

# A NEW APPROACH TO ELECTRICITY MARKETS

HOW NEW, DISRUPTIVE  
TECHNOLOGIES CHANGE  
EVERYTHING

## REPORT

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**BOLD** IDEAS  
for CHANGE

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## Erratum

Page 35: an earlier version of this report suggested that Ofgem employed secondees from incumbent energy firms. This is not the case, and we are happy to correct the record.

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## SUMMARY

Tackling the policy trilemma of achieving an affordable, decarbonised and secure electricity supply is extremely challenging. The UK's current policy framework is faltering because it is propping up the large-scale, centralised utility business model, which is dying.

Rapid cost reductions and innovation are occurring in 'smart', distributed electricity technologies that disrupt how electricity systems traditionally operate and spell the end to the dominance of the large-scale utility business model. These technologies – including solar photovoltaics, onshore wind power, batteries, smart thermostats and appliances, and highly efficient lights – hold the key to a cheaper, cleaner, more competitive and secure electricity system, that works better for consumers.

A fundamental change in direction is required so that the innovative businesses and entrepreneurs developing these new technological solutions to the UK's energy challenges receive the backing of the government, rather than the incumbent utilities. This requires major reforms to energy regulation and policy to be implemented. It also requires reforms to the fundamental structures of the energy market and how it is regulated, in particular to enable the rapid development of a 'smart grid'. If this occurs, there is a bright future ahead for the UK's electricity sector.

### A new technological paradigm in electricity and the end of the reign of the large-scale utilities

Britain's existing electricity system was constructed around a centralised model dominated by large-scale fossil fuel power stations. Fossil fuel and nuclear power stations benefit from economies of scale and until recently this configuration was appropriate to keep down system costs. Distributed electricity technologies now challenge this logic.

- Solar power costs are falling rapidly and the technology is fundamentally transforming energy markets across the globe. Respected Wall Street brokerage firm Sanford Bernstein believes solar will 'become so large that eventually there will be consequences everywhere' and that solar will overthrow everything we take for granted within global energy politics within 'the better part of a decade'. By contrast, the impact 'fracking' will have on electricity markets in the UK pales in comparison.
- In countries such as Germany, Italy, Spain, Portugal, Australia and the US south-west solar-generated electricity without a subsidy is already as cheap as electricity provided via the grid, a level of costs referred to as 'grid parity'. Citibank recently projected that solar would reach grid parity in the UK by 2020.
- Developments in solar are supported by sharp cost reductions in high-tech batteries, which can store solar-generated electricity and enable it to be used when the sun isn't shining. Barclays estimates that solar and battery systems will reach grid parity for 20 per cent of US electricity consumers within four years.
- The cost of onshore wind power is also falling fast. It is approaching the average wholesale electricity price in Italy, Spain, China and the UK and is already competitive with fossil fuel generation in Brazil.
- Electricity generated by both onshore wind power and solar power, operating at small scales, is already substantially cheaper in the UK than electricity generated by offshore wind, which the government is prioritising.

Solar, onshore wind and other renewable technologies have highly disruptive impacts on the traditional operation of electricity systems because they have no marginal fuel costs. This means they will always be drawn upon when there is demand for power before fossil fuel power stations, which do have marginal fuel costs (that is for gas or coal), thus eroding the size of market that is available to the utilities.

The traditional electricity system and utility business models are further disrupted by distributed electricity technologies that adjust and reduce levels of demand for electricity.

The electricity system was designed so that the amount of electricity being supplied at any one time varies to match the amount of demand there is for electricity. Peaks in demand create major costs for the electricity system because the power stations that come online during these periods are the most expensive to operate. One estimate is that as much as 20 per cent of the total cost of providing electricity in a year in the US comes from 100 hours' worth of peak demand.

New smart technologies and energy efficiency technologies hold the potential to radically reduce the costs of running an electricity system by reducing peaks in demand. But by doing so they undermine the existing utility business model, which has traditionally relied on periods of peak demand to make money. Energy efficiency technologies, which have the added benefits of directly reducing consumers' bills and reducing the requirement to transport electricity, also reduce the total amount of electricity demand that is available for the utilities to supply.

- Smart electricity technologies integrate sophisticated digital and communication technologies into devices such as meters, thermostats, appliances and lights and enable real-time adjustments in how much electricity is being used. In the US these technologies have been shown to be capable of delivering a staggering 90 per cent reduction in the peak time electricity price.
- Smart technologies have been referred to as the 'killer app' for the electricity sector and have the potential to develop very rapidly. Some of the world's biggest technology companies, including Google and Apple, have made major investments in the smart energy technology sector.
- The costs of energy efficiency technologies are falling rapidly. Highly efficient light emitting diodes (LEDs) have reduced in cost by 85 per cent over the last five years.

Large-scale utilities across the world are facing financial difficulties because of the current and projected disruptive impacts of distributed electricity technologies that we have outlined.

- The value of Europe's top 20 utilities has been slashed in half over the last six years and their credit ratings have been downgraded.
- Barclays downgraded its bond credit rating for the entire US electric utility sector in May of this year on the basis of its predictions for solar and battery technology.
- Citibank projects that distributed electricity technologies will lead to a halving in the size of the market open to utilities over the next two decades. It has claimed that 'the rationale of the prevailing utility business model [is coming] under severe pressure and [could] potentially, ultimately, crumble'.

## A new approach to electricity markets

Developments in distributed electricity technologies should be strongly supported by the government because of the benefits they bring. They can make the operation of the electricity system far more efficient and reduce costs. They can unleash an entirely new wave of competition into the energy markets comprising businesses from technology start-ups to technology giants, as well as internet and



communication companies, and electrical appliance companies. They can also enable individuals, communities and local authorities to become active in the market and benefit from new income streams to offset rising energy bills, including by investing in generation.

Distributed electricity technologies should also be a priority area of focus for the government because of the disruptive impacts they have on the functioning of electricity systems and the risks these pose to the government's policies. We describe below how the disruptive impacts of these technologies are already impacting on the UK government's ability to raise *private sector* investment in the electricity sector.

As things stand, major reforms are needed to address a prevailing bias that exists across energy regulation and policy towards the large-scale utility business model. Only by enacting these reforms can the electricity system be adapted to the new distributed electricity technology paradigm.

### Breaking the grip of the 'Big Six'

The first stage of reform is to comprehensively address barriers to entry which restrict competition to the dominant 'Big Six' from the challenger companies that can build new business models around distributed electricity technologies. This report highlights two barriers to entry that Ofgem has failed comprehensively to address despite being aware of these issues for six years. We also highlight how regulations that Ofgem has recently introduced could detrimentally impact on the deployment of distributed electricity technologies by restricting innovation in tariffs.

- Each of the Big Six retains a legacy of large numbers of price insensitive ('sticky') customers from their time as monopoly suppliers before the energy markets were liberalised. Since 2008 Ofgem has been aware that the Big Six have taken advantage of the stickiness of their legacy customers by charging them more than new customers. This has given the companies the opportunity to cross-subsidise discounts for new customers and undercut competition from challenger companies. Despite Ofgem's attention to this issue, the amount legacy gas customers were overcharged almost trebled from £20 to just under £60 from 2010 to 2013. Legacy electricity customers have been overcharged by around £34 since 2011. To illustrate this: British Gas could be earning in the region of £637 million more per year selling gas to its legacy customers than would be the case if other suppliers sold them the same amount of gas.
- Each of the Big Six has a vertically integrated business model in electricity, operating in both supply and generation. This pattern emerged after the wholesale market trading arrangements were reformed in 2001. The pool model for trading that previously existed was replaced by the current system in which bilateral trades can occur between generators and suppliers. For many years, there have been widespread concerns that the current trading arrangements and pattern of vertical integration have a detrimental impact on competition. This includes how 'self-supplying' by the Big Six between their supply and generation arms can lead to poor liquidity in the wholesale markets, which acts as a barrier to entry and growth for independent suppliers and generators. This was identified as a problem by the Treasury and the Department of Energy and Climate Change back in 2010. Given this context, it was striking that Ofgem stated in its *State of the Market Assessment*, published in March of this year, that it had an unresolved view on the costs and benefits of vertical integration. It is a damning indictment of Ofgem that it has not fully investigated the impacts of vertical integration and the bilateral trading arrangements as part of its efforts to improve competition in the energy markets.
- Through its Retail Market Review, Ofgem has introduced a range of regulations on the tariffs that suppliers can offer. The regulations are intended to simplify

information for consumers and increase the level of consumer engagement in the energy markets, which is currently low. However, these regulations are likely to restrict innovation in tariff offerings that could support the deployment of distributed electricity technologies, for example community tariffs linked to local renewable generation and an array of ‘smart’ tariffs that could incentivise households to adjust their energy usage away from peak periods. We believe a better approach for increasing consumer engagement which would not hamper tariff innovation is to regulate, and encourage development in, services that act as intermediaries for consumers in the energy market, such as switching websites.

It is welcome that the Competition and Markets Authority (CMA) has launched an investigation into the health of competition in the UK’s energy markets. The CMA must set out a comprehensive plan of action for tackling the barriers to entry that protect the market share of the Big Six and for removing the barriers to developments in distributed electricity technologies.

**Recommendation:** A new regulation should be introduced stipulating that the Big 6 will face an automatic fine every year at an order of magnitude higher (for example x10) than the amount they overcharge their legacy customers. Ultimately the companies should face the risk of having their licences revoked if they continue to overcharge their legacy customers.

**Recommendation:** The Competition and Markets Authority should carry out a full investigation into the potential to improve competition by restricting the Big Six from self-supplying between their generation and retail arms and introducing a new ‘pool’ system for wholesale energy trading.

**Recommendation:** The Competition and Markets Authority should review the tariff regulations introduced by Ofgem through its Retail Market Review and reform or remove them where they could restrict innovation in tariffs that support the deployment of distributed electricity technologies. The potential for regulating intermediary services, such as switching websites, as a way to increase consumer engagement in the energy market should be examined.

### Reforming policy to stop propping up the incumbents

The second area of reform should be to policies that have been recently introduced as part of the major package of Electricity Market Reforms. Specifically this should include the contracts for difference subsidy framework for encouraging private sector investment in low-carbon generation and the capacity market mechanism that is intended to maintain the security of the electricity system.

These policies are intended to achieve a decarbonised electricity system while keeping costs affordable and the electricity system secure. The government states that its approach with these policies is ‘technology neutral’, but this is not the case in practice. In fact the policies prioritise large-scale forms of energy generation (nuclear power, offshore wind, and fossil fuel generation) that are aligned with the increasingly redundant large-scale utility business model, over distributed electricity technologies. This report explains how, because of this ‘technology bias’, the policy framework is unnecessarily costly, limits competition, and risks undermining decarbonisation objectives.

- The ‘contracts for difference’ subsidy mechanism prioritises large-scale nuclear power and offshore wind developments over solar and small to medium-scale onshore wind, as well as other smaller generation technologies. This can be seen in how nuclear and offshore do not have to compete for contracts for subsidies while both solar power and wind power do have to compete. It is also evident in the unbalanced allocation of subsidies between the different technologies,



the complexity of the contracts themselves, which are best suited to large-scale developers, and in the low prioritisation given to the feed-in tariffs subsidy scheme for smaller technologies. Nuclear power and offshore wind are also the only low-carbon generation technologies to have dedicated industrial strategies.

- The effect of the government's focus on large-scale, low-carbon generation technologies, combined with the deteriorating financial health of the listed large-scale utilities, has been to encourage foreign state-backed energy companies to invest in the UK and reap the benefits of bill-levied subsidies. This undermines smaller-scale, domestic *private sector* investment. In 2012, 68 per cent of nuclear generation and 50 per cent of offshore wind generation in the UK was attributed to foreign governments. This is in stark contrast to Germany where smaller technologies are the focus and around half (47 per cent) of renewable power is owned by individuals and communities while energy companies own just 12 per cent.
- The government's 'capacity market' mechanism is intended to maintain the security of the electricity system as deployment of low-carbon technologies increases by providing payments to providers of reliable capacity. But the system that has been designed for allocating payments favours capacity from fossil fuel generation over smart distributed electricity technologies that would provide a cheaper option by reducing peaks in demand and increasing the efficiency of electricity usage. Indeed, highly polluting coal-fired power stations are likely to receive large payments through the capacity market.

In sum, the current policy framework encourages the shift into low-carbon energy production, but still maintains the increasingly defunct large-scale, centralised supply model for the electricity system (with a combination of fossil fuel and low-carbon technologies rather than just fossil fuel technologies).

Even with the rise of distributed electricity technologies, large-scale low-carbon generation technologies will continue to play a central role in the UK's electricity sector and efforts to encourage investment in these technologies should not be abandoned. However, now that the disruptive impact of distributed electricity technologies on electricity systems is clear, and the end of the reign of the large-scale utility business model is in sight, the government must respond and adapt its approach. Promoting smart, distributed electricity technologies must become a central element of the government's approach to tackling the energy policy 'trilemma'.

**Recommendation:** The government should acknowledge that the nature of electricity technologies is now so diverse that it is impossible to adopt a technology-neutral approach with its policies. Instead, the government is going to be the arbiter of which technologies are prioritised for many years to come. Once this is accepted, the government must fundamentally reorient its approach so that the full range of distributed electricity technologies receives much greater priority in its policies.

In relation to support for low-carbon generation technologies this could include rebalancing the allocation of subsidies so that more is made available for distributed generation technologies. In addition, given the challenge that smaller developers face in getting support via the contracts for difference mechanism, consideration should be given to increasing the capacity threshold for the small-scale feed-in tariffs programme so that larger technologies are eligible (for example from the current maximum installation size of 5MW up to 15MW).

Particular attention should be given to the support that is given to solar. Government predictions for solar costs and solar deployment have consistently been overtaken by developments on the ground. This has led to the government focusing on how it can limit deployment of the technology rather than seeking to maximise its benefits. Instead of constantly playing catch up with solar, the

government should get ahead of the market and take action now to prepare for large-scale deployment of the technology.

**Recommendation:** The government must immediately begin work on a strategy for accommodating large-scale deployment of solar power into the electricity system so that Britain is not prevented from capturing the benefits this technology has to offer.

The capacity market could have been an effective instrument for supporting smart technologies and energy efficiency technologies but it will not sufficiently capture these benefits because it has been designed to focus on generation capacity. This will have led to unnecessary costs. The government should move towards a 'system-wide' approach in how it develops policy so that demand and supply receive equal attention, which will require the Department of Energy and Climate Change to build its expertise in DETs.

**Recommendation:** The capacity market should be scrapped and new plans for maintaining system security should be drawn up from scratch. A new approach should be investigated that includes a fundamental review of the regulatory model for the networks (see below).

To support the deployment of smart technologies, alongside the development of smart meters, half-hourly settlement of electricity system balancing should be introduced for the residential sector as soon as possible. The option of introducing a feed-in tariff to support deployment of energy efficiency technologies should be reconsidered.

### Developing a 'smart grid'

The final focus of reform should be the fundamental market and regulatory structures that underpin the electricity system. The technological foundations on which these structures were established (that is where the centralised, large-scale fossil fuel supply model was the most cost efficient) no longer apply.

In particular, the regulatory model for the networks will need to be overhauled. The functioning of the electricity networks will need to be transformed to enable distributed electricity technologies to be integrated, through the development of what is commonly called a 'smart grid'. Part of the challenge is investing in the district (local) networks so that they can support these new technologies. As it stands, current investment plans for developing a smart grid set out by the district network operators and agreed by Ofgem are predicated on scenarios for deployment of distributed electricity technologies that are already substantially outdated. Indeed, Ofgem does not envisage making major steps towards a smart grid until the mid-2020s and 2030s, which is clearly out of step with the rapid advances occurring in distributed electricity technologies.

More fundamentally, there will need to be an increased focus on balancing supply and demand at a local level, in order to maintain the integrity of the system and reduce costs. This would help address the security of supply challenges the capacity market has been designed to address. Local balancing is not currently the responsibility of the regulated district network operators but arguably should become their responsibility.

The New York State electricity regulator is undertaking a wide-ranging review of the electricity market and regulatory arrangements in its jurisdiction to identify reforms that are required to adapt to the new distributed electricity technology paradigm. A similar approach could be adopted in the UK.

**Recommendation:** The government should launch a review into the existing model of network regulation to ascertain where reform is needed to unlock barriers to

deployment of distributed electricity technologies and accelerate the development of the smart grid.

The review should cover the ownership structures of the networks, the location of responsibility for system balancing, the location of responsibility for maintaining system security, and role of the regulator in relation to the networks. The way in which costs are allocated for grid balancing and for connecting new generation technologies to the network should also be reviewed to ensure they do not fall excessively on distributed electricity technologies.

Meanwhile, at the earliest opportunity, the government should require the network operators to significantly scale up their projections for the deployment of distributed electricity technologies so that they align with the increased priority placed on these technologies in policy.

## Conclusion

Developments in distributed electricity technologies give reason for great optimism. They provide an opportunity to increase radically competition in the energy markets and build new industries, while creating an affordable, decarbonised and secure energy system. But they are being held back by a bias that is evident across the UK's electricity system in favour of the large-scale utility business model. It is time to break with the past and embrace the bright new future that these technologies offer.

# INTRODUCTION: A NEW TECHNOLOGICAL PARADIGM IN ELECTRICITY MARKETS

From nationalisation in the 1940s until the mid-1980s there was a largely unquestioned political consensus that gas and electricity were natural monopolies and best kept in state ownership (Pearson and Watson 2012). In a 1982 speech Nigel Lawson, then energy secretary, challenged this paradigm, stating that it was not the proper role of the state to plan energy and that it should instead create a framework which allowed a market to operate with ‘a minimum of distortion’ from the state (Lawson 1982). His view was that private markets were more efficient and effective at delivering services than the state, and his speech marked the start of a movement towards privatisation and then later competition in the sector.

The process began in 1986 with the gas sector and the privatisation of the British Gas Corporation in what was then the biggest privatisation of a state company in British history. The privatisation of the electricity sector began in 1990, with the sale of the Regional Electricity Companies. By 1998 a fully liberalised model with competitive wholesale and retail markets and regulatory oversight was in place for gas and the same occurred for electricity by 1999. The networks were set up as regulated monopolies. Retail prices were originally subject to price controls but these were lifted in the early 2000s (Pearson and Watson 2012).

The market and regulatory structures that were constructed for the electricity system during the 1980s and 1990s adopted a centralised, supply-focused model, based around large-scale, predominantly fossil fuel, power stations. The large-scale, centralised utility business model that currently dominates in Britain developed alongside this model. Now, however, the era of the centralised electricity system model is coming to an end.

Rapid cost reductions and innovation are occurring in ‘smart’ distributed electricity technologies (DETs) that disrupt how electricity systems traditionally operate. These technologies – including solar photovoltaics, onshore wind power, batteries, smart thermostats and appliances, and highly efficient lights – hold the key to a cheaper, cleaner, more competitive and secure electricity system, that works better for consumers. They also spell the end to the dominance of the large-scale utility business model.

The central argument of this report is that the UK’s electricity system remains wedded to the large-scale, centralised utility business model, which is rapidly being made redundant. We argue that significant reforms are required across energy regulation and policy to adapt the electricity system to the new distributed electricity technology paradigm to enable these technologies to flourish. Moreover, we argue that without a change in approach the government’s policies could be significantly undermined.

Chapter 1 sets out the disruptive impacts that distributed electricity technologies have on the operation of electricity systems and the detrimental impact these technologies are already having on the financial health of utilities across the world. We then show the rapid developments that are occurring in three forms of distributed electricity technology: distributed generation (in particular solar PV), smart technologies and energy efficiency technologies. We explain why these developments should be welcomed because of the benefits they can bring for consumers.

Chapters 2 to 4 sets out reforms that are required to adapt the UK's electricity system to the new distributed electricity technology paradigm.

Chapter 2 focuses on reforms that are required to address barriers to entry which restrict competition to the dominant 'Big Six' from the challenger companies that can build new business models around distributed electricity technologies. This report highlights two barriers to entry that Ofgem has failed comprehensively to address. Specifically we look at how the Big Six overcharge their 'legacy customers' and problems that arise from the vertically integrated business models of the Big Six in electricity. We also highlight how regulations on tariffs that Ofgem has recently introduced could detrimentally impact the deployment of distributed electricity technologies by restricting innovation.

Chapter 3 reveals how two major policy interventions that have occurred in the electricity market as part of efforts to achieve an affordable, decarbonised and secure supply of electricity serve to prop up the large-scale, centralised utility business model. These are the 'contracts for difference' subsidy framework for low-carbon generation technologies, and the 'capacity market' that has been introduced to maintain system security. We show how each policy has underprioritised the role for distributed electricity technologies and identify risks that distributed electricity technologies pose to the government's policy objectives. We then set out a framework for a new policy approach and propose a number of policy reforms.

Chapter 4 looks at the current approach to developing a 'smart grid', which will be essential to support deployment of DETs. We consider whether a fundamental change to the regulatory model of the networks is required to accelerate the development of a smart grid.

Policy recommendations are provided throughout the report and summarised in the report's conclusion.

# 1. THE RISE OF DISTRIBUTED ELECTRICITY TECHNOLOGIES AND THE END OF THE REIGN OF THE LARGE-SCALE UTILITIES

Over the last six years, the value of Europe's top 20 utilities has been slashed in half. Over a similar time period, the credit ratings of utilities have been downgraded (see figure 1.1). Barclays downgraded its bond credit rating for the entire US electric utility sector in May of this year (Aneiro 2014).

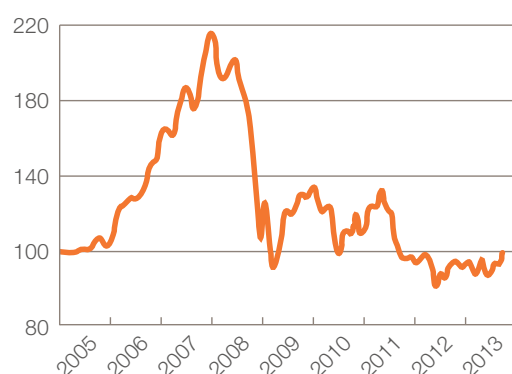
These developments have occurred as the revenues of the large-scale utilities have been hit by increasing deployment of distributed electricity technologies (DETs), and the financial sector has become increasingly aware of the existential threat these technologies pose to the large-scale utility business model.

Citibank has claimed that 'the rationale of the prevailing utility business model [is coming] under severe pressure and [could] potentially, ultimately, crumble' (Citi Research 2013: 18).

Analysts at the respected Wall Street brokerage firm Sanford Bernstein believe solar will 'become so large that eventually there will be consequences everywhere' and overthrow everything we take for granted within global energy politics within 'the better part of a decade' (Evans-Pritchard 2014a).

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**Figure 1.1**  
The falling value of European utilities



Source: Economist 2013

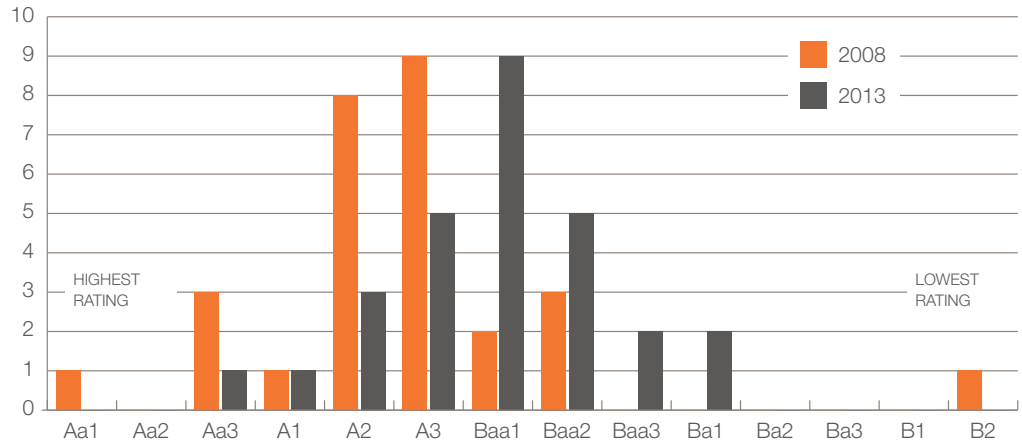
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Utilities are ill-equipped to prosper in the new DETs markets because the diversity of the technologies, their inherently small size and their non-centralised nature lend themselves to development by smaller and more nimble companies. The experience in other sectors is that incumbent companies rarely drive forward disruptive changes to their industry (Pollitt and Nilleson 2014).



**Figure 1.2**

Downwards revisions in utilities' credit ratings



Source: Citi Research 2013

Moreover, DETs operate in ways which fundamentally undermine the existing utility business model. The three forms of DET that are covered in this chapter all erode the size of market that is available to incumbent large-scale utilities whose businesses are based largely around fossil fuel power stations.

1. Distributed renewable generation technologies like solar and wind power have essentially zero marginal costs and, because of how the electricity system operates, will always be drawn upon when there is demand for power before fossil fuel power stations, which have marginal fuel costs (that is for gas or coal).
2. Smart technologies and energy efficiency technologies reduce peaks in electricity demand, which is where the utilities traditionally make their money.
3. Energy efficiency technologies also reduce overall energy usage and therefore the revenue available to utilities from selling energy at all times.

According to Citibank, developments in DETs will halve the size of market open to utilities over the next two decades (Citibank 2013).

While DETs are detrimental to the large-scale utilities, they should be strongly supported by the government because of the benefits they bring. They can make the operation of the electricity system far more efficient and reduce costs. They can unleash an entirely new wave of competition into the energy markets comprising businesses from technology start-ups to technology giants, as well as internet and communication companies, and electrical appliance companies. They can also enable individuals, communities and local authorities to become active in the market and benefit from new income streams to offset rising energy bills, including by investing in generation.

Below we set out the rapid developments occurring in three forms of DETs – distributed generation, smart technologies and energy efficiency technologies – and highlight the benefits these new technologies can bring.

### 1.1 Distributed generation technologies

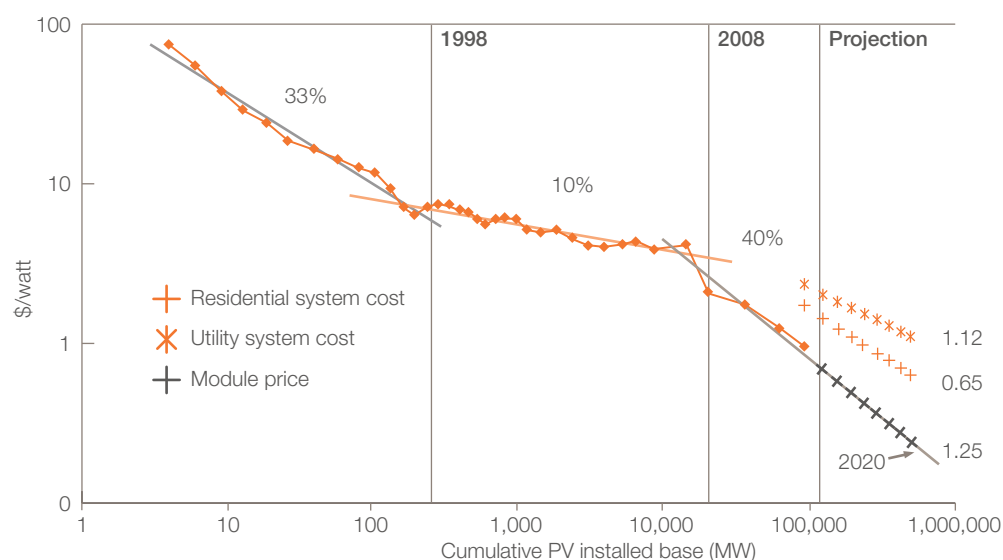
Since the advent of the modern electricity system, power has been generated by very large centralised power stations. Fossil fuel and nuclear power stations benefit from economies of scale and until recently this configuration was appropriate to keep down system costs. New distributed generation technologies challenge this logic.

The most disruptive distributed generation technology is solar PV. This is because the cost of solar PV has fallen incredibly quickly in recent years and these cost reductions are predicted to continue.

The learning rate for a technology refers to how its costs change for every doubling of installed capacity. Data from Citibank shows that solar PV has achieved an average learning rate of 22 per cent since the 1970s, and that the rate since 2008 has been around 40 per cent (see figure 1.3). According to Citibank (2013), ‘the rate at which the price of solar panels has reduced has exceeded all expectations’. In many countries the cost of solar-generated electricity is already equivalent to the cost of grid-supplied electricity without subsidies (referred to as having reached ‘grid parity’). This includes Germany, Italy, Spain, Portugal, Australia and the US south-west (Citi Research 2014).

Technological advances in solar PV technology will ensure that rapid cost reductions continue. The US National Renewable Energy Laboratory, for instance, claims scientists recently set a new world record for solar technology efficiency by capturing 31.1 per cent of the sun’s energy (Evans-Pritchard 2014a). According to Citibank: ‘The key point about the future is that these fast “learning rates” are likely to continue, meaning that the technology just keeps getting cheaper’ (Citibank 2013). British households could have access to solar electricity at grid parity as soon as 2020 (Citi Research 2014).

**Figure 1.3**  
The falling cost of ground-mounted solar PV generated electricity



Source: Citibank 2013  
Note: In recent years the learning rate has increased to 40 per cent.

The disruptive potential of solar is supported by advances in battery technologies that can enable solar-generated electricity to be stored.

Battery costs are falling at a rate of around 9 per cent a year (see figure 1.4). Continued cost reductions can be expected because batteries have a central role to play in both the electric vehicle sector and the electricity sector. Cost reductions are therefore an important focus for both industries and the US government’s 2008 stimulus invested heavily in developing the technology (Grunwald 2012). Currently, the California Self-Generation Incentive Program (SGIP) (Hoerner 2013)

and Germany's solar storage incentive (Bayar 2013) both provide up-front subsidies to support uptake of battery technology as part of their policies to support solar deployment. Leading international electric vehicle company Tesla intends to construct the world's largest battery factory, a 'gigafactory', that will bring down the costs of its battery packs by 30 per cent by 2017 (Tesla Motors 2014).

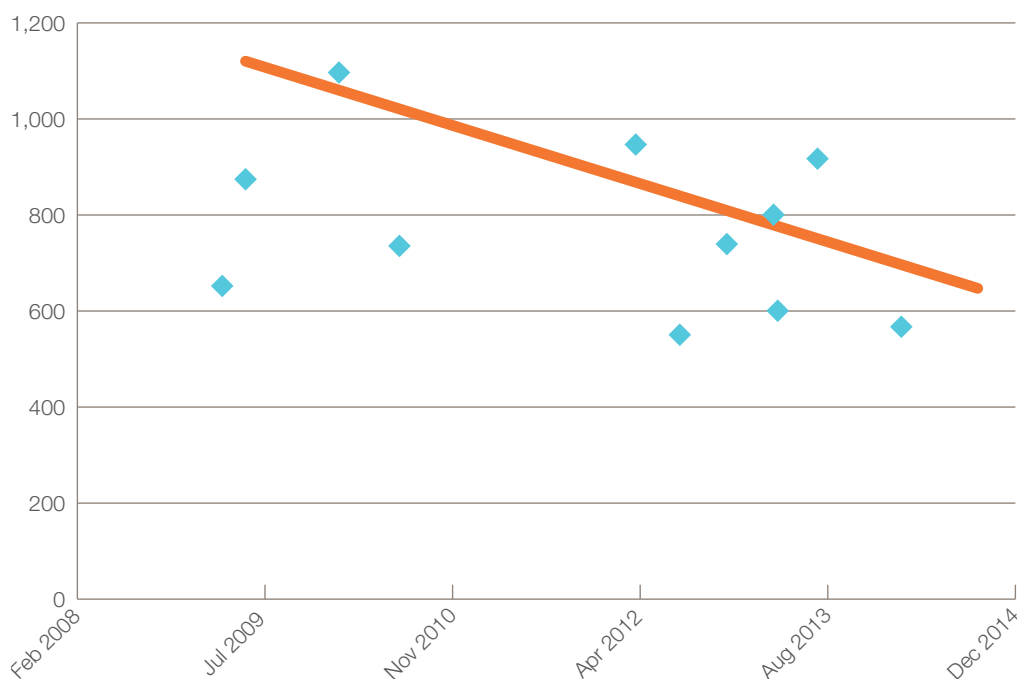
In some countries, solar and battery combinations on a property are approaching grid parity. Earlier this year, when downgrading its bond credit ratings for all US electric utilities, Barclays estimated that 20 per cent of US electricity consumers will be able to get power from solar and battery systems for the same price as they can from the grid by as early as 2018. Barclays concluded:

*'We believe that solar and storage could reconfigure the organization and regulation of the electric power business over the coming decade ... [There are] near-term risks to credit from regulators and utilities falling behind the solar and storage adoption curve.'*

Aneiro 2014

Compared to the disruptive impact of solar power, the fossil fuel extraction technique known as fracking will have a limited impact on electricity markets (see box). But solar is not the only generation technology challenging the cost effectiveness of the centralised electricity generation model.

**Figure 1.4**  
Falling battery costs (\$/kWh)



Source: Wile 2014

Onshore wind costs are now approaching the average wholesale electricity price in many countries including Italy, Spain, China and the UK. It has already surpassed the wholesale electricity price in Brazil. The cost of the technology has reduced at a rate of 7 per cent a year and industry analysts expect this rate of reduction to continue (ibid).

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### Solar, fracking and the worsening economics in the fossil fuel sector

Analysts at Sanford Bernstein believe developments in solar are creating a new order of 'global energy deflation' that must ineluctably erode the viability of oil, gas and the fossil fuel nexus over time (Evans-Pritchard (2014a)). Such a statement may come as a surprise given the high level of attention recently for the new technique for extracting previously 'hard to reach' shale gas and shale oil deposits, known as fracking.

Fracking has led to substantial reductions in energy costs for the US, which pioneered the use of the technology and has ideal conditions for its deployment. However, while fracking may be necessary in the UK to reduce gas imports, there is little hope of this experience being replicated because the price of gas is set on the international market (IEA 2012, BNEF 2013, EY 2013). Lord Stern, author of the review on the Economics of Climate Change, has branded claims that UK shale gas will reduce prices as 'baseless economics' (Bawden 2013).

In fact, fracking is arguably a signal of the worsening economics in the fossil fuel sector. Fracking would not have been developed if there was ample supply of 'easy to reach' or 'cheap' fuel deposits. In other areas of the fossil fuel industry, in particular oil, the cost of extracting new reserves is becoming increasingly expensive.

Spending on exploration and production of oil has radically increased over the past six years to a total of \$5.4 trillion over the period, but little has been shown for it, with production from conventional oil fields peaking in 2005 (Evans-Pritchard 2014b). According to Morgan Stanley, the biggest European oil groups (BP, Shell, Total, Statoil and Eni) spent \$161 billion on operations and dividends last year but generated \$121 billion in cash flow. The *Wall Street Journal* reported in January how total capital expenditure of Chevron, Exxon Mobil and Royal Dutch Shell grew to £70 billion in 2013, yet all three have experienced huge declines in production relative to cost as their budgets are stretched by the need to open new wells in challenging environments (Gilbert and Scheck 2014).

In addition to these mounting costs for exploration and extraction, the economics of the fossil fuel industry are being further damaged as awareness grows that many of their currently listed reserves are at risk of becoming 'stranded assets'. Analysis by Carbon Tracker has found that 60–80 per cent of coal, oil and gas reserves of publicly listed companies are unburnable if the world is to have a chance of achieving international commitments to keep the average temperature increase from climate change below 2°C (Carbon Tracker 2013). As analysts further recognise fossil fuel assets to be highly overvalued, there is risk of a collapse in their financial value.

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The increasing cost-effectiveness of distributed generation technologies should be strongly welcomed by the government. They lend themselves to a diverse mix of ownership because they have lower capital costs and require less technical expertise to construct and operate than larger technologies.

Consumers, communities, local authorities and businesses are among those who are well placed to invest in these technologies. This has been shown in Germany, where around half (47 per cent) of renewable power is owned by individuals and communities while energy companies own just 12 per cent (Morris 2013). The German experience shows that these groups can raise large sums of investment and they could make large contributions towards the UK's investment requirements in energy. This is particularly important given the financial troubles facing the large-scale utilities.

By supporting a diverse pattern of ownership, distributed generation can help to ensure that subsidies levied through energy bills are returned to communities, instead of going to large-scale utilities as is generally the case. The profile of who benefits from subsidies should be an important consideration for government policy. Survey evidence, carried out for the government and published in March 2014, shows that a large majority (81 per cent) of the public would support a renewable development if it provided some direct benefit to communities in which they are located (DECC 2014a: 24). Germany's pattern of renewable ownership is a central

reason why there is strong, cross-party support for renewable deployment in the country (Lockwood 2014). While lower-income groups may not have the capital to invest in projects, local authorities and communities interested in developing renewable projects tend to focus on sharing the benefits of their projects with low-income households, for example through the provision of local tariffs.

Diverse investment in generation could also help to increase low levels of engagement in the energy markets, which, as we discuss in chapter 2, undermines the effectiveness of competition. As the energy and climate change committee has said:

*'Local energy projects ... have the potential to broaden public understanding of energy issues, encouraging energy-conscious behaviour and greater engagement in carbon reduction activities at community level.'*

HOC 2013

## 1.2 'Smart' technologies

'Smart' electricity technologies integrate sophisticated digital and communication technologies into devices such as meters, thermostats, appliances and lights and enable real-time adjustments in how much electricity is being used. These technologies form part of the emerging 'internet of things', and have been referred to as the 'killer app' for the electricity system (Liebreich 2014). There is the potential for very rapid innovation in these technologies.

The smart energy technology sector is developing quickly and includes some of the world's largest technology companies:

- Nest, the developer of 'smart' home thermostats, which was founded by one of the designers of Apple's iPod, was recently acquired by Google for \$3.2 billion (£1.8 billion) (Warman 2014).
- LG and Samsung both announced earlier this year that a suite of their electrical white goods are to be internet enabled from 2014 (Warmerdam 2014): LG has already released fridges and ovens that can be controlled by text message (LG 2014) and Samsung, through its Smart Home initiative (Grobart 2014), will sell air conditioners, fridges and washing machines which can be controlled from smartphones and smartwatches (Bradshaw 2014).
- Apple recently unveiled HomeKit, which is a suite of tools to allow a range of smart devices to control third party smart-home gadgets (Kelion 2014).

Smart technologies bring an entirely new type of functionality to electricity systems. The level of demand for electricity and the amount being supplied must always match within an electricity system in order to maintain the reliability of the system and avoid interruptions in supply, including blackouts. To achieve this, the electricity market was designed so that the amount of power being supplied alters over time in relation to levels of demand, while demand was left largely unmanaged. By managing and adjusting levels of demand in real time, in a process referred to as demand response, smart technologies transform demand from being a passive to an active participant in the electricity market.

Smart technologies can also produce substantial economic benefits by reducing costly peaks in demand. But by doing so they also undermine the existing utility business model, which has traditionally relied on these peaks to make money.

Currently, when there is a peak in electricity demand there must be sufficient generating capacity online – operating power plants in other words – to service that demand. The power stations that come online at times of peak demand are the most expensive to operate. Because of how the electricity trading arrangements work, they set the market price for all of the other electricity generated at the time. As a result, periods of peak demand create huge costs for the electricity system.

It has been estimated that in the US as much as 20 per cent of the total cost of providing electricity in a year comes from just four days' worth (100 hours) of peak demand (NPR 2010). By reducing peaks in demand, these costs can be avoided and the amount of related electricity system infrastructure, including generation and transmission networks, can be reduced.

Smart technologies also have a central part to play in integrating renewable technologies, such as solar, into the electricity system. Smart technologies can adjust demand for electricity in accordance with the supply of renewable power at any given time, thus improving the productivity of these assets and helping to keep supply and demand in balance on the electricity system.

The potential of smart technologies is significant:

- Nest has claimed it has been able to deliver a 50 per cent reduction in cooling loads during peak times (Nest 2014b).
- PassivSystems, a British pioneer in the smart technology sector, claims that white goods deployed in UK homes within the next eight years will offer the potential of 45GWH of responsive demand (Calder 2014).
- Demand-side response has been used in the US to deliver a staggering 90 per cent cut in the peak time electricity price (RAP and ClientEarth 2014).

Smart technologies could produce substantial benefits for consumers. Widespread adoption of smart technologies, by adjusting electricity usage away from peak times, will reduce the overall costs of running the electricity system and therefore reduce all consumers' bills. Individual consumers who install smart technologies would also benefit directly by buying their electricity when prices are lower. In some instances consumers could even be paid to adjust when they use their electricity, in order to reduce peak loads on the system. This approach is being trialled in various locations in the US (see Nest 2014a).

### 1.3 Energy efficiency technologies

The third group of DETs that can produce significant benefits for consumers but have negative impacts on the existing utility business model are energy efficiency technologies.

Increasing the efficiency of energy usage is an important focus for governments across the world. In 2013 David Cameron set out an ambition for Britain to be 'the most energy efficient country in Europe' and acknowledged the economic importance of energy efficiency:

*'The economies in Europe that will prosper, are those that are the greenest and the most energy efficient ... And in a race for limited resources it is the energy efficient that will win that race ... Far from being a drag on growth, making our energy sources more sustainable, our energy consumption more efficient, and our economy more resilient to energy price shocks – those things are a vital part of the growth and wealth that we need.'*

Cameron 2013

Using energy more efficiently is essential to the 'smart' operation of electricity systems because it addresses each component of the energy policy 'trilemma'. It tackles affordability by reducing expenditure. It is generally the cheapest way to reduce carbon emissions. It contributes to security goals by reducing a country's reliance on imported fossil fuels. Because of these benefits, the International Energy Agency has argued that energy efficiency should be viewed as the 'world's first fuel' (IEA 2014). From the perspective of the utilities, however, energy efficiency is detrimental to their businesses.



Similarly to smart technologies, energy efficiency technologies reduce the peaks in demand where the utilities have traditionally made their money. In addition, energy efficiency technologies reduce levels of demand overall, thereby reducing the size of market that is open to the utilities.

The potential for increasing the efficiency of electricity usage in the UK is substantial. A study carried out for the government by consultants McKinsey (2012) estimated that there was the potential to reduce electricity usage by around 146 TWh, or 36 per cent of total demand, in 2030. Moreover, given the rapid technological developments occurring in this area, this is likely to be an underestimate of the real potential.

Highly efficient LEDs have reduced in cost by 85 per cent over the last five years (Hastings-Simon et al 2014). PassivSystems claims it can deliver an average 23 per cent saving on the cost of running a heat pump by adjusting heating controls in response to a household's behaviour and the weather (PassivSystems 2014). As Amory Lovins (2014), a global pioneer in demand reduction, has said: 'the low-hanging efficiency fruit keeps growing faster than it's harvested'.

We have shown that DETs are developing rapidly and bring with them disruptive impacts on the traditional utility business model. These technologies have the potential to create huge benefits for the UK and should be supported by the government. The first stage of reform to support these technologies is to address problems with competition in the energy markets.

## 2. BREAKING THE GRIP OF THE BIG SIX

Although the architects of the UK's liberalised energy markets accepted that some form of economic regulation would be required during the early-stage development of the markets, they believed the need for regulation would gradually wither away once competition was fully established (Pearson and Watson 2012).<sup>1</sup> Stephen Littlechild, the head of the first regulator under the new market arrangements, summed up this theory when he wrote:

*'Regulation is essentially the means of preventing the worst excesses of monopoly; it is not a substitute for competition. It is a means of "holding the fort" until competition arrives.'*

Littlechild 1983

This vision of competition developing to operate perfectly without the need for regulation has not been realised. Instead the markets have been persistently characterised by poorly functioning competition.

- In 2008 the energy markets regulator Ofgem carried out and published findings from the *Supply Probe* – its first comprehensive review revealing systemic problems with competition in the energy markets (Ofgem 2008).
- In 2010 the Treasury and the Department of Energy and Climate Change (DECC) published the *Energy Market Assessment* (HM Treasury 2010) identifying how problems with competition, particularly in the electricity market, would restrict government's ability to achieve energy security and decarbonisation objectives.
- In 2012 IPPR's *True cost of energy* report demonstrated a lack of efficiency savings and high profit margins by the dominant energy companies, providing further evidence of poor competition (Platt 2012).
- In 2014 Ofgem, the Office for Fair Trading and the Competition and Markets Authority (CMA) published the *State of the Market Assessment* and proposed that the CMA carry out a full investigation into the energy markets (Ofgem 2014a). This investigation is currently taking place and will be complete by the end of 2015.

At the centre of the problems that exist in the energy markets are the dominant 'Big Six' energy companies: British Gas, EDF, E.On, N-power, SSE and Scottish Power. Together they supply 94 per cent of domestic customers and own 70 per cent of all energy generation (ibid).

Unless these companies are able to implement major changes to their business models, their role in the energy sector will inevitably be diminished through the rise of distributed electricity technologies (DETs). However, the opportunities for challenger companies that can develop new business models around DETs and facilitate their integration into the energy system are restricted by barriers to entry that the Big Six enjoy.

Below we highlight two barriers to entry that Ofgem has failed comprehensively to address. Specifically, we look at how the Big Six overcharge their 'legacy'

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<sup>1</sup> This applies to the retail and wholesale markets but not the networks which were set up with a regulated pricing structure.

customers, and the impacts of their vertically integrated business models in electricity. We also highlight how regulations that Ofgem has recently introduced could detrimentally impact on the deployment of distributed electricity technologies by restricting innovation in tariffs.

It is welcome that the CMA is now investigating the energy markets. We set out reforms that should be introduced to support the development of DETs.

## 2.1 Barriers to entry that restrict competition to the Big Six

When the energy markets were privatised before being liberalised, 14 regional electricity monopoly suppliers and one national gas monopoly supplier were created. Through a number of divestments, mergers and acquisitions the market has consolidated into the Big Six companies that exist today.

The dominance of the Big Six can be traced back to their origins as regulated monopolies before the markets were opened to competition. The advantages they gained from their incumbency have been protected and extended through their vertically integrated business models in the electricity sector and the bilateral arrangements that exist for wholesale trading.

Each of the Big Six retains a legacy of large numbers of customers from their time as monopoly suppliers. In 2010 the old electricity monopoly suppliers (which include all of the Big Six apart from British Gas) had at least 64 per cent of the electricity market share, rising as high as 85 per cent, in their former monopoly regions (Labour Party 2014). British Gas, the former gas monopoly supplier, retained 40 per cent of the UK's gas customers nationwide (ibid). Similar evidence from the *State of the Market Assessment (2014)* showed that the incumbent suppliers held an average of 70 per cent of the market share in their former monopoly regions according to fuel type.

These 'legacy customers' are considered to be 'sticky' because they are price insensitive and have not switched to a different supplier despite the opportunity to do so. Vulnerable groups are particularly overrepresented among legacy customers (Platt et al 2014).

The Big Six have consistently taken advantage of the 'stickiness' of their legacy customers by charging them more than new customers.

- In 2013, the amount paid for gas by British Gas customers was on average £59 higher than for those who had switched to a different supplier for using the same amount of fuel (DECC 2014b).<sup>2</sup>
- Customers supplied by the company that used to be the monopoly electricity supplier in their area paid on average £32 more than customers who had switched to a different supplier (ibid).<sup>3</sup>

This pattern of overcharging has provided the Big Six with a substantial competitive advantage over new entrant energy companies that do not have legacy customers. For illustration, British Gas could be earning in the region of £637 million (DECC 2014c) more per year selling gas to their legacy customers compared to other suppliers selling the same amount of gas. By overcharging their legacy customers, the Big Six have had the opportunity to offer heavily discounted tariffs to customers who are actively looking to switch, thereby undercutting competition from new entrant companies (Platt 2012).

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2 Analysis based on DECC figures. Standard credit differential = £55. Direct debit differential = £75. Prepayment differential = £46.

3 Analysis based on DECC figures. Standard credit differential = £33. Direct debit differential = £31. Prepayment differential = £31.

The advantages enjoyed by the Big Six on account of their incumbency were extended when new electricity trading arrangements were introduced on 27 March 2001 (called the New Electricity Trading Arrangements or NETA), which promoted the pattern of vertical integration currently seen in the sector.

NETA replaced the pool model for trading that previously existed and enabled bilateral trades between generators and retailers. The result created a strong economic incentive for companies to merge and trade with themselves (Helm 2014). This enabled the companies to minimise the risk of high imbalance charges by balancing the level of customer demand at the retail end of the business with the amount of generation capacity that was owned.

For the companies, vertical integration produces cost benefits from economies of scale and reduced transaction costs. But from a market perspective, vertical integration combined with bilateral trading restricts competition, thereby reducing the pressure on the companies to pass these cost savings on to consumers (Helm 2014, Mitchell 2014a).

One problem is the practice of ‘self-supplying’ between the electricity generation and supply arms of each of the Big Six, which the Treasury and DECC identified as a key cause of poor liquidity in the wholesale markets in 2010 (HM Treasury 2010). Poor liquidity is a barrier to entry and growth for independent suppliers and generators because it restricts their potential to trade and limits the visibility of trades taking place in the market, which is required to provide a reference point on prices. Another problem is that the incentive on the Big Six to keep their generation and supply arms in balance limits the stimulus to grow (or reduce) their customer numbers. As this incentive applies to all the Big Six companies, there is little motivation but for the energy markets to remain in stasis.

## 2.2 Reforms to address the barriers to entry

Ofgem first identified the overcharging of legacy customers as a problem and raised concerns about the effects of vertical integration in 2008 (Ofgem 2008). Six years on and these issues have still not been comprehensively addressed.

Ofgem’s initial approach to tackling legacy customer overcharging was to place a new licensing obligation on suppliers. Introduced in 2009, licence code SLC25A stipulated that suppliers could not discriminate on the prices offered to different sets of customers without ‘objective’ justification as to why this discrimination was necessary. Despite its belief that SLC25A was effectively reducing pricing differentials between customers, Ofgem allowed this code to lapse in 2012 in the hope that suppliers would continue to act ‘in the spirit’ of the obligation when it was removed (Fletcher 2012). Ofgem’s claims were flawed on both counts.

First, figure 2.1 shows the average difference in the prices paid between legacy customers and customers who have switched since SLC25A was introduced (DECC 2014b).<sup>4</sup> While the ex-electricity monopoly suppliers, on aggregate, did reduce the difference in prices from 2009 to 2012 when licence code SLC25A was removed, British Gas did not. The amount legacy gas customers were overcharged almost trebled over this period, from £20 to just under £60.

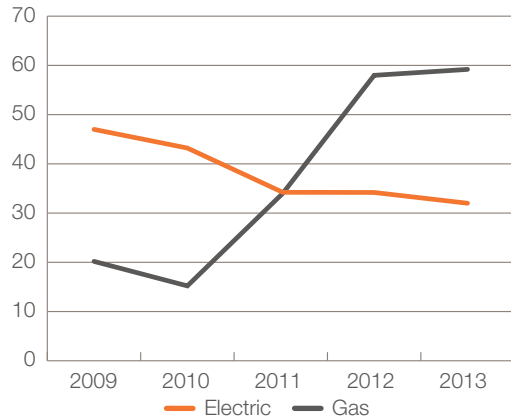
Second, in the year after SLC25A was removed (2012–13), the suppliers did not act ‘in the spirit’ of the licensing code as Ofgem hoped they would. There was only a marginal reduction in the amount legacy electricity customers were overcharged while the amount legacy gas customers were overcharged marginally *increased*.

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<sup>4</sup> Analysis based on DECC figures. Standard credit differential = £55. Direct debit differential = £75. Prepayment differential = £46.

**Figure 2.1**

Overcharging of 'legacy' gas and electricity customers over time



Source: IPPR analysis based on DECC 2014b

Ofgem should have taken stronger action to enforce SLC25A and it should not have been allowed to lapse in 2012. Ofgem has recently stipulated that customers who are currently on a tariff that is no longer available (called 'dead' tariffs), which could include many legacy customers, must be moved on to the cheapest available 'evergreen' tariff – that is a non-fixed-term tariff. This could help to address the overcharging of legacy customers but is unlikely to resolve the issue. Suppliers could continue to discriminate between their customers by offering a more expensive evergreen tariff in their ex-monopoly regions compared to other areas.

**Recommendation: A new regulation should be introduced stipulating that the Big Six will face an automatic fine every year at an order of magnitude higher (for example x10) than the amount they overcharge their legacy customers. Ultimately the companies should face the risk of having their licences revoked if they continue to overcharge their legacy customers.**

An approximation of the scale of overcharging can be produced using data that the government already collects. If the Big Six wish to contest these figures they should be required to open up their customer account data for investigation by the regulator.

Ofgem's failure to stop legacy customer overcharging has been compounded by its failure to tackle the problems that arise from vertical integration and bilateral wholesale trading in electricity. Ofgem revealed in the 2014 *State of the Market Assessment* that it had an unresolved view on the effects of vertical integration:

*'We have not attempted to weigh the costs against the benefits of vertical integration of electricity markets. Such an exercise would require a more detailed examination of the effects of vertical integration than has been possible in this assessment. Nevertheless we do not consider the benefits of vertical integration are so clear cut as to make this an unnecessary exercise. We also consider that the costs to retail competition in terms of the barriers to entry and expansion resulting from vertical integration may be significant – particularly in a market where competition is already weak.'*

Ofgem 2014a: 14

This is a striking revelation. There have been widespread concerns for many years that vertical integration combined with the bilateral trading arrangements have a detrimental impact on competition. It is therefore a damning indictment of Ofgem

that it has not fully investigated the impacts of these issues on the energy markets. In fact, Ofgem undertook a protracted process of policy development from 2008 to 2014 intended to identify reforms that could improve liquidity in the electricity (Ofgem 2014c). Since it is widely believed that the vertically integrated businesses of the Big Six are a cause of poor liquidity, as was the view of the Treasury and DECC in 2010 (HM Treasury 2010), a thorough investigation into the costs and benefits of vertical integration should have been carried out.

It is welcome that the CMA intends to assess the impact of vertical integration as part of its current investigation into the energy markets.

**Recommendation: The Competition and Markets Authority should investigate the potential to improve competition by restricting the Big Six from self-supplying between their generation and retail arms and introducing a new ‘pool’ system for wholesale energy trading.**

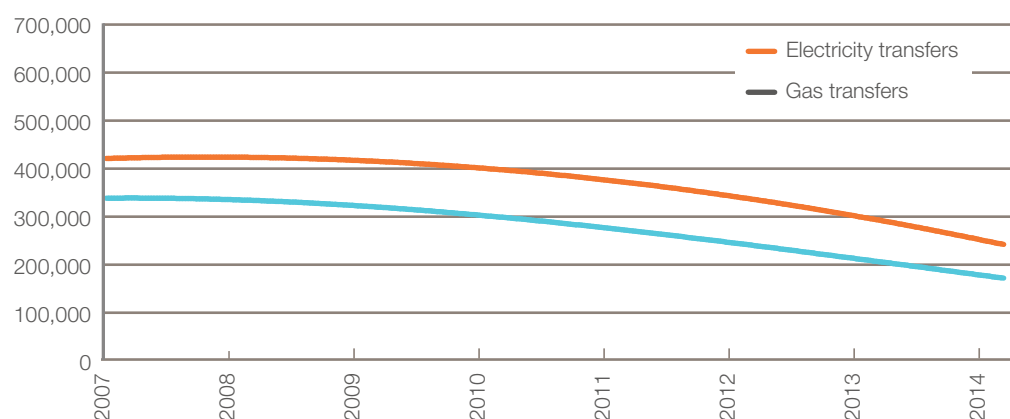
### 2.3 Increasing consumer engagement without restricting innovation

Ofgem’s approach to regulation has focused heavily on increasing consumer engagement in the energy markets. The liberalised model for the energy markets assumed that active participation by customers in the markets would drive competition and keep costs down (Mitchell et al 2014). In practice this has not occurred and Ofgem is therefore right to have taken steps to try and increase engagement. However, Ofgem’s approach is likely to restrict innovation in tariff offerings which would promote and enable integration of DETs into the energy system.

The average number of consumers that switch suppliers each year has remained relatively low since the liberalisation of the energy markets and has been declining in recent years. While approximately 19–22 per cent of the population switched supplier in 2006 (Consumer Focus 2013), the most recent switching rates are around 11–12 per cent of the population (Ofgem 2014a) (see figure 2.2). Switching rates did spike in autumn/winter 2013 but this was the result of intense media and political scrutiny into large tariff increases by the Big Six and it is yet to be seen if there will be a sustained increase in switching rates. Almost two-thirds (62 per cent) of customers can not recall ever having switched supplier (Ipsos Mori 2013).

**Figure 2.2**

Declining switching rates in the UK residential gas and electricity market over the past decade



Source: DECC 2014d



Evidence on consumer behaviour shows that where there is too much choice and the choices on offer are confusing, consumer engagement can be restricted (Dolphin and Silim 2014). To tackle this problem Ofgem has introduced a number of regulations on tariffs through its Retail Market Review (RMR) reforms, including placing a limit on the number of tariffs that suppliers can offer (Ofgem 2013a).

The option of limiting tariff numbers for suppliers was originally proposed by IPPR in 2012 (Platt 2012). Since then the rapid advances occurring in DETs and the disruptive potential of these technologies have become apparent.

For this reason we believe it is appropriate that we revise our position on limiting tariff numbers. In fact, we believe the entirety of the tariff reforms Ofgem has introduced through the RMR should be reviewed in light of the developments occurring in DETs to ensure they do not restrict tariff innovation.

A promising alternative approach for increasing consumer engagement that would not hinder innovation in tariffs is to regulate and encourage development in services that act as intermediaries for consumers in the energy market. Switching websites play a key role in helping consumers to navigate tariff offers but the information they provide can be inconsistent and unreliable. In addition, more sophisticated internet-based services are now developing that will facilitate a switch on behalf of consumers (Ctrl-Shift 2014). As smart meters are deployed there is the potential for these intermediary business models to thrive and they could be encouraged through effective regulation.

**Recommendation: The Competition and Markets Authority should review the tariff regulations introduced by Ofgem through its Retail Market Review and reform or remove them where they could restrict innovation in tariffs that support the deployment of distributed electricity technologies. The potential for regulating intermediary services, such as switching websites, as a way to increase consumer engagement in the energy market should be examined.**

Eliminating the barriers to entry that restrict competition to the Big Six and ensuring innovation in tariffs is not restricted is essential for the deployment of DETs. But fundamental reforms to the government's policies are also required for the full potential of these technologies to be realised.

### 3.

## REFORMING POLICY TO STOP PROPPING UP THE INCUMBENTS

The priorities for the energy sector have changed dramatically in three areas since the existing regulatory and market structures were established in the 1980s and 1990s.

- **Affordability:** a 220 per cent increase in the average energy bill over the last decade, from £610 in 2004 to £1,346 in 2014 (CCC 2012 & Ofgem 2014d), has brought affordability issues to the fore.
- **Decarbonisation:** in 2008 tackling climate change became a central policy priority when the Climate Change Act (HM Government 2008) was passed placing a legal obligation on the government to reduce the UK's greenhouse gas emissions to 80 per cent below 1990 levels by 2050.
- **Energy security:** the UK's increasing dependence on gas imports (DECC 2014e) and the planned closure of a significant proportion of the UK's power stations in the 2010s, due to age or contravention of EU pollution regulations, has pushed security of supply up the agenda.

The distributed electricity technologies (DETs) we described in chapter 1 have a central role to play in tackling this 'trilemma' of issues and are disrupting the large-scale, centralised utility business model. Despite this, the government's policies to address the trilemma in the electricity sector prioritise supporting large-scale generation technologies. This policy approach is more expensive than is necessary and risks delaying the move to a smarter, cheaper, more secure and efficient energy system. In addition, the government's ambition to bring forward private sector investment in new low-carbon generation is undermined because of the impact DETs are having on the finances of the large-scale utilities.

In the following sections we examine two major interventions into the energy markets that have been introduced as part of the government's recent electricity market reforms and identify how they are propping up the increasingly defunct large-scale utility business model. The first intervention is the 'contracts for difference' framework for subsidising low-carbon generation technologies. The second is the 'capacity market' for maintaining system security. We then set out a framework for a new policy approach and propose a number of policy reforms.

### 3.1 The contracts for difference subsidy mechanism

The government has recently introduced major changes to the electricity market, called Electricity Market Reforms (EMR), to drive decarbonisation (HM Government 2013). This includes a mechanism for bringing forward private investment in low-carbon generation called contracts for difference (CFD). CFD will replace the existing Renewables Obligation (RO) subsidy scheme, which will close in March 2017. The existing feed-in tariffs (FiTs) scheme that supports small renewable developments will remain in place.

CFD involve long-term fixed-price contracts being given to low-carbon generators as an incentive for investment in the UK. The current 'strike prices' for investment are substantially higher than the wholesale energy price to account for the low-carbon price and the immaturity of several low-carbon generation technologies.

The government has claimed it is taking a technology-neutral approach to promoting low-carbon generation technologies with CFD. The stated aim is that, over time, a wide variety of technologies – including a range of renewable technologies, such as onshore and offshore wind, solar power and biomass, nuclear power and fossil fuel power stations fitted with carbon capture and storage (CCS) technology – will directly compete through auctions for support (DECC 2014f). In August 2010 the previous energy and climate change secretary Chris Huhne explained the approach: ‘the market will decide which low-carbon technologies will be used’(BBC 2010).

This approach is fundamentally flawed. It is very hard to conceive of a balanced auction system in which a new nuclear power plant with a generating capacity of 3.2GW (3200MW) requiring a 35-year contract (such as the planned development at Hinkley Point C) could compete directly with a 5MW solar PV development that requires a 15-year contract. Carbon capture and storage technologies, meanwhile, have a fundamentally different cost structure to these technologies because of the requirements for fuel inputs (that is coal and gas) with high marginal costs. Both nuclear and solar power have high capital construction costs and very low, effectively zero in the case of solar, marginal fuel costs.

The ambition for a technology-neutral framework can be traced back to a commitment in the coalition agreement between the governing coalition parties that no public subsidy would be provided to support new nuclear power plant developments. This was explained in 2010 by then energy minister Charles Hendry MP:

*‘The coalition agreement clearly sees a role for new nuclear, provided that there is no public subsidy. We are clear. It is for private sector energy companies to construct, operate and decommission new nuclear plants.’*  
Hendry 2010

As we explain below, the government has categorically failed to deliver on its objective of raising *private sector* investment in nuclear.

In the absence of an effective carbon price it is highly likely that, contrary to the government’s aim, different support mechanisms will need to stay in place for each group of technologies. This means the level of support given to the different technology groupings will continue to be administratively determined, as it is currently. The challenge that faces the government, therefore, is to decide how to prioritise between different technologies.

As it stands, the government’s policies clearly prioritise large-scale nuclear and offshore wind technologies over distributed low-carbon generation technologies, in particular solar PV and onshore wind.

- At present ‘established’ renewable technologies, including solar and onshore wind,<sup>5</sup> need to take part in an auction to receive a contract.
- Nuclear power, however – without doubt the most ‘established’ of the low-carbon technologies having been in use since the 1950s – does not need to compete in an auction for a contract but can receive one directly through negotiation with government.
- Similarly, ‘non-established’ or less mature renewable technologies, in particular offshore wind, do not need to compete in an auction to receive a contract.<sup>6</sup>

The CFD mechanism is better suited to large-scale developments and large-scale generation technologies than smaller developments.

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5 Eligible ‘established’ technologies include: onshore wind (>5 MW), solar photovoltaic (PV) (>5 MW), energy from waste with CHP, hydro (>5 MW and <50 MW), landfill gas and sewage gas.

6 Eligible ‘non-established’ technologies include: offshore wind, wave, tidal stream, advanced conversion technologies, anaerobic digestion, dedicated biomass with combined heat and power, and geothermal.

- The contractual arrangements for CFD are complex and burdensome for smaller developers.
- The financial risk of developing a project and not getting a contract is significantly harder for smaller developers to bear.

The allocation of subsidies for low-carbon generation technologies, which are capped by a mechanism called the Levy Control Framework, is not balanced.

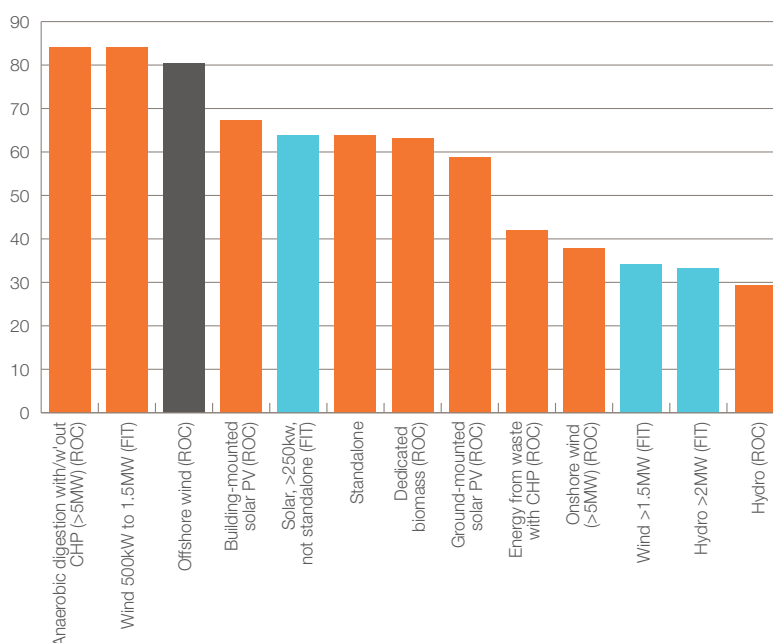
- In the first year (2014) of contract allocations under CFD three times as much subsidy (£155m/year) has been allocated to the non-established technologies than to the established technologies (£50m/year) (DECC 2014g).
- The government intends to end financial support through the RO for solar projects over 5MW in size two years earlier than was planned (that is 2015) in order to retain money for spending on CFD (DECC 2014h).
- Distributed generation developments under 5MW in scale which are eligible for subsidies through the FiTs scheme are not being prioritised. Spending on FiTs is projected to be £834 million in 2015/16 rising to just over £1 billion by 2020/20, an increase of £262 million. Over the same time period spending on CFD will increase by around £2.5 billion or 10 times this figure, from £58 million in 2015/16 to £2.5 billion in 2020/21. Spending on the RO is projected to stay at around £3.2 billion from 2015/16 onwards (NAO 2013: 30).

The government's industrial policy is prioritising nuclear and offshore wind, and planning policy is restricting solar and onshore wind.

- Nuclear and offshore wind are the only low-carbon generation technologies to have dedicated industrial strategies (BIS and DECC 2013a, 2013b).
- The communities and local government secretary Eric Pickles has directly intervened in planning decisions to restrict solar PV and onshore wind developments (see for example Mendick 2014 and Pickard 2014).

**Figure 3.1**

The cost of renewable energy subsidies (£/MWh, 2013/14 prices)



Source: IPPR analysis based on DECC 2013a, DECC 2013b, DECC 2013c, Ofgem 2014e and Ofgem 2014f  
 Note: Figure shows all technologies included in the Renewable Obligation subsidy scheme and the cheapest technologies under the feed-in tariff scheme.

We showed in chapter 1 how the cost of solar PV and onshore wind are falling fast and have reached grid parity in a number of countries. Even at a very small scale, the cost of these technologies is significantly cheaper than offshore wind (see figure 3.1).

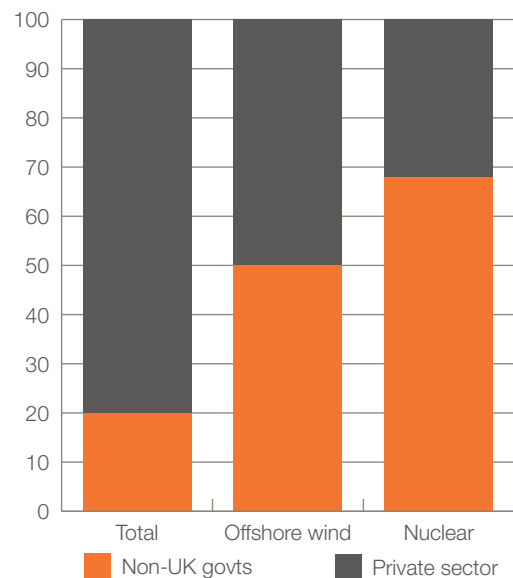
We also explained in chapter 1 how distributed generation technologies lend themselves to a diverse mix of ownership because they have lower capital costs and require less technical expertise to construct and operate than larger technologies. As a result, the most competitive part of the generation market is in these distributed generation technologies that the government is not prioritising.

In 2012 the Big Six energy companies owned 71.3 per cent of total generating capacity in the UK; the Big Six plus a further 4 companies owned 85.8 per cent of all capacity; and the remaining 14.2 per cent of generating capacity was owned by a 'a long tail of smaller generators' (Rutledge 2012). Most of this 'long tail' was composed of onshore wind and combined heat and power.

In fact, investors in nuclear and offshore wind are largely state-backed energy companies. In 2012, 68 per cent of nuclear generation and 50.4 per cent of offshore wind generation in the UK was attributed to foreign governments (see figure 3.2) (ibid). As a result, large amounts of public subsidy are going to state-backed investors from other countries, which risks undermining public support for these subsidies (Platt et al 2014).

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**Figure 3.2**  
Public ownership of UK electricity generating sector by non-UK national and regional governments, 2011/12



Source: Rutledge 2012

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Indeed, the new nuclear plant that is planned for Hinkley Point on the basis of a CFD contract is an entirely state-backed project. The plant will be built by a French state-backed energy company (EDF), financed by two Chinese state-backed energy companies (China National Nuclear Corporation and China General Nuclear Power Corporation) (BBC 2013b), on the basis of a 35-year fixed-price contract provided by the UK government for which no other bids were received. It would be hard to imagine France or the United States allowing this arrangement to take place.

Indeed the US Nuclear Regulatory Commission prohibits an alien or any corporation or other entity from owning or operating a nuclear power plant 'if the Commission knows or has reason to believe it is owned, controlled, or dominated by an alien, a foreign corporation, or a foreign government' (USNRC 2014).

As the negative impact of DETs on the financial health of the large-scale utilities increases, thereby undermining the ability of listed utilities to invest, the level of state investment in large generation technologies can be expected to increase. Peter Atherton of Liberum Capital has said:

*'[It is] inconceivable that a listed utility could raise substantial amounts of equity capital to fund investment. The state is now by far the biggest investor.'*  
Atherton 2014

### 3.2 The capacity market

The government has become concerned about how to manage the reliability of the electricity system as the deployment of renewable technologies increases. It has therefore decided to introduce a 'capacity market', which will involve payments being given to providers of reliable capacity that can help service peaks in demand on the basis of contracts that are awarded through a competitive auction process.

Large-scale generation is one way to meet peaks in demand but it will generally be far more cost-effective to reduce the peaks using DETs, including smart technologies and energy efficiency technologies. For illustration, we highlighted how McKinsey (2012) estimated that there is the potential to reduce electricity usage by around 146 TWh, or 36 per cent of total demand, in 2030. Green Alliance has calculated that this would deliver a reduction in peak load of 6.4GW (Watts and Metternich 2014). This would remove the need for eight 800MW combined cycle gas turbine power plants on the system and deliver a saving of over £3.9 billion in capital costs alone. Further savings would be generated by avoiding operational costs and deferred investment in transmission and distribution infrastructure. The approach of the government, however, underprioritises the role for DETs in favour of a focus on large-scale generation.

The government did not focus on the potential to support DETs until very late in the development of the EMR. The energy and climate change select committee scrutinised the EMR proposals before they were debated in parliament and subsequently adopted under the Energy Act 2013, and stated:

*'As with many aspects of energy policy, the Government has fallen into the trap of focusing far too closely on the supply side of the energy system, while neglecting to consider the contribution that demand-side activities could make to security and climate change objectives. Thinking about the demand-side needs to be given a much higher priority in the Bill, not least because it is likely to deliver much more cost effective solutions than building ever greater levels of generating capacity.'*

HOC 2012: 4

A technical panel was asked to review the design of the capacity market for the DECC and reported:

*'Although the Panel does not claim to know the full potential demand side resource that might be available, the Panel believes that the design as it stands necessitates relatively modest assumptions regarding the capacity that can be sourced. One aspect of this is that the capacity mechanism is more suited to some behaviours, methods and technologies than others ... We believe that there will be limited uptake of the total distributed*

*energy resource potential that has been demonstrated in other markets with capacity auctions, particularly those in the US.'*

DECC 2014i: 40–41

The government has been expecting to support around 400 to 900 MW of smart demand-side capability through the capacity market, which would reduce peak demand by about 1 per cent (RAP and ClientEarth 2014). In the US the average peak reduction delivered by the demand side in capacity markets is 6 per cent and the successful Pennsylvania Massachusetts and New Jersey electricity market (PJM) market reduces the peak by 10 per cent (Mitchell 2014b).

The limited ambition for DETs in the capacity market is seen in how the auction process for procuring capacity gives preferential treatment to generators. A two stage auction process will be held. One auction will occur four years ahead of delivery (the first will take place in December 2014 for capacity to be delivered in 2018–19) and the second will be held one-year ahead of delivery (that is in 2017 for delivery in 2018–19). While different forms of capacity can bid into the different auctions, the four-year ahead auction is most appropriate for fossil fuel generation as this would align with construction times for new capacity. Smart technology companies will struggle to guarantee capacity four years ahead of delivery because the UK industry is at an early stage of development and this is a long time for a new business to wait for revenue. Contracts for new generation plants in the four-year ahead auction will be up to 15 years in duration. Demand-side providers will only be able to access single-year contracts through the year ahead auction. This arrangement is clearly imbalanced.

In addition, if demand falls below projections for any one year and the requirement for reliable capacity is reduced, the amount of capacity auctioned through the year ahead auction will be cut. The four-year auction will remain intact. In other words, if demand is successfully reduced, the incentive to reduce demand will be cut back (ibid).

The government is carrying out a pilot in January 2015 to see whether electrical efficiency, or 'demand reduction', could be included in the capacity market (DECC 2014j). It is a positive step forward that the government is intending to support energy efficiency, but unnecessary limitations have been placed on the projects that are eligible to participate. To be eligible for a capacity payment through the pilot it must be demonstrated that an energy efficiency project would not have occurred without a capacity payment and the project cannot be in receipt of any additional government support. Neither of these conditions apply to energy efficiency where it is included in capacity markets that operate in the US. To compound these issues, the capacity payments available for energy efficiency projects are not high enough to significantly increase their economic attractiveness (Watts and Metternich 2014).

Due to the way in which the capacity market has been designed, there is a widespread expectation that a significant number of highly polluting coal-fired power plants – that would otherwise have shut down due to EU pollution legislation – will receive support. This risks significantly undermining the UK's ability to achieve its decarbonisation objectives. E3G has estimated that about 10GW of old coal plants could be included in the first batch of capacity that the government intends to procure (Littlecott 2014).

There is evidence that capacity markets are being seen by existing utilities across Europe as a way to recover revenue that has been lost due to increasing deployment of DETs (ibid). In this context, it is notable that the government originally intended to introduce a different form of capacity mechanism that would have offered more flexibility to procure demand-side resources and would not have resulted in payments going to old coal-fired power plants. It would also have been cheaper.



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### How the government changed its mind and chose an inferior, more costly capacity mechanism

Instead of the capacity market that has been implemented, the government originally intended to introduce a 'targeted strategic reserve' (DECC 2010: 96, para 69) for maintaining the security of the electricity system. This would have involved the electricity system operator (National Grid) tendering for capacity to be part of the strategic reserve. The capacity would then be kept outside the market and only deployed at times of system stress.

In 2011 the government identified that the strategic reserve would offer more control over the type of capacity being secured than a capacity market, and that there was a risk with the latter option that the wrong sort of capacity would be attracted (DECC 2011). This is precisely what is now set to occur with support being provided to old coal plants. It also identified that the strategic reserve would cost around £1.5 billion less (or less than half) than the market option up to 2023.

In addition, the government recognised that the strategic reserve would have a smaller distortionary effect on the energy markets than the capacity market. The capacity market involves a very significant degree of market intervention and requires complex administrative design by the state in order to function. It is therefore more liable to produce inefficient outcomes due to administrative error and is more vulnerable to influence by industry lobbying (Mitchell 2014b).

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### 3.3 An outline of a new policy approach

In sum, the current policy framework encourages the shift into low-carbon energy production but focuses heavily on large-scale generation, thus maintaining the increasingly defunct large-scale centralised supply model for the electricity system (with a combination of fossil fuel and low-carbon technologies rather than just fossil fuel technologies).

Even with the rise of distributed electricity technologies, large-scale low-carbon generation technologies will continue to play a central role in the UK's electricity sector and efforts to encourage investment in these technologies should not be abandoned. However, now that the disruptive impact of distributed electricity technologies on electricity systems is clear, and the end of the reign of the large-scale utility business model is in sight, the government must respond and adapt its approach. Promoting smart distributed electricity technologies must become a central element of the government's approach to tackling the energy policy 'trilemma'.

**Recommendation: The government should acknowledge that the nature of electricity technologies is now so diverse that it is impossible to adopt a technology neutral approach with its policies. Instead, the government is going to be the arbiter of which technologies are prioritised for many years to come. Once this is accepted, the government must fundamentally reorient its approach so that the full range of distributed electricity technologies receives much greater priority in its policies.**

In relation to support for low-carbon generation technologies this could include rebalancing the allocation of subsidies so that more is made available for distributed generation technologies. In addition, given the challenge that smaller developers face in getting support via the contracts for difference mechanism, consideration should be given to increasing the capacity threshold for the small-scale feed-in tariffs programme so that larger technologies are eligible (for example from the current maximum installation size of 5MW up to 15MW).

Particular attention should be given to how solar is supported by government policies. The rapid cost reductions that have occurred with solar, and which are set to continue, make it, without question, the biggest success story in the newly

developing range of low-carbon technologies. The UK must position itself to maximize the benefits it gains from this game-changing technology.

As it stands, the UK is constantly playing catch-up with solar. It is the case that government predictions for solar costs and solar deployment have consistently been overtaken by developments on the ground. While the government should welcome these developments and maximise its benefits, instead the focus has been on how to *limit* deployment.

The government should take note of the view of Barclays:

*'We fully expect utilities and regulators to be playing a constant game of catch-up as solar develops. The costs of solar and storage technologies are falling quickly and may fall even faster as higher demand builds additional scale. But the cost of distribution grids and thermally generated power are more likely to rise than to fall, in our view [which will increase the economic attractiveness of solar]. As a result, regulators and utilities will be constantly trying to respond to a moving target, which is precisely the environment where slow-moving incumbents can fall behind.'*

Wile 2014

It is true that the profile of electricity generated by solar does not match well with the times when electricity is in demand in the UK. Solar generation is high in summer, when demand is relatively low, and low in winter, when demand is relatively high. However, we do not agree with the Committee on Climate Change (CCC 2014) that this means solar should only receive limited support from the government up to 2020 and that an approach to investment in solar should be developed beyond 2020.

Rather than seeing the seasonal profile of solar electricity as an encumbrance that is best avoided, or at least delayed, we prefer a more optimistic outlook. The question for government is this: how should the UK prepare for incorporating very large amounts of cheap, solar generated electricity, which will occur primarily during the summer, into the grid? It is a poor strategy to avoid the potential for cheap solar-generated summer electricity because we haven't yet developed a solution for balancing generation requirements across seasons.

The government also needs to alter its approach to solar because of the risks this highly disruptive technology poses to their policies. Before too long, with or without significant government support, cost reductions in solar are likely to make the technology an attractive investment proposition for British businesses and consumers. This can be expected to lead to high levels of uptake, which will force the government to have to tackle the seasonality generation profile issue. In essence, large-scale deployment is likely to be inevitable. Moreover, this uptake is likely to occur much earlier than many would generally assume. Indeed, solar could hit grid parity for residential properties in the UK as soon as 2020 (Citibank 2013), meaning it will hit grid parity for businesses with large roof spaces before this.

Instead of constantly being behind the curve with solar, the government should get ahead of the market and take action now to prepare for large-scale deployment of the technology.

**Recommendation: The government must immediately begin work on a strategy for accommodating large-scale deployment of solar power into the electricity system so that Britain is not prevented from capturing the benefits this technology has to offer.**

Inevitably, accommodating solar will involve placing a strong focus on the development of storage technologies, smart technologies and energy efficiency technologies. This highlights why it is important for the government to move

towards a 'system-wide' approach in how it develops policy so that demand and supply receive equal attention. As it stands the government has not focused enough on the demand side and this will have led to unnecessary costs.

This is seen most notably in the design of the capacity market, which could have been an effective instrument for supporting smart technologies and energy efficiency technologies, but instead has been designed to focus on generation capacity.

**Recommendation: The capacity market should be scrapped and new plans for maintaining system security should be drawn up from scratch.**

This presents an opportunity to reconsider the most effective way of maintaining the security of the electricity system as deployment of low-carbon generation technologies increases and the approach to supporting smart technologies and energy efficiency technologies.

The government's own impact assessments showed that a 'strategic reserve' model, in which system security is the responsibility of the system operator (National Grid), would have been cheaper and more effective than the capacity market model that was implemented. However, an alternative approach that should be considered is for this responsibility to be given to the network operators that operate at the district level (the 'district network operators'). As deployment of DETs increases there will need to be an increased focus on balancing supply and demand at the level of distribution networks, which the distribution network operators (DNOs) operate. This approach would require a change to the regulatory model for the district networks.

For smart technologies, the priority should be to ensure that they are effectively supported by the roll-out of smart meters into people's homes. Smart meters can monitor and communicate energy usage in real time and will be key to facilitating the development of smart technologies. However, for this to occur, half-hourly settlement of electricity system balancing will need to be introduced for the residential sector. Government could also support the development of smart technologies by mandating that new appliances are internet-enabled with communication systems that are consistent and interoperable across Europe.

A promising approach for supporting energy efficiency technologies is to introduce a feed-in tariff subsidy mechanism (Green Alliance 2011), similar to that which exists for small-scale renewable generation technologies, which the government previously rejected. This decision should be reviewed. This mechanism could be financed by reallocating funds that are currently earmarked for the capacity market.

**Recommendation: The new approach to maintaining system security should include a fundamental review of the regulatory model for the networks. Half-hourly settlement of electricity system balancing should be introduced for the residential sector as soon as possible to support the deployment of smart technologies. The option of introducing a feed-in tariff to support deployment of energy efficiency technologies should be reconsidered.**

The government should also take the opportunity of a review of the capacity mechanism to consider why DETs have received scant attention in its policies, despite the benefits that these technologies can offer. It is evident that a lack of expertise on DETs in government is partly to blame.

The technical expert panel that reviewed the design of the capacity market raised concerns about a lack of expertise within government institutions on DETs and noted 'the importance of building a strong institutional knowledge of Distributed Energy Resources amongst DECC and National Grid' (DECC 2014i: 5). A recent independent review carried out for DECC also identified a lack of expertise on DETs and how they

are not fully captured in the government's energy system modelling that supports its policy development (Hinton and Thumin 2014).

Problems that arise from this low level of expertise may be compounded by an overreliance on the private sector, which inevitably means primarily the large-scale utilities, to help with policymaking (Carrington 2011). It has been claimed that there is a 'revolving door' of secondees to DECC from the Big Six (Mitchell 2014a), which is likely to result in regulatory and policy decisions favouring these companies. Even if the information provided by these secondees is not purposefully biased, it is likely to favour reforms that support the large-scale utility business model because that is their expertise.

**Recommendation: The Department of Energy and Climate Change and Ofgem must take steps to build their expertise on distributed electricity technologies.**

In this chapter we have argued that a fundamental change in the government's policy approach is required so that greater priority is placed on DETs. This is the most important step that the government needs to take. However, for the technologies to truly fulfil their potential, the government will need to substantially accelerate the development of a smart grid, which will require the regulatory model for the networks to be reviewed.

## 4. CREATING A SMART GRID

The electricity network arrangements in the UK must be completely overhauled to enable DETs to flourish. The network infrastructure and regulation has been developed to serve predictable and regular patterns of demand and generation (Shaw et al 2010) with power flowing one-way, from large power stations to consumers. Integrating DETs into electricity systems fundamentally alters this model, with electricity movements becoming bidirectional and demand becoming an active market participant (DECC 2009). They will need to be accommodated through the development of a 'smart grid'.

Ofgem is soon to introduce new pricing agreements for the district network operators (DNOs) that will be in place for eight years, with 2015–2023 being the first period. Given the rapid pace of technological change that is occurring in DETs, it is vital that these agreements are designed to engender a rapid transition to the smart grid. Ofgem's plans do not currently achieve this.

Ofgem initiated a review into the price control mechanisms for the networks in 2008. Their RPI-X@20 (Ofgem 2010b) project identified how the 'RPI-X' pricing mechanism that was in place at the time did not sufficiently incentivise the network companies to operate in ways which supported the development of a smarter grid. One of the issues they identified was that investments to connect distributed generators to the networks were not effectively incentivised. There were also concerns that network companies were seeking overgenerous allowances for spending on capital assets, such as wires, as this would generate a larger return. It was acknowledged that there was limited research and development on new technologies and operational approaches for the future of networks. The review also noted that DNOs were restricted from having direct relationships with customers who could potentially assist them in becoming active system operators who manage flows on their network (Lockwood 2013b).

Ofgem has developed a replacement regulatory framework called RIIO (Revenue = Incentives + Innovation + Outputs) intended to address these problems. However, it represents an evolution in the structure of the networks as opposed to a revolution (ibid). Ofgem and DECC essentially see the development of the smart grid as a slow and 'incremental process' (Lockwood 2013b, DECC 2009), which is in stark contrast to the rapid developments in DETs we have outlined above.

Ofgem has stated that:

*'The take up of low-carbon technologies is predicted to increase significantly during RIIO-ED2 and RIIO-ED3 ... The RIIO-ED1 period represents an opportunity to start to deploy smart grid solutions and get prepared for the more radical network changes that may be required in the future.'*

Ofgem 2013b

RIIO-ED2 and RIIO-ED3 are the second and third price control periods that run for the eight-year periods 2024–32 and 2033–2041 respectively. Therefore, Ofgem is not envisaging making major steps towards the development of a smart grid until the mid-2020s.

It is notable that other countries and regions, such as Germany and Denmark, are trying to tackle smart grid issues on a much quicker timescale (Lockwood 2013a).

One DNO, Electricity North West (ENW), recently highlighted how the UK is behind other countries in the development of smart grids:

*'We conducted a number of reference client engagements with both British DNOs and with US electricity and gas companies. We found that internationally, the maturity of the smart grid roadmap ... is generally more advanced than in the UK.'*

ENW 2014: 96

The problems with this approach given the rapid technological advances in DETs described above are self-evident. In fact, the scenarios for low-carbon technology deployment, constructed by DECC in 2001 (Lockwood forthcoming), on which the proposed RIIO-ED1 price agreements are based, are already outdated. In the development of their business plans many networks chose the 'low' scenario, which projected installed capacity of low-carbon technologies reaching 1.95 GW by 2030. In the 'medium' scenario installed capacity reached 2.3 GW in 2020 and 6.64 GW by 2030. By January 2014 installed solar PV alone had already reached 2.75 GW, far outpacing even the 'high' scenario. There is an opportunity to review these plans at the midpoint of the pricing period, in 2019, which should be taken.

**Recommendation: At the 2019 review point for the network operators' RIIO-ED1 pricing control period the distribution network operators should be required to substantially scale up their projections for distributed electricity technology deployment so that they align with the increased priority placed on these technologies in policy.**

In the meantime it is necessary to consider whether much more radical reform to the existing regulated network model is required. As it stands, DNOs are responsible for estimating low-carbon technology growth and their own smart grid strategies, but it may be necessary for them to receive far greater direction from the regulator about how they should be developing the smart grid in their area. The government's own *Smart Grid Vision and Routemap* states:

*'there is continuing need to provide strategic direction on the future of the electricity system and smart grids to build and sustain confidence in the direction Great Britain is taking. Without this it is difficult for the industry, consumers and the supply chain to invest for the future.'*

DECC and Ofgem 2014: 31

Consideration should be given to giving DNOs responsibility for balancing supply and demand. Balancing currently occurs at the national level and is the responsibility of the system operator, National Grid. But as deployment of DETs increases there will need to be an increased focus on balancing at the local level in order to maintain the integrity of the system and maximize the efficiency with which the system is run. This could involve the DNOs procuring capacity as a means to maintain system security, in the model of the 'strategic reserve' capacity mechanism the government intended to implement.

A more radical option still would be to take responsibility for smart grid development away from the regulator and place it into the hands of an independent body with responsibility for coordinating investments. This is the model that exists in Denmark and is being considered in New York State (NYSPSC 2014). This would involve taking responsibility the system operator role out of National Grid and putting in into the public sphere as an agency and would overcome any barriers to smart grid development that exist because of the privately owned nature of National Grid and the DNOs. The agency could then coordinate the move to a smart grid with a combination of national and local system balancing, and take on the responsibility managing the 'strategic reserve' capacity mechanism. This approach would include a rewriting of relevant network codes and the Balancing and Settlement Code.

Whichever option is pursued, network connection charging methodologies must be reviewed to ensure they do not restrict the development of distributed technologies.

Given the range of options that are available and their complexity the UK could follow the example of the New York State regulator and carry out a comprehensive review into whether the existing regulatory structures are fit for purpose (NYSPSC 2014 and Zibelman 2014).

**Recommendation: The government should launch a review into the existing model of network regulation to ascertain where reform is needed to unlock barriers to deployment of distributed electricity technologies and accelerate the development of the smart grid. The review should cover the ownership structures of the networks, the location of responsibility for system balancing, the location of responsibility for maintaining system security, and role of the regulator in relation to the networks. The way in which costs are allocated for grid balancing and for connecting new generation technologies to the network should also be reviewed to ensure they do not fall excessively on distributed electricity technologies.**



# CONCLUSION

A new technological paradigm in electricity has emerged. The market and regulatory structures that were constructed for the electricity system during the 1980s and 1990s were based around a centralised, supply-focused model, dominated by large-scale, predominantly fossil fuel, power stations. Now a range of distributed electricity technologies exist that hold the key to a cheaper, cleaner, more competitive and secure electricity system, that works better for consumers.

We have shown that distributed electricity technologies disrupt how electricity systems traditionally operate and spell the end to the dominance of the large-scale utility business model. And yet the UK's electricity system remains wedded to the large-scale, centralised utility business model, which is rapidly being made redundant. Unless significant reforms are undertaken across energy regulation and policy the full potential of distributed electricity technologies will not be captured and the government's ability to achieve its policy objectives could be significantly undermined.

In this report we have set out a range of reforms that should be undertaken to adapt the UK's electricity system to the new distributed electricity technology paradigm.

The grip of the Big Six utilities on the UK's energy markets must be ended by tackling barriers to entry that restrict competition from challenger companies that can build new business models around distributed electricity technologies.

The government's policies for addressing the 'trilemma' and achieving an affordable, decarbonised and secure electricity system must be fundamentally reviewed because at present they focus on large-scale generation and prop up the ailing large-scale utility business model.

Finally, the regulatory model for the networks should be reviewed to enable the rapid development of a smart grid.

If the reforms we have outlined are implemented there is a bright future ahead for the UK's electricity sector. The rapid advances occurring in distributed electricity technologies give reason for great optimism. They provide an opportunity to increase radically competition in the energy markets and build new industries, while creating an affordable, decarbonised and secure energy system.

As things stand there is a bias evident across the UK's electricity system in favour of the increasingly redundant large-scale utility business model. It is time to break with the past and embrace the new, distributed electricity technology paradigm.

## Summary of policy recommendations

### Regulatory reforms

- A new regulation should be introduced stipulating that the Big Six will face an automatic fine every year at an order of magnitude higher (for example x10) than the amount they overcharge their legacy customers. Ultimately the companies should face the risk of having their licences revoked if they continue to overcharge their legacy customers.
- The Competition and Markets Authority should investigate the potential to improve competition by restricting the Big Six from self-supplying between their generation and retail arms and introducing a new 'pool' system for wholesale energy trading.

- The Competition and Markets Authority should review the tariff regulations introduced by Ofgem through its Retail Market Review and reform or remove them where they could restrict innovation in tariffs that support the deployment of distributed electricity technologies. The potential for regulating intermediary services, such as switching websites, as a way to increase consumer engagement in the energy market should be examined.

### **Policy reforms**

- The government should acknowledge that the nature of electricity technologies is now so diverse that it is impossible to adopt a technology-neutral approach with its policies. Instead, the government is going to be the arbiter of which technologies are prioritised for many years to come. Once this is accepted, the government must fundamentally reorient its approach so that the full range of distributed electricity technologies receives much greater priority in its policies.
- The government must immediately begin work on a strategy for accommodating large-scale deployment of solar power into the electricity system so that Britain is not prevented from capturing the benefits this technology has to offer.
- The capacity market should be scrapped and new plans for maintaining system security should be drawn up from scratch.
- The new approach to maintaining system security should include a fundamental review of the regulatory model for the networks. Half-hourly settlement of electricity system balancing should be introduced for the residential sector as soon as possible to support the deployment of smart technologies. The option of introducing a feed-in tariff to support deployment of energy efficiency technologies should be reconsidered.
- The Department of Energy and Climate Change and Ofgem must take steps to build their expertise on distributed electricity technologies.

### **Reforms to the networks**

- At the 2019 review point for the network operators' RIIO-ED1 pricing control period the distribution network operators should be required to substantially scale up their projections for distributed electricity technology deployment so that they align with the increased priority placed on these technologies in policy.
- The government should launch a review into the existing model of network regulation to ascertain where reform is needed to unlock barriers to deployment of distributed electricity technologies and accelerate the development of the smart grid. The review should cover the ownership structures of the networks, the location of responsibility for system balancing, the location of responsibility for maintaining system security, and role of the regulator in relation to the networks. The way in which costs are allocated for grid balancing and for connecting new generation technologies to the network should also be reviewed to ensure they do not fall excessively on distributed electricity technologies.

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