortages or prices).

More recent energy research has challenged a strict demarcation between improving energy efficiency and reducing energy service demand. Current thinking addresses the technical and social aspects of energy demand reduction as necessarily interdependent. This is partly because of definitional issues. For example, car sharing can be described in either category depending whether the 'service' delivered is vehicle-km or person-km, while defining the service as 'accessibility' opens up broader options such as changes in land-use. More importantly, the same example illustrates that 'service' and 'efficiency' are unlikely to change independently. For example, insulating a house tends to produce a significant increase in average internal temperature, even if the thermostat setting is unchanged.

### 4.1 Technology and infrastructure drivers

Access to new energy infrastructure tends to increase demand for energy services, but also to lead to improved efficiencies. For example, the development of an extensive natural gas infrastructure was a significant enabler of central heating use in UK homes, contributing to a ~6 degree rise in average internal temperatures in UK homes between 1970 and 2010. However, the same change also enabled improvement in the efficiency of heating systems, through the phasing out of open fires and then through the widespread adoption of condensing boilers once they became mandatory. The overall impact of changes to heating system efficiency and building insulation has been that energy demand for heating in homes is lower now than in the 1970s.

This is a common pattern in energy demand. As new infrastructure enables new energy services, energy demand rises. Then, as demand for the service saturates, technical efficiencies continue to improve and demand falls.

This has been observed with residential lighting, refrigeration and laundry, all of which have higher service levels and lower energy use than in earlier decades.

The type of infrastructure also matters. Increasing capacity for any type of transport infrastructure has a huge effect on travel patterns. Electrification of vehicles will improve vehicle efficiency, but requires extensive charging infrastructure. In both cases, the likely impact will be to reduce energy demand. Delivering these infrastructures depends on social norms and political choices.

The scope for future technical energy efficiency improvement remains large, except for in energy- intensive industrial processes. Even just improving the efficiency of existing types of end-use technology might give a 25% reduction in demand (Paoli et al, 2020). The switch to low carbon fuels in heating and vehicles alone can produce additional savings in excess of 30% of total demand (Eyre, 2019). Broader assessments allowing for more radical changes, including passive efficiency measures such as insulation, estimate a much larger potential of 85% (Cullen et al, 2011). The extent to which these are achieved will depend on the level of investment in these technologies and their effective use.

These examples illustrate that human behaviour and technological change need to be considered together, as their interactions are often critical and sometimes hard to predict. This is consistent with other analyses, notably from the House of Commons Science and Technology Select Committee (House of Commons, 2011) and the Committee on Climate Change (CCC,2019), which concluded that most potential for further carbon emissions reduction is from measures in which both technical and social change are involved (see Figure 2).

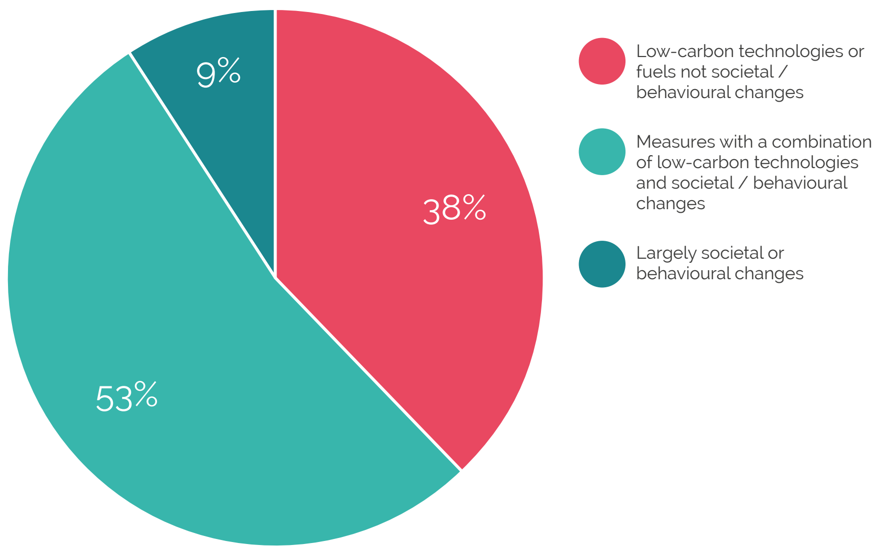


**Figure 2: The role of technological and social/behavioural changes in reaching net zero. Committee on Climate Change (CCC, 2019).**

### 4.2 Social change drivers

The history of long-term social change is predominantly one of increases in energy service demands. Particularly in the 20th Century, there have been huge increases in mobility and comfort levels (Fouquet, 2008). And the average UK household had more than three times as many electrical appliances in 2010 than in the 1970s (EST, 2011).

It has been common to assume that energy service demands will continue to rise. But this does not need to be the case in all areas. Already social trends are reducing some energy service demands. Increased recycling of post-consumer waste has reduced the (very significant) energy service demand of manufacturing new energy-intensive primary materials, such as aluminium and glass. There have also been signs of similar trends in some aspects of personal transport. UK citizens make 16% fewer trips than 1996 and travel 10% fewer miles than in 2002 (Marsden et al, 2018). In general, wider trends in society and the economy can have very significant effects.

New technologies lead to new ways of using energy. For example, digital devices and their impacts on energy use in data centres have been a major area of increased energy demand in the last two decades. However, the trend will not necessarily continue in the same direction. Social change can lead to diversification or consolidation in device use. For example, a single smart phone can provide the same service previously provided by multiple different gadgets, enabling a reduction in standby power consumption from 72W to 2.5W (Grubler et al, 2018). This trend may now be happening in the UK, where household electricity use in ICT has stabilised.

In these cases, the behaviours of individuals are clearly changing. But this appears to be the result of changing social norms, as well as economic and technological trends, not specific behavioural interventions. Working with the grain of social change can be effective, but this may require regulation and incentives (Marsden et al, 2018).

## 5. Research to inform energy demand reduction policy

Research on energy demand is needed to inform policymakers about the drivers of demand, but also to assist in designing policy interventions and their likely impacts. Given these insights above, policy to support zero carbon will be best addressed from a socio-technical perspective (Foxon and Pearson, 2008). Even for relatively straightforward technical improvements, social acceptability is important, as illustrated by the relative success of the LED lamp compared to the CFL lamp in providing cost-effective, efficient lighting. For more complex innovations, such as heating systems and mobility mode shifts, there is likely to be a need for supply chains skills and user practices to change at the same time as infrastructure and user technologies. Policy instruments may therefore need to address multiple issues. The result is that 'policy packages' of multiple instruments are more effective than single interventions (Rosenow et al, 2016, Kern et al, 2017).

Research also has a role in evaluating policy interventions. One of the advantages of the behavioural interventions approach is that it is supported by a robust evaluation literature.

Single behavioural interventions are easier to evaluate through controlled trials, which form the 'gold standard' for evaluation professionals in areas such as medicine.

Evaluation is much more problematic for complex interventions. However, the evidence is that policy packages tend to be more effective, even if they are less amenable to controlled experimentation. So, it is important that policy choice determines how evaluation is done, rather than vice versa.

Fortunately, in many cases, there is now sufficient data to draw robust conclusions from the analysis of real-world data. For example, understanding of the energy savings benefits of specific technical changes has been improved by using large datasets of household energy efficiency installations and actual energy use (Hamilton et al, 2014). Similarly, better understanding of car use patterns has been gained from the dataset of MOT tests (Chatterton et al, 2015). In both cases, the large datasets provide more confidence of 'real world' operation than could be achieved from a behavioural intervention trial alone. The growing body of data, for example from smart meters, will provide more opportunities for these types of technique in future. Advanced machine learning, fuzzy logic, clustering, data mining and big data techniques in general have opened up new possibilities for understanding trends and change.

More detailed understanding of how energy use changes can often be achieved from case studies (Chiu et al, 2014). In general, only a mix of methods is likely to provide an adequate analysis.

## 6. Conclusions for policy interventions

Reducing energy demand on the scale needed for the low-carbon energy transition cannot be achieved by relying on individual actors making public-spirited choices to increase frugality and reduce waste.

Fortunately, historical and current evidence shows that the vast majority of change occurs in other ways. Whilst household energy-saving actions are, by definition, changes in behaviour, they are not principally driven by policies usually described as 'behavioural interventions'. And much energy saving (as well as some increases in energy use) occurs as the result of changes made for other reasons, e.g. home improvement and home working.

The main influences on energy demand are technological, economic, institutional, regulatory and social. Decisions by government, planners, technology supply chains and energy providers set the framework within which individual and household decisions are made. Even the non-technical drivers of change are usually economic incentives and wider social norms, rather than specific external interventions. Effective public policy intervention for reducing energy demand therefore can, and should, draw on all the options used in policymaking for energy supply, i.e. regulation, financial incentives and information programmes.

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There are good examples of environmental transformation and broader economic and technological trends using different types of policy instrument. For example, the switch away from using lead in petrol was begun using fiscal policy (Ekins, 1999), but the switch to efficient boilers relied very heavily on regulation (Elwell et al, 2015). For a rapid transition, the consensus that is developing in the research community is that regulation will be critical, but a broader set of measures will also be needed (e.g. Eyre and Killip, 2019; Marsden et al, 2018). These will include information interventions to make markets work better, and there are examples of these proving effective, but primarily as part of wider policy packages (Eyre et al, 2011; Stern, 2020). Most analysis points to the need for policy combinations that include energy pricing, support for innovation and more targeted interventions to address specific market failures (Stern, 2006; Grubb, 2014).

It is also important to recognise that energy demand reduction at scale will need active public policy in areas outside the usual scope of energy policy. In some cases, these are relatively well-defined areas, e.g. the efficiency of buildings, appliances and vehicles, in housing, trade and transport policies. Other drivers are more diffuse, but potentially very important, for example, energy use in transport is hugely influenced by land use planning (Bertaud, 2003). The implication is that effective policy needs a strategic approach across Government.

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## About CREDS

The Centre for Research in Energy Demand Solutions (CREDS) was established as part of the UK Research and Innovation's Energy Programme in April 2018, with funding of £19.5M over five years. Its mission is to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable, low carbon energy system.

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