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Getting more from less

realising the potential of negawatts in the UK electricity market

By Amy Mount and Dustin Benton

Summary

The UK risks having to pay for at least eight new power stations because it is failing to harness its huge potential for saving electricity. The UK electricity market would save over £2 billion by 2025 if power stations were made to compete against electricity saving, which is disadvantaged by current rules and financial incentives.

Current market biases create a perverse effect: the UK pays to keep polluting coal-fired power stations in operation, via the capacity market, and then pays again for low carbon technology to displace them, via contracts for difference for low carbon power. Demand side response, which temporarily brings down power demand at peak times, would reduce the need for coal-fired power stations dramatically if it were given fair access to the capacity mechanism.

Similarly, negawatts, delivered via permanent electricity demand reduction measures, are available at £30 per MWh, and can compete with new power stations, which cost a minimum of £76 per MWh.

We propose a new strategy for electricity markets that responds to technological change, removes the policy bias toward supply side options and holds consumer bills in check. It would create competition between cheap, easily implemented demand side measures and more expensive new power stations. The core of this strategy is the creation of incentives, enabling companies to aggregate energy efficiency measures and compete to deliver them on the most cost effective basis.

In practice, this would require two changes to the electricity market:

- **A negawatts feed-in tariff**, paid on the basis of avoided energy consumption, with recipients competing in an auction to deliver energy savings in homes and businesses at lowest cost. This would keep the UK on the least cost, long

"The UK electricity market would save over £2 billion by 2025 if power stations were made to compete against electricity saving."

term decarbonisation trajectory by reducing electricity demand by 6.4 GW by 2030, equivalent to the capacity of eight 800 MW combined cycle gas turbine power stations. We calculate that the ensuing investment in electricity demand reduction alone could yield net savings to British consumers of £2.4 billion by 2025.

- Opening the capacity market to competition from demand-side response and energy demand reduction on an equal basis with electricity generation. This could bring forward 6 GW of additional load shifting and reduction by 2023, covering most of the coal capacity deficit created by the prime minister's pledge to phase out unabated coal.

Introduction

"Businesses and consumers spend too much on electricity supply rather than investing in cheaper efficiency options."

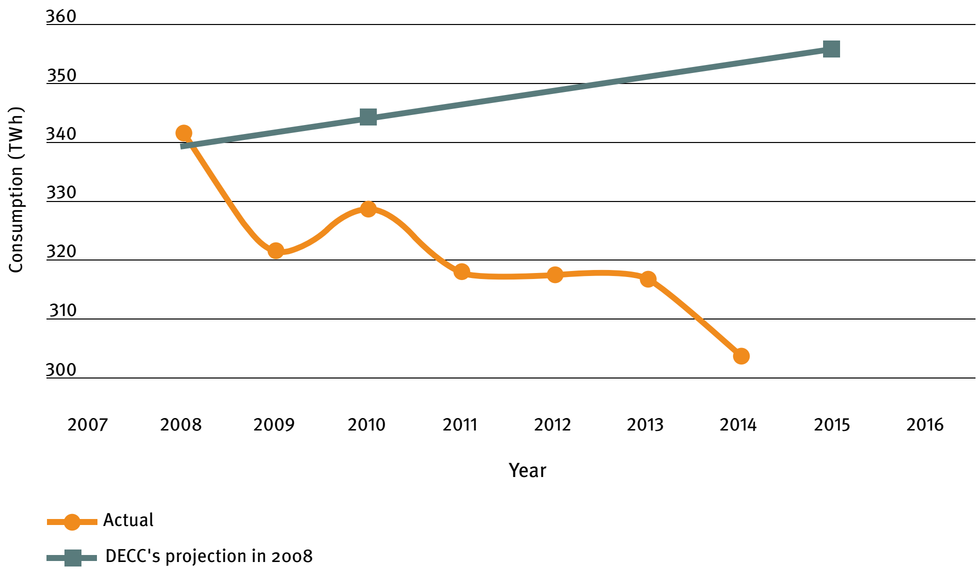
The UK's electricity market is hugely distorted in favour of supply side measures at the expense of cheaper demand side measures. This leads to an expensive misappropriation of resources. Businesses and consumers spend too much on electricity supply rather than investing in cheaper efficiency options. Meanwhile, most of the services provided by electricity efficiency are still not paid for; they remain externalised and, therefore, under supplied.

Add to this the significant, and well known, barriers to efficiency and the reasons for the lack of uptake of demand side measures become clear: upfront cost, hassle and disruption of building work, the low priority that consumers give to energy issues, lack of reliable advice at point of installation, and the current poor integration of the supply chain all require sensitively designed policy to create a level playing field.[1] For businesses in particular, the problem is not access to finance, but competition with other investment priorities. Energy efficiency does not have a strong enough business case at the moment.[2]

Efficiency policies such as the Ecodesign Directive, introduced in 2008, have already had an impact: they help to explain the 11 per cent reduction in UK electricity consumption between 2008 and 2014.[3] It would have taken nearly one and a half Drax power stations to generate this amount of electricity.[4] This reduction in electricity demand is equivalent to 16.8 million tonnes of CO_2 emissions.[5]

Actual consumption is the opposite of what the Department for Energy and Climate Change (DECC) projected in 2008, as illustrated below. The initial drop in 2008 can be attributed to the recession brought on by the financial crisis, but, since then, growth and electricity consumption have been decoupling due in large part to efficiency improvements.[6]

UK electricity consumption, 2008-14[7]



However, progress on improving the efficiency of buildings and appliances, which had been moving on apace since 2008, is now slowing.[8]

Current policy flaws

"A better deal for consumers would be assured if demand side measures were allowed to compete on equal terms with supply."

The UK has two mechanisms to enable demand side response (DSR) and electricity demand reduction (EDR) to compete to increase energy security and reduce the cost of decarbonisation, but both are severely flawed.

The first mechanism is the capacity market, which provides payments for guaranteed sources of electricity capacity, to ensure security of supply.[9] DSR is allowed to compete in the capacity market, increasing the grid's capacity margin by reducing load at times of peak demand. The first capacity auction was held in December 2014, to secure capacity for delivery in 2018-19. Further auctions will be held on an annual basis.[10]

Running parallel to the capacity market is the electricity demand reduction pilot, which is designed to test whether EDR could one day participate in the capacity market alongside electricity supply and DSR. The pilot is a two-year programme; the first EDR pilot auction took place in January 2015 and the second will take place in January 2016.[11]

Three weaknesses

Three weaknesses are inherent in both of these approaches to incentivising negawatts: 1) asymmetrical additionality requirements; 2) shorter term contracts; and 3) limited potential for new market entrants. These weaknesses, which we discuss in more detail below, distort the market in favour of the supply side.

A better deal for consumers would be assured if demand side measures were allowed to compete on equal terms with supply, because the former are a cheaper way of both providing capacity and decarbonising the power sector.

1. Asymmetrical additionality requirements

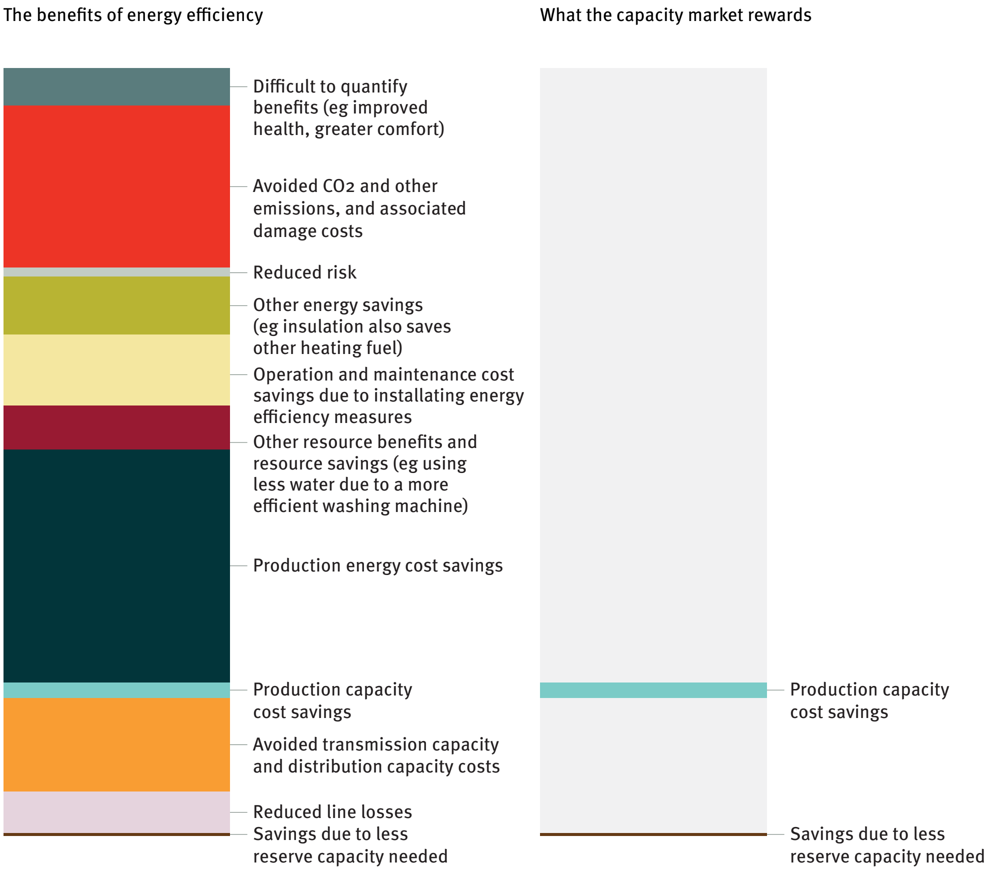
Negawatts provide multiple economic and social benefits, quantified in the diagram opposite. The value of these benefits is equivalent to £130 per MWh, far greater than the cost of the negawatts, at £30 per MWh.[12] In a perfect market, negawatts would claim rewards for each one of those benefits. But the capacity market and the EDR pilot only reward a small portion: those that relate to keeping the lights on during times of peak electricity demand. EDR measures should be able to access additional incentives from other policies with other aims, to pay for the other services that EDR provides.

Yet measures are not eligible to participate in the EDR pilot if they benefit from other government incentives, such as Climate Change Agreements and Salix loans.[13] This effectively excludes a lot of electricity intensive companies, with their potential for large savings.

In the UK, the additionality requirement hampers uptake. In contrast, in US electricity efficiency markets, co-ordinated by PJM and ISO-NE, projects only have to prove that they will reduce peak demand; that's what the capacity payment pays for. The evidence from the US is that negawatts out compete power stations on price, when they are treated equally with generation, and can access multiple sources of funding.[14]

Another aspect of the additionality requirement biases the capacity market in favour of supply side measures. In the UK capacity market, coal plants such as Cottam and West Burton, which won three year contracts in the 2014 auction, did not have to prove they would close without the capacity payment. The regulators also did not ask for any demonstration that capacity payments were required for peaking services which they are already incentivised to provide via higher electricity prices.

The benefits from electricity efficiency, and how much the capacity market rewards[15]



"If DSR were allowed to compete on equal terms, it would save bill payers up to £359 million in the first year alone."

2. Shorter term contracts

In both the capacity market and the EDR pilot, demand side measures are disadvantaged by shorter term contracts than those available to supply side measures.

New power plants are eligible to win 15 year contracts in the capacity auction and power plant retrofits can receive three year contracts. However, DSR is only eligible for one year contracts. Evidence presented to parliament's Energy and Climate Change Committee suggests that, if DSR were allowed to compete on equal terms, it would save bill payers up to £359 million in the first year alone.[16]

Similarly, EDR measures are restricted to one year contracts in the pilot. This deters potential participants whose proposed measures have multi-year payback times. It also discourages participation from new entrants who need longer term agreements to apply for credit and expand their businesses.

The disparity between contract lengths creates a risk for bill payers, because EDR and DSR measures cannot compete with new generation beyond one year into the future. In 15 years' time, EDR and DSR measures may be available to provide the same amount of capacity at lower cost than a new gas plant, for example. But demand side measures have no way of competing to deliver that future capacity. This is an open goal for the gas plant.

3. Limited potential for new market entrants

Neither of the currently available incentive mechanisms is likely to do much to encourage the enormous technical potential for energy savings that the UK possesses. A conservative estimate suggests EDR measures could reduce electricity demand by 38.6TWh by 2030, equivalent to eight new 800 MW gas plants.[17] But the capacity market, despite the small pilot scheme for EDR, is not enough of an opportunity to stimulate new market entrants on a large scale. Participating in any of the current schemes is highly complex; this not only deters existing market actors but also holds back potential new entrants.

The need for a holistic strategy

Rather than continuing to bolt ad hoc efficiency components onto existing programmes, a holistic strategy for delivering energy efficiency is required to realise the significant potential for cost savings and carbon reduction. Current policy is based on the mistaken assumption that energy efficiency's cost effectiveness is sufficient to motivate individuals and businesses to act.

But, as EEF makes clear, even in large businesses "efficiency improvements are competing for management attention with other potential investments that also have powerful business cases, often in groups looking to allocate investment between different countries as well as different priorities. Energy costs make up less than five percent of overheads for three quarters of companies; something more than price is needed to bring energy to the attention of those business leaders."[18]

Instead, a well designed strategy would enable innovative companies to develop new business models that aggregate the delivery of energy efficiency measures, and compete with power stations to deliver the energy services consumers want on the most cost effective basis. Aggregators, enabled to profit from selling negawatts in a market framework, would actively seek out efficiency opportunities from households and businesses.

A strategy to deliver negawatts could rest on the following two policies, outlined below:

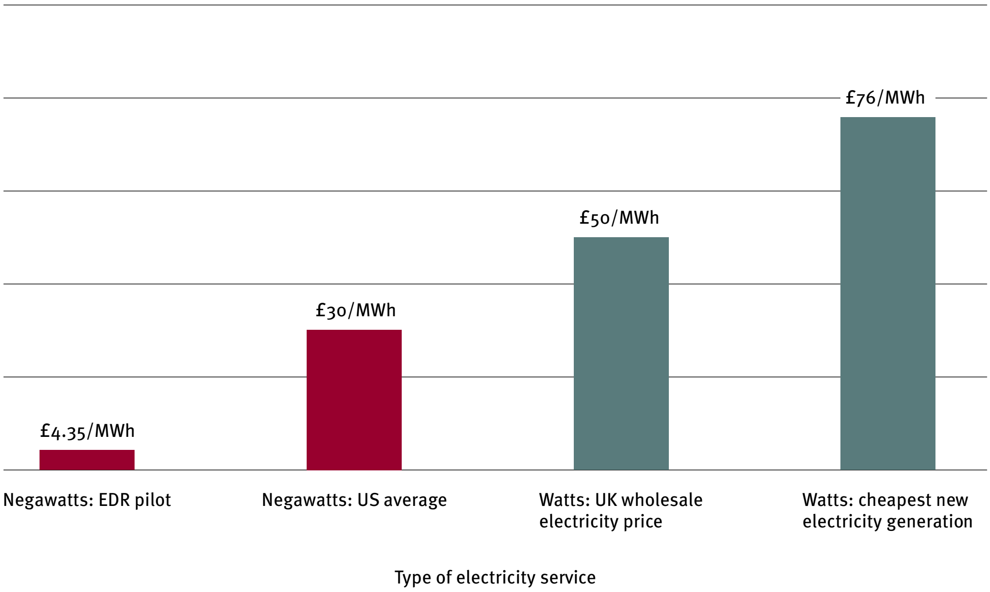
- **Introduce an energy efficiency feed-in tariff** to keep the UK on a least cost, long term decarbonisation trajectory
- **Level the capacity market playing field** to protect security of supply

1. Introduce an energy efficiency feed-in tariff

Paying for efficiency savings is a far cheaper way of securing energy services such as warmth and light, than paying for electricity generation or burning fuels. Yet, due to the market distortions discussed above, efficiency measures are structurally under supplied in the UK.

Electricity savings, for example, are much cheaper than the cheapest form of new electricity generation, as well as being cheaper than the wholesale electricity price. A survey of 20 efficiency programmes in the US found the average cost of negawatts was around £30 per MWh.[19] The small quantity of negawatts obtained in the UK's EDR pilot auction, almost all through lighting efficiency measures, have cost as little as £4.35 per MWh.[20] In comparison, new combined cycle gas turbine (CCGT) power plants cost in the region of £76 per MWh, and the UK wholesale electricity price fluctuated between £48-£52 per MWh during 2014.[21,22]

The cost of watts and negawatts compared



In the US, the mechanisms used to incentivise negawatts have been successful because they have enabled efficiency aggregators to operate at scale and flexibly deploy innovative technology. Similar conditions for success in the UK could be created by a feed-in tariff (FiT) to enable electricity efficiency to compete with low carbon supply to deliver decarbonisation.

How an electricity efficiency feed-in tariff could work

An efficiency FiT could pay for electricity savings across sectors, including households, local authorities and businesses. This would create business opportunities for companies that aggregate individual small savings and lower the cost of installing efficiency measures, through streamlining the process, delivering at scale, and concentrating the necessary administrative and energy efficiency knowledge. More importantly, by paying per avoided kWh, aggregators would have a simple business model, enabling them to focus their efforts on finding and deploying efficiency, rather than on complicated schemes to finance efficiency.

DECC is understandably wary of FiTs, because in existing models the amount of money spent depends on consumer uptake. With solar FiTs, for example, the policy cost is demand led, and there is no easy way for DECC to cap spending.

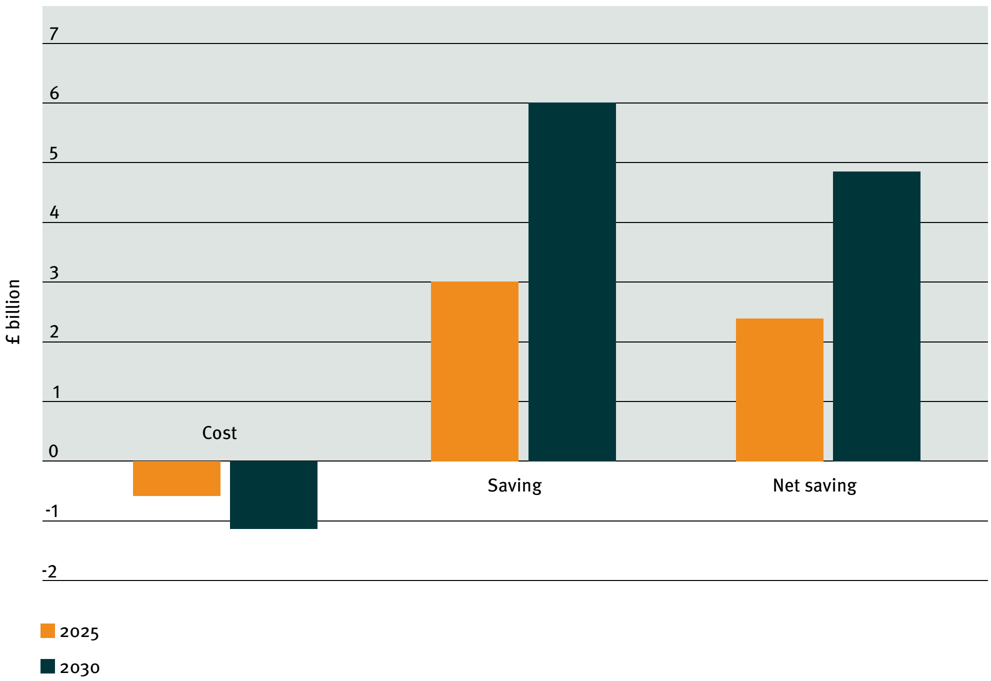
But we can learn lessons, both from the EDR pilot and from the way the contracts for difference (CfD) auction has been implemented. The concern about runaway spending can be resolved using the same approach that DECC has used for renewables funding in its shift from the Renewables Obligation to CfDs: by introducing an auction mechanism. Each EDR auction participant would bid for funding for a stated amount of electricity savings, as with the EDR pilot. That way, the amount of money available for efficiency measures is capped, reducing any risk of overspending.

Including electricity efficiency would dramatically improve the LCF's cost effectiveness

An electricity efficiency FiT would require extra spending under the next levy control framework (LCF), but this investment would more than pay for itself.[23] To pay for the full potential of electricity efficiency measures, the size of the LCF would need to increase by an estimated £1.1 billion by 2030.[24] However, because this spending is an investment that reduces the need to purchase electricity, the net impact on bills would be a huge reduction. Electricity bills would fall by £4.8 billion.[25]

The Committee on Climate Change recommends that the LCF should be set at £9 billion in 2025 (although this does not account for any projected overspend before 2020).[26] If we make the conservative assumption that, of the potential savings by 2030, an electricity efficiency FiT results in just half being realised by 2025, that still represents a net saving of £2.4 billion off consumer bills by that time. That takes the net impact of the LCF to only £6.6 billion on consumer bills in 2025. This would dramatically improve the cost effectiveness of the UK's decarbonisation pathway, without having to restrict the capacity of the LCF to incentivise investment in low carbon generation.[27]

Consumer bill savings from an electricity efficiency FiT



Getting more out of the FiT

This measure could be further enhanced in at least two ways. One change could be to use it to incentivise heat savings as well as electricity savings, if two separate tariff auction pots are established. A FiT that paid for electricity and heating savings would reduce the complexity that comes with having different policies.

A single tariff mechanism would enable aggregators to offer whole building packages, avoiding the inefficiency of incremental schemes which incentivise installers to install measures in stages, the cheapest first, and then the second cheapest, and so on. So they might visit the same property several times, each time to install a slightly more expensive measure. If heat and electricity efficiency measures were incentivised through the same mechanism, aggregators would find it more cost effective to install different measures in a building on a single visit. This would improve the cost effectiveness of decarbonisation over time.

The tariff for heat savings would be cheaper, because measures to save heat often cost less than those to save electricity. However, the net financial benefits would also be smaller, because the avoided costs of additional gas consumption are lower than the avoided costs of additional electricity consumption.

A second adaptation would be to provide a higher tariff for measures installed in fuel poor households. This option, which has already been deployed successfully in the US, would incentivise aggregators to target benefits towards the most vulnerable consumers.[28] This could form part of a broader social policy effort to tackle fuel poverty.

2. Level the capacity market playing field

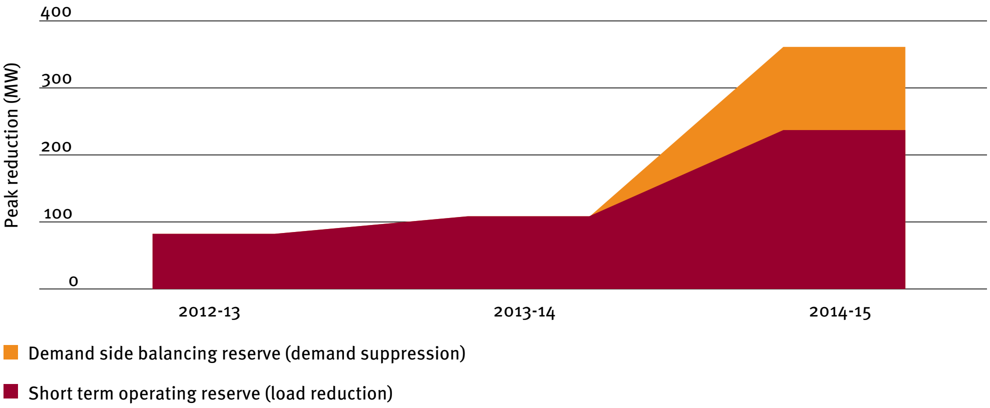
The UK has enormous technical potential to reduce demand for electricity at peak times, both via EDR measures that reduce electricity use all the time and by DSR, which reduces electricity use at peak times only through load reduction or storage. Together, these can keep the lights on without needing to build expensive new power stations, or pay old coal power stations to stay on the system.

A conservative estimate shows that 'generating' EDR negawatts could reduce peak load by 6.4 GW in 2030, equivalent to the capacity of eight 800 MW CCGT power stations.

That is good news for consumer bills, because it would avoid £3.9 billion in capital costs and there would be additional savings from avoided operation costs and deferred investment in transmission and distribution infrastructure.[29]

DSR is equally promising: it has grown four fold in two years, encouraged by new 'Demand Side Balancing Reserve' (DSBR) auctions, demonstrating that it can scale up much faster than new power stations.

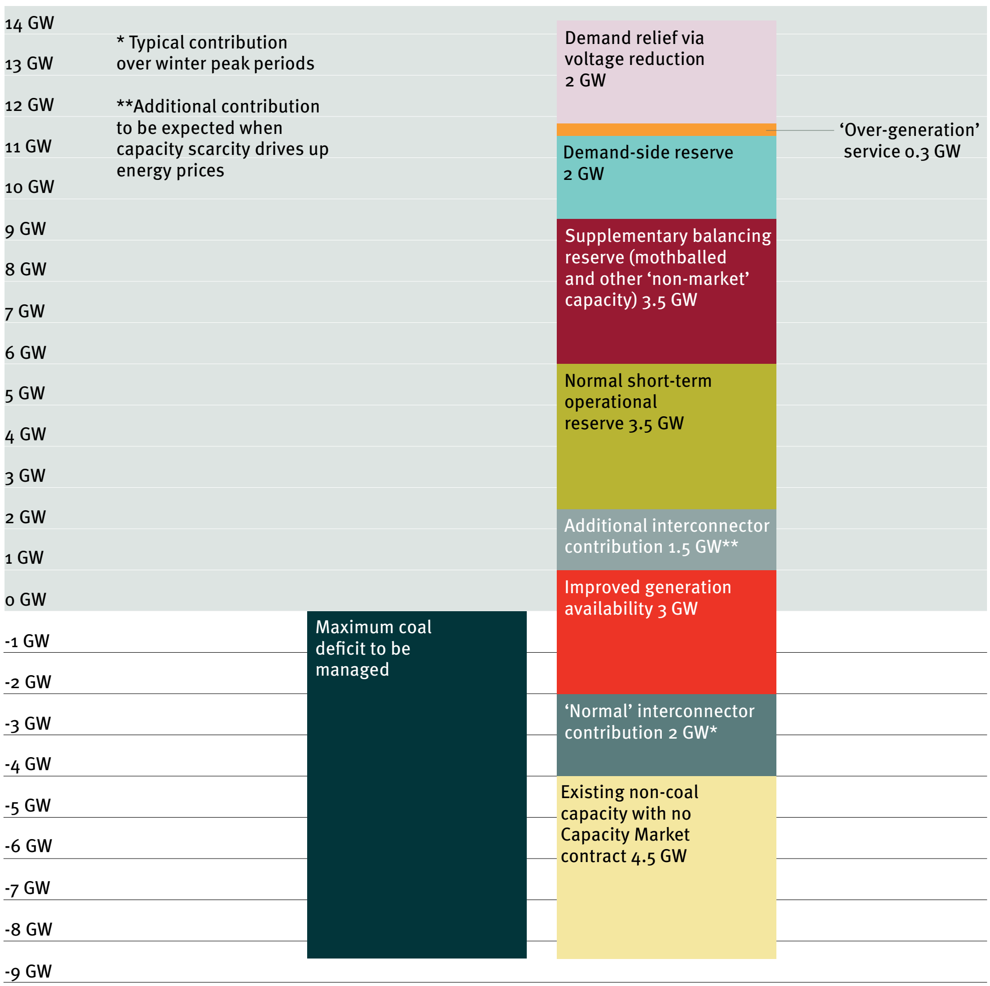
Growth in demand side response since 2012[30]



DSR is already a proven means of keeping the lights on. In the PJM market on the east coast of the United States, a market with three times the electricity demand of the UK, 15 GW, or nine per cent of total capacity in 2015-16, will be provided by DSR.[31] Demand response kept the lights on during last year's 'polar vortex' in the US, when old coal power stations stopped because their coal stacks had frozen solid.[32] In New England, negawatts and DSR have proved so reliable that the system operator was confident enough to avoid investing $260 million (£156 million) in grid upgrades.[33]

For the UK, there's a second benefit: the ability to shut off old coal-fired power stations without risking the lights going out. Research from Trilemma UK shows that a combination of measures are available in an 'extreme shut down' scenario, in which coal plants give just two year's notice before closing, ie less time than that required to build new capacity. The available measures, including 2 GW of DSR, would more than cover the loss of the 8 GW of coal remaining on the UK grid.[34]

How the grid would currently cope with coal phase out[35]



Looking to the future, policy to enable both EDR and DSR to compete with generation could bring forward 6 GW of additional load shifting and reduction by 2023, covering most of the coal capacity deficit.[36] A comprehensive assessment of the technical potential for load shifting suggests that 18 GW of peak winter demand could have been shifted in 2010 across all sectors, suggesting much more load shifting could be brought forward if incentives are set appropriately.[37]

Increasing capacity with negawatts

Three policy changes would enable the demand side to increase the capacity of the electricity grid while reducing costs and emissions.

First, EDR and DSR both should be allowed to compete on the same basis as generation in the capacity market. This would mean that negawatts, like generation, could receive payments related to the electricity use they avoid and for the capacity that they provide during periods of system stress. Both EDR and DSR should be allowed to bid for contracts of the same length as generation, and not be required to meet asymmetric additionality requirements compared to new generation (which does not have to prove that it would not be built without capacity market payments). This is particularly important for new DSR entrants, who face start-up costs and may have payback periods beyond the one year contract period currently offered to DSR.

Second, capacity provided by negawatts and DSR should be despatched on an economic basis, rather than on a "last resort, after all other actions available in the market have been exhausted" basis as is the case with the large amount of new DSR brought forward by National Grid's DSBR programme.[38,39]

Third, changes to the capacity market need to make it simple and flexible for aggregators. Both EDR and DSR rely on new technology or new configurations of technology, and the capacity market should enable rather than stifle innovation. DECC has made several improvements to its EDR pilot: notably, it has changed some of the measuring and verification requirements, simplifying some and allowing more time for others; it has given more time to install measures; and it has allowed aggregators to leave 40 per cent of potential demand reduction mechanisms unspecified before delivery, giving room for new aggregators to be flexible in their deployment, as long as they deliver capacity when required. These should be incorporated across the capacity market, not just applied to the EDR pilot.

Conclusion

"This approach should form the basis of a new, long term, least cost decarbonisation strategy for the UK."

We have set out a two pronged approach that, if implemented, would carve out an explicit and robust role for the demand side in ensuring sufficient capacity, delivered cost effectively, for the UK's electricity market. Embedding energy efficiency in this way would significantly lower the costs of meeting the UK's legislated carbon budgets during the 2020s. It would improve our energy market's competitiveness. And it would boost energy security, by widening the capacity margin of the national electricity grid.

This approach would address the key shortcomings of current electricity efficiency policy, and should form the basis of a new, long term, least cost decarbonisation strategy for the UK. Finally, it would encourage the emergence of new business models, as companies take advantage of the opportunities for aggregating efficiency savings in UK homes and businesses.

Glossary

Energy efficiency This implies a reduction in the amount of energy required to deliver a given amount of goods or services. At the macroeconomic scale, improvements in energy efficiency can be described by the ratio of energy input to GDP output.

Electricity efficiency This is a subset of energy efficiency that refers specifically to electricity savings.

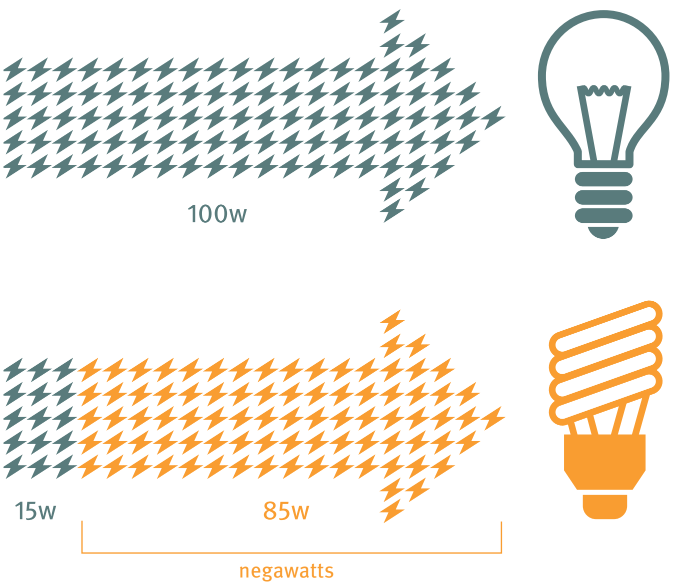
Demand side response (DSR) This does not reduce electricity use absolutely, but shifts demand away from peak times, thereby reducing pressure on the national grid. One example is giving industrial refrigerators an extra boost of power just before peak electricity demand time, so that they can then be turned off for a couple of hours.

Electricity demand reduction (EDR) This is the absolute reduction in electricity use, reducing the need for electricity generation in power plants. It has a role in reducing households' and businesses' electricity bills and carbon emissions. One example is replacing an old, inefficient washing machine with a more efficient model.

Negawatt This is a theoretical unit of power that refers to electricity saved rather than electricity generated. DSR and EDR measures both 'produce' negawatts.

What are negawatts?

Imagine a 15 watt lightbulb replacing a 100 watt bulb. The 85 watts saved can be used elsewhere: these are negawatts.



Endnotes

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2 EEF, 2015, *The low-carbon economy – moving from stick to carrot*, www.eef.org.uk/resources-and-knowledge/research-and-intelligence/industry-reports/the-low-carbon-economy-moving-from-stick-to-carrot

3 Committee on Climate Change, 2015, *Reducing emissions and preparing for climate change: 2015 progress report to parliament*

4 Based on 2014 Drax generation of 26.7TWh. Source: Drax Group PLC, 2015, *Preliminary results for the year ended 31 December 2014*.

5 Source: Committee on Climate Change. Based on 2014 UK emission intensity of 442.8g/kWh

6 I Kaminska, 2014, 'Energy is gradually decoupling from economic growth', *Financial Times*, http://ftalphaville.ft.com/2014/01/17/1745542/energy-is-gradually-decoupling-from-economic-growth/

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8 Committee on Climate Change, 2015, op cit

9 www.gov.uk/government/collections/electricity-market-reform-capacity-market

10 www.nationalgridconnecting.com/keeping-the-lights-on/

11 www.gov.uk/guidance/electricity-demand-reduction-pilot

12 Converted from 19 cents per kWh, exchange rate as of 1 October 2015. The average UK retail electricity price was 15.93p/kWh in 2014. Data source: www.ofgem.gov.uk/publications-and-updates/charts-outlook-costs-make-energy-bills#thumbchart-c5884043569676578-n87942

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20 Green Alliance calculations in £/MWh over a three year lifetime at 12 hours per day, based on EDR auction results and figures provided by DECC that assume lighting measures have a three year lifetime. £/MWh .

21 The most recent study from Bloomberg New Energy Finance identified a cost of $115/MWh for new CCGT, converted to £76/MWh, exchange rate as of 6 October 2015, www.prnewswire.com/news-releases/wind-and-solar-boost-cost-competitiveness-versus-fossil-fuels-300154606.html

22 ICIS, 6 January 2014, quoted in www.telegraph.co.uk/finance/personalfinance/energy-bills/11329893/Energy-prices-tumble-so-how-far-will-gas-and-electricity-bills-fall.html

23 The current LCF runs until the financial year 2020-21. The government has

indicated this will be followed by a second one.

[24] Today's prices; based on £29.63/MWh cost of installing energy efficiency measures.

[25] Today's prices; based on average retail price of electricity 15p/kWh in 2014. Data source: DECC, June 2015, *Quarterly energy prices,* tables Annex, Table 2.2.3, p 7, www.gov.uk/government/uploads/system/uploads/attachment_data/file/437336/QEP_Tables_Annex.pdf

[26] The Committee on Climate Change, in its 2015 progress report, op cit, recommends that the required support in 2025 is £9 billion, "support investment in an appropriate portfolio of low carbon options and provide the conditions for a competitive pipeline driving cost reduction" (p 63). This does not account for the LCF overspend that the Office for Budget Responsibility projects by 2020.

[27] Caveat: auctioning, while controlling policy cost, is likely to reduce the number of total measures installed, reducing the 38 TWh figure. So total LCF expenditure and also savings on bills likely to be lower than these potential numbers.

[28] See, for example, this Texan energy efficiency programme, targeted specifically at people on low incomes: www.aeptexas.com/save/residential/programs/TCC/TargetedLowIncomeProgram.aspx

[29] Green Alliance, 2014, op cit

[30] Data sources: www.ofgem.gov.uk/ofgem-publications/56997/national-grid-presentation-demand-side-response-event-autumn-2012.pdf; www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=30187; www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=37710; and www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=40910

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[33] Green Alliance, 2014, op cit

[34] 'Assessing the balance of risks associated with coal plant closure', February 2015, Trilemma UK for E3G, www.e3g.org/docs/Assessing_the_balance_of_risks_associated_with_coal_plant_closure.pdf

[35] Based on a graph from 'Assessing the balance of risks associated with coal plant closure', February 2015, Trilemma UK for E3G

[36] Based on 3.2 GW of permanent demand reduction (negawatts), 1 GW of household DSR and 2 GW of DSR from SMEs, derived from www.gov.uk/government/uploads/system/uploads/attachment_data/file/48551/5759-electricity-system-analysis--future-system-benefit.pdf

[37] S Hesmondhalgh et al, 2012, *GB electricity demand – 2010 and 2025: Initial Brattle electricity demand-side model – scope for demand reduction and flexible response,* www.sustainabilityfirst.org.uk/docs/2011/Sustainability%20First%20-%20GB%20Electricity%20Demand%20Project%20-%20Paper%202%20-%20GB%20Electricity%20Demand%202010%20and%202025%20-%202012.pdf

[38] Ofgem, 2014, *Funding arrangements for new balancing services: final proposals,* www.ofgem.gov.uk/ofgem-publications/86479/fundingarrangementsfornewbalancingservices-finalproposals.pdf

[39] National Grid is legally required to operate as the balancer of last resort, which is why it despatches DSR in this way. A better system would despatch DSR where it makes economic sense to do so.

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Green Alliance
Green Alliance is a charity and independent think tank, focused on ambitious leadership for the environment. With a track record of over 35 years, Green Alliance has worked with the most influential leaders from the NGO and business communities. Green Alliance's work generates new thinking and dialogue, and has increased political action and support for environmental solutions in the UK.

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