The disrupted decade

4 disruptions that will shake things up for energy consumers

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Summary

It has been said that people often overestimate what can happen in 2 years and underestimate the change that will take place in 10. This is true of the UK energy market today.

Most debate focuses on rising or falling prices, incremental policies and worries about looming supply shortages. However, new technology such as cheap solar power, advanced batteries and big data analytics could mean more dramatic change.

This report looks at potential changes to the energy market over the next 10 years and how we can make sure what happens is in the interest of consumers.

We looked at disruptions that could affect the energy industry and identified four that could have the most impact on consumers. These are:

New pricing models

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Intermediation of energy retail

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Re-allocation of network costs

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1. New pricing models

How energy is priced hasn't changed a lot for decades. Most consumers are billed (usually on estimated use) a fixed standing charge and flat per unit charge.

In the next 10 years, new technology and better understanding of consumer behaviour could lead to the creation of pricing models that are far more tailored to consumers' lifestyles. The biggest change is 'time of use' (ToU) tariffs, that vary energy costs by time of day. Another is energy bills indexed to wholesale costs. Regulators need to understand these developments, because the impact of the changes will vary for different groups of consumers.

2. Energy retail intermediaries

Most consumers buy household energy directly from a retail energy company. However, in the next decade, we see the rise of intermediaries who could allow consumers to reduce their energy bills, making it easier to find and switch tariffs by handling part or all of the switching process for them.

More sophisticated intermediaries will use smart meter data to advise consumers on how to cut their consumption. We need to know how barriers to entry can be lowered (to allow these innovations) and how these intermediaries would be regulated.

3. Widespread adoption of storage

Storage could dramatically reduce demands on the electricity network at peak times by matching demand to supply from a different time of day. This becomes more important if rising demand for electricity continues, and if the grid uses more intermittent renewables like solar. These changes could make electricity cheaper for consumers, and make it far easier and more efficient to use renewable energy.

4. Distributed generation and costs

The rise of distributed generation, like rooftop solar panels, may result in a re-allocation of network costs.

If we keep the tariff structure we have now costs will be spread out unfairly. People using solar generation or storage will increasingly escape paying for networks, while those who don't will pay over the odds. The longer we delay changing this system, the gap will get larger, and change will be harder.

Using technology to help consumers

New technology should be broadly positive for energy consumers. However, there are risks and challenges for some, particularly vulnerable, consumers.

To get the best result we need to support innovation and while keeping consumer protections robust.

Regulators and policymakers need to look at existing rules to see if they allow helpful innovation while protecting consumers against harm. They will also need to review what steps can be taken to avoid the benefits of innovation going to a small, engaged set of consumers, and instead be widespread across the entire energy consumer base.

These trends are not unique to the energy market. Post, telecoms, water and transport are all undergoing disruptions on an unprecedented scale and barriers between sectors are coming down.

As a result of the four disruptions we highlight in this report, the experience of an energy consumer in 2030 will by very different from today. As a consumer champion we have raised important questions that we will be exploring in the coming months:

- How to reduce the number of 'disengaged consumers' and encourage switching
- How to help consumers navigate a set of increasingly complex market
- How to ensure equitable access to the benefits of innovation
- How to maintain competitive pressure on energy market decisions

This report is divided into six chapters. Chapter 1 describes the consumer, economic and technological trends that will affect the energy system. Chapter 2 describes how the impacts those trends could have on the energy sector and energy consumers. Chapters 3 to 6 discuss the four disruptions likely to have the biggest impact or present the biggest consumer protection issues.

Introduction

Over the last decade, new technology has reshaped the energy sector in unexpected ways. Since 2005, declining costs of solar panels, the emergence of shale gas and oil, and the digitisation of energy markets have transformed the sector.

The next decade will also see great change. The arrival of smart meters will mean energy companies can offer a wider range of services. Policy changes, from the UK's exit from the European Union to the legacy of the Competition and Markets Authority investigation, will require industry and the regulator to adapt. The need to decarbonise the energy system and replace ageing infrastructure will maintain pressure on household bills.

As part of our commitment to protect the interests of present and future energy consumers, this year Citizens Advice plans to instigate a series of projects on future disruptions in the energy market.

We will focus on measures to keep consumer costs under control while maintaining secure supplies and progress on reducing greenhouse gas emissions.

This project is the first stage in that work and part of our wider work to champion consumer interests in a fast-changing world. Based on a structured approach and drawing on interviews with experts, it aims to give the best sense of which disruptions are most likely and will be most significant in their impact.

It identifies a long list of disruptions which could stem from ongoing macroeconomic, sectoral and technology trends. Then, it delves into case studies in four areas where those impacts seem largest or most uncertain. Two areas deal with consumer's direct experiences of the energy market (new pricing models and energy retail intermediaries) and two deal with they way the energy system is operated and governed in consumers' interests (storage and changing transmission and distribution charging).

These changes will be complex, and have the potential to lead to both positive and negative outcomes for consumers. Policymakers now have critical decisions to make and consumer interests must be a decisive part of their consideration.

1: Trends shaping the energy market

Summary

Changes to how households and small businesses consume energy will be driven by technological advances within and outside the energy sector, as well as evolving macroeconomic and consumer trends.

Some of those trends are already in place and have started to take effect, while others are more uncertain.

Macroeconomic trends around public spending, trade and demographic change shape socio-demographic, economic and policy factors relating to the energy sector.

Consumer preferences and segments are changing, prioritising convenience and ease of access, changing consumer needs in the energy marketplace.

Introduction

Citizens Advice hosted a discussion under the Chatham House Rule to identify a long-list of potentially disruptive energy market innovations and underlying trends.[1] We looked at 3 different categories of long-term trends: technological, socio-demographic, and consumer preferences. We generated a list of 17 potential disruptions in the energy market then assessed these for likelihood and potential impact. We selected 4 with the greatest potential impact, likelihood, and implications for Citizens Advice's energy consumer advocacy work for deeper study. We used insights from leading experts to draw on experience from overseas and from comparable (non-energy) markets.

This chapter summarises the results of those discussions. It identifies technological, socio-demographic, economic, policy and consumer trends that could reshape how consumers get their energy.

[1] When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.

The next chapter combines and distils those into a series of potential disruptions that could affect the energy markets. Chapters 3 to 6 look in more depth at some of the most interesting or contentious possibilities highlighted in those discussions.

The role of technology

Technology is the most commonly cited driver of change in the energy market. It determines sources of energy and the relationship between energy producers and consumers. Some of these trends have already begun to take effect; others are more speculative and inherently uncertain.

Established technological trends in the energy sector

Falling solar costs: The cost of generating electricity from renewable energy sources is reducing and could eventually reach parity with fossil fuel-based technologies, especially if fossil fuels are subject to a carbon price. Solar photovoltaic (PV) is falling most rapidly (albeit from a high starting point), with solar PV module costs falling 80% since the end of 2009. If this decline in prices continues, it may soon offer an attractive alternative to conventional electricity sources without reliance on subsidy payments.

Storage: According to industry predictions, battery prices will fall sharply over the next 5 years. This would open new possibilities for storage on the electrical grid and create new opportunities for electrification of other services, most prominently transport.

More electric vehicles: Increasing adoption of electric vehicles (EVs) is being driven both by regulation, falling component (especially battery) costs and consumer demand. Carmakers are offering a widening range of EVs, from cheaper options like the Nissan LEAF to high-end, high-performance cars made by Tesla and BMW. Governments around the world are pushing EVs to market with tax incentives. The 17 member states of the Electric Vehicle Initiative hope to deploy at least 20 million passenger car EVs by 2020 - by the end of 2014 the figure stood at 665,000.

Smart meters: Smart meters record and transmit real-time power consumption data to consumers and suppliers, eliminating the need for manual meter readings and allowing more sophisticated energy services to be provided. As things stand, the government has mandated that energy suppliers offer to install smart meters in every British household by 2020.

Internet of things and the connected home: The 'internet of things' is the result of connecting many appliances, objects and devices to the Internet and giving people new ways to communicate with them. It promises to bring together people, processes, data and objects to create new capabilities and more valuable networks. One proposed application is the ‘connected home’, where household appliances, security services, healthcare monitoring, heating and lighting are connected through the Internet to enable centralised control with smart devices. Smart locks offer keyless entry, security functions allow remote monitoring and smart thermostats enable remote control of heating and cooling systems using a tablet or smartphone.

Advanced building technologies: New energy-efficient technologies include LED bulbs, smart glass (that can control how much sunlight passes through or absorb solar energy to create electricity), ultra-efficient compressorless heating, ventilating and air conditioning and heat pumps. Over time the price of this technology will fall. The most developed of these, LED bulbs, may reach price parity with fluorescent light bulbs in the next 5 years.

Big data and advanced analytics: More data and greater computing power at lower cost is driving a revolution in advanced analytics. This allows companies to better understand their customers, create new products and services and reduce costs.

Emerging and more speculative technological advances

Carbon capture and storage (CCS): CCS can capture up to 90% of carbon dioxide emissions produced by fossil fuel. The CCS chain involves capturing, transporting and storing the carbon dioxide underground in depleted oil and gas fields or suitable geological formations. Establishing a CCS sector would create a new network system, to transport carbon dioxide, which consumers may be asked to pay for. However, the future of CCS in Britain is uncertain after the government scrapped a £1 billion CCS programme in November 2015.

Broadband over power line (BPL): BPL involves transmitting data communication signals using power cables to deliver electricity into homes and businesses. Experiments with BPL have not yet led to a commercial product as it hasn’t delivered sufficient reliable bandwidth at acceptable cost. However, indoor BPL has been more successful. It’s estimated that at least a million power-line adapters have been installed in UK households. Developing a commercial BPL application could see interlinking of electricity and communications network hardware.

Wireless electricity transfer: Wireless transfer would potentially allow charging of appliances and electronic devices wirelessly. Inductive charging, or near-field energy transfer, can be found in increasing numbers of household products such as electric toothbrushes and mobile phone charging pads. If the technology develops further, it could allow more efficient and longer-distance charging and could gain widespread use in the energy sector.

Low-loss transmission: Developments in materials sciences (including long-sought after superconducting materials) could reduce the losses associated with electricity transmission - in the most optimistic cases to near zero.

Macroeconomic and social-demographic trends

Brexit: It's too early to judge the government's approach following the decision to leave the European Union but it will unavoidably have an impact on energy policy.

Austerity: Over the past five years, the UK has significantly reduced public spending in response to a large budget deficit. The process is expected to continue until at least 2020. In March 2016, total government expenditure was forecast to fall to 36% of GDP by 2020. These figures are now highly uncertain. Any downturn that results from Britain's withdrawal from the European Union could worsen the fiscal position while, on the other hand, the new government has signalled an easing of fiscal policy. Cuts could continue to affect spending in the energy sector, for example through further reductions in clean generation and energy efficiency programmes. Alternatively, the new government has signalled an appetite to borrow more to finance infrastructure development, which may open up new pathways to fund energy projects.

Ageing population: The population of the UK is ageing. Ageing refers to both an increase in the average (median) age of the population and an increase in the number and proportion of older people in the population. In 2012 the number of over 65s in the UK surpassed 10 million for the first time. In 2020 the state pension age will rise to 66, then to 67 between 2026 and 2028, and be linked to life expectancy thereafter. Other sectors, such as financial services, are grappling with similar challenges.

Trends in the UK housing market: Increasing demand for housing, driven by population growth, inward investment, increasing single occupancy, smaller non-traditional families and constrained supply, is leading to record house price to salary ratios. Consequently, a growing number of people are living in private rented accommodation. This could make it harder for those residents to choose their preferred energy supplier, and limit use of energy efficient technology. If political attention turns towards building more homes, energy efficiency regulations may change if they are seen as a barrier to building.

Climate change and decarbonisation: The UK has committed to reducing its greenhouse gas emissions by at least 80% by 2050, relative to 1990 levels. Meeting this ambitious target will require significant changes to the way industry operates, how people travel and how electricity is generated and heating supplied.

Inequality: More than 40% of UK wealth is owned by just 10% of households, and the UK's energy market is characterised by very uneven levels of understanding and participation among different demographic groups. Disruptions in the energy sector that can only be accessed with costly investments are likely to be distributed unevenly across the population.

Globalisation and trade: In most goods and many services markets, production lines and trade patterns have become globalised. UK electricity and gas networks have so far been only partially affected by this trend. Gas supplies have become increasingly internationalised as a result of LNG shipping, which has reduced the need for geographical proximity to trading partners. UK electricity connections, by contrast, are currently limited to links with France, the Netherlands and Ireland, although there are plans to significantly increase the number of connections and to diversify trade partners.

Consumer trends

As the consumer champion, we see many examples from all sectors of the economy of how consumer behaviour and consumer challenges are changing over time. Below are some ways those changes could have an impact on energy consumption.

Convenience in a complex world: Consumers are increasingly time-pressed and struggle to manage complexity. This has resulted in a high degree of disengagement from the energy market. Other markets have seen a growing number of 'convenience' services, which provide simplified time-saving solutions that help navigate complicated systems, like Nutmeg which simplifies investments and Deliveroo which offers easy access to takeaway food via smartphones.

The rise of the digital marketplace: Consumers are choosing to do much of their shopping online and on smartphones. Mobile access has accelerated the digital marketplace.Visits to ecommerce sites using smartphones and tablets accounted for 37% of all online sales in the UK in 2014.

Awareness of behavioural insights: Behavioural insights can help understand why people struggle with poorly designed systems, and help us redesign them. Behavioural insights can help strengthen consumer protection and ensure markets deliver good outcomes. As energy companies and regulators embrace this knowledge, customer service relationships should become smoother.

Prosumers: Rather than simply passively 'consuming' products, people are increasingly 'co-creating' products or reviewing and promoting others' products. The popularity of review websites shows how 'prosumers' encourage companies to focus on customer satisfaction. In energy, self-generation (most commonly with solar PV panels) has developed into a prominent, if small, niche of the market.

Segmentation by business of increasing social and behavioural diversity: Increasing cultural diversity in the UK is contributing to the emergence of 'micro-segments', with businesses tailoring products to a much larger range of consumer types. This allows businesses to adopt pricing and targeting strategies which maximise revenue from targeted consumer groups, which in some cases may be anti-competitive practices.

Sharing economy: Business models where the producing assets are owned not by the company but by a network of individuals, happy to let others use their home or their car for a fee (such as Uber or AirBnB) are emerging. These act as matchmakers between diffuse groups of consumers and providers, but own few tangible assets, challenging existing models of regulation. By freeing up existing assets to be used more productively, they can improve consumer experience, making new services available, or making existing ones cheaper.

Natural consumer: Some consumers are motivated by sustainability and the environment. This is already reflected in the increased availability of products and services that are organic, sustainable, locally produced or carbon-neutral. Some consumers place a premium on eco-friendly products, and are willing to spend more on them. However, dedicated green or renewable energy tariff options are niche options, at present accounting for less than 1% of the electricity market.

2: Potential disruptions

Summary

The trends identified in the last chapter come together to disrupt how households use energy. For example, consumers want convenience and new technologies make this possible, creating a market for intermediaries.

We identify a long list of 17 such disruptions ranging across the energy value chain.

Four disruptions have been selected for case studies: new pricing models, energy retail intermediaries, widespread adoption of storage and re-allocation of network costs responding to distributed generation.

Introduction

By combining the trends discussed in Chapter 1 we identified a list of 17 potential disruptions in the energy market. For example, big analytics, smart data, and consumer demand for convenience creates the potential for disruptive new pricing models.
We explored each of these ideas , discussing them with our interviewees and conducting detailed desk research. The findings of this research are summarised here for brevity. We combined these insights with interviews with a worldwide network of industry experts to score the disruptions on a 3x3 matrix to assess impact and likelihood.

The 4 disruptions with the highest combined likelihood and impact were then explored in greater detail (in Chapters 3 to 6).

The long list

1. Low carbon stays expensive

Energy bills rise as a result of investments in low-carbon generation technology. The government has committed to reducing greenhouse gas emissions by 80% by 2050 compared to 1990 baseline. This requires a move from fossil fuels to zero-carbon energy sources. If low carbon energy sources remain more expensive than alternatives, consumers will have to bear the cost of selecting them . Investment costs could rise as a result of increased financing costs due to the effects of Brexit. Energy efficiency measures (reducing units of energy consumed) are not enough to counter rising prices per unit. Paying for these investments through energy bills allocates the costs more regressively than paying through taxes would.

Not selected for case study: While consumer impacts could be high, they manifest as pass-through costs with little ability for consumers to influence.

Relevant trends: Climate change and decarbonisation, solar PV, advanced building technologies, Brexit, austerity, inequality.

2. Storage

Electrical storage becomes a significant part of the UK electricity system as costs decline. As storage costs decline, there are a range of potential new applications for storage at household, local and national network and generation sites. These applications include grid support, load shifting and back-up to solar PV for households and industry. A commercial case depends on large swings between low and high prices which storage operators can arbitrage.

Commercial storage applications could reduce the need for other demand smoothing activities, such as time of use tariffs. It could mitigate the need for investing in base load capacity in a network with large quantities of weather-dependent renewable energy. Future storage costs are highly uncertain.

Selected for case study: (Chapter 5) Potential impacts affect wide selection of industry participants, and may be instructive in decisionmaking when technology future is very unclear.

Relevant trends: Storage, solar PV, climate change and decarbonisation, natural consumers

3. Carbon capture and storage

Carbon capture and storage develops as a method for tackling climate change. CCS involves the capture of carbon dioxide at power stations and industrial works, transporting it and storing it underground rather than releasing it into the atmosphere.

Consumers are asked to support development of new CO_2 transport networks, even though their use is based on decarbonising industry as well as energy supply. (Consumers have not previously been asked to support industrial decarbonisation in this way).

Not selected for case study: Government support for CCS demonstration has recently been withdrawn. No new timetable has been set for work to resume. The question of who pays for the network, and how, remains important if work is resumed.

Relevant trends: Carbon capture and storage, climate change and decarbonisation

4. Peer-to-peer trading

Peer-to-peer trading of electricity develops as household producers sell excess production to local users, via an online platform. Several companies are trialling this model, including Piclo in the UK, Yeloha in the US, and Vandebron in the Netherlands. Peer-to-peer suppliers could potentially increase competition in the market, but it is unclear how they will be able to operate as part-time suppliers. Impacts on network cost allocation difficult to predict. Solar generation is the main driver of this model, and its success is tied to that of the solar PV sector.

Not selected for case study: Prospects appear more marginal than other disruptions with some similar characteristics (intermediation and new pricing models) which were selected for case studies.

Relevant trends: Solar PV, smart meters, sharing economy, natural consumer, digital marketplace

5. International supergrid

Low-loss transmission networks enable much greater electricity interconnection, allowing generation to be outsourced to countries with comparative advantages such as deserts (for solar production) or generation capacity surpluses, allowing electricity to be generated where conditions are most conducive. While increasing geopolitical risk in the electricity system, such networks open up the possibility of reduced consumer costs through trade. Such a shift would require the gains from more efficient location of generation (and possible carbon benefits) to outweigh the cost of developing an international network.

More interconnectors (without low-loss transmission) are already in development, with interconnection expected to rise from 4 to at least 10GW of capacity in the next decade. However, the effects of Brexit on proposed connections with Europe and beyond have yet to be felt. Some or all of these proposals may be under review in light of the new political landscape.

Not selected for case study: Technology prospects for low-loss transmission seem more distant than the 10-year remit of this project. Costs (or savings) likely to be passed through to consumers, with no change in consumer behaviour expected or resulting.

Relevant trends: Low-loss transmission, Brexit, trade and globalisation

6. Modernise transmission and distribution charging

A decreasing proportion of households bear an increasing share of transmission and distribution network costs, as owners of self-generation (mostly solar PV) units avoid charges. Current charging methodologies base payment for networks on units of electricity drawn from the grid. Solar PV owners currently reduce, (and with storage may be able to eliminate) the amount of power they draw from the grid, even as they use it to sell excess power to other users. The grid costs are reallocated to its remaining users. As solar PV owners tend to be wealthier, this also entails a shift of the cost burden from richer consumers to poorer ones. If solar deployment increases further, changes may be needed to ensure equitable allocation of transmission and distribution system cost.

Selected for case study: (Chapter 6) Due to high likelihood and distributional effects.

Relevant trends: Solar PV, climate change and decarbonisation, austerity, inequality, natural consumers

7. Utility mega-bundling

Broadband over power lines or other technology combinations allow mega-bundling of utility services. Bundling of utilities already exists, especially for commercial customers, as operations such as billing and customer services are overlapping functions. Technology developments could allow for much greater intertwining of systems between, for example, broadband and electricity providers, allowing for more integrated utilities. Customers could have a simpler experience, dealing with one company for all their utilities (whether this convenience outweighs the benefits of corporate specialisation is hard to judge). This would create particular challenges for regulation, which is already grappling with the increasingly fuzzy boundaries between energy and communications (data) services as smart metering is deployed.

Not selected for case study: While development of broadband over power line technology appears stalled, issues around bundling of multiple utility services (including energy, communications, and soon water) are likely to increase.

Relevant trends: Broadband over power line, convenience

8. Intermediaries

New entrants with superior customer service and/or better technology act as intermediaries between energy companies and consumers, taking control of supplier choice. The introduction of smart meters enables easy switching and can provide abundant usage data. New entrants could offer superior customer service, be more trusted than incumbents, and simplify consumer interactions with digital interfaces. They could facilitate automated switching to the best deals, leading to lower bills for customers. They could also lead to a 'digital divide' whereby participant customers increasingly avoid costs passed on to others - or help eliminate it by making engagement with the energy market simpler and more painless for consumers.

Selected for case study: (Chapter 4) Due to numerous consumer and regulatory policy challenges.

Relevant trends: Smart meters, prosumers, convenience, digital marketplace, inequality, segmentation

9. Household-serving energy service companies

Evolution of household-serving energy service companies authorised to control aspects of consumers' energy use. Energy service companies (ESCOs) are already common in the commercial sector. For a fixed fee, they control a business's energy use, and may make investments in energy efficiency measures or other cost saving methods, in order to increase the difference (and thus the profit margin) between their fee and actual energy use. The business buying the service knows that the ESCO, rather than them, holds the risk of energy price rises.

This model could conceivably transferred to individual households (though the sums may be too small to make a real difference) or in shared living spaces such as apartment blocks.

Consumers may have to abide by specific contractual terms in order to comply with agreements, which may restrict freedom, for instance, to have windows open or set thermostats at higher temperatures.

Not selected for case study: Many overlaps with current ESCO practice in commercial sector, combined with low commerciality in residential sector suggests relatively little scope for additional learning.

Relevant trends: Smart meters, connected home, sharing economy

10. Demand side response aggregation

New opportunities for remote demand side response (DSR) aggregation develop, using smart appliances and connected home technology. DSR companies create agreements with consumers to reduce power consumption in connected devices in exchange for a payment. At times of peak demand, energy suppliers or networks can purchase demand reduction for DSR companies, enabling them to avoid costly investments in grid reinforcement or additional generating capacity.

New entrants will need to ensure that consumers are clear on the terms of the arrangement when they are signed up. Improvements in energy efficiency of appliances could reduce the gains available from short term reductions in use, reducing the viability of this type of programme.

Not selected for case study: Both in the UK and internationally, companies are setting up to deliver these kinds of services. The appetite for them at a household level (where savings are relatively small and diffuse compared to commercial sectors) is unclear.

Relevant trends: Smart meters, connected home, sharing economy

11. New pricing models

Following the roll-out of smart meters, companies will be able to introduce new pricing models which are significantly different from those currently on the market. Time of use tariffs are the most widely discussed, and which carry both the most opportunities and the most risks for consumers, but other models are also viable. New pricing models could offer more sophisticated ways of targeting and engaging consumers. However, they also risk vastly increasing complexity in energy retail, which may prove a turn-off to consumers.

Time of use tariffs entail particular challenges, as vulnerable consumers may struggle to reduce demand at peak times, and be exposed to higher prices as a result. The potential application of time of use tariffs has been part of the case behind smart meters, and has been proposed as a way of managing intermittent generation on a low-carbon electricity system.

Selected for case study: (Chapter 3) Consumer impacts are wide-ranging

Relevant trends: Smart meters, climate change and decarbonisation, big data and analytics, digital marketplace, segmentation

12. Wireless power on the go

Improvements in wireless charging could enable greater access to 'power on the go', allowing for charging of electronic devices, or even electric vehicles, in public places. This leads to questions about who pays, and how, for the power which is used.

Not selected for case study: Technology too speculative and business model too hazy to develop case study.

Relevant trends: Wireless charging, digital marketplace, electric vehicles

13. Data conflicts

Following the smart meter roll-out, there will be an abundance of energy data created. There may be a risk of data conflicts as consumers and commercial providers both claim property rights over data created by their activities.

Even if commercial suppliers stop short of actively depriving consumers of access to data, there could be a risk of misleading practices which lead consumers to believe they have less control over their data than they do.

Not selected for case study: Principle of consumer ownership of smart meter data is established and we see no grounds for regulators to backtrack on this. While commercial lobbying is ongoing, it can and should be resisted.

Relevant trends: Smart meters, big data and analytics

14. Cyber security

The creation of smart networks and connected home technologies creates a variety of cyber security challenges. At a macro scale, new vulnerabilities could be created that may increase the risks of power cuts or price spikes if parts of the supply or network systems are brought down. At a micro level, consumers' personal data, and potentially control over their appliances, could be vulnerable to malicious or criminal activity.

There are clear concerns about the cyber-security of new smart networks, with security services taking an influential role in the design specification for smart infrastructure.

Not selected for case study: These issues are better addressed by organisations with a specialism in data security

Relevant trends: Smart meters, connected home

15. Electric vehicles go mainstream

Increasing adoption of electric vehicles would have a number of implications for electricity markets. Overall demand for power would be expected to increase, especially during overnight charging periods. Tariffs could be designed for EV users to discourage charging at peak demand times. Batteries could be used as remotely controllable storage (see also item 2/Chapter 5). High uptake of EVs could reduce decarbonisation efforts needed in other areas of the economy; low uptake could see other sectors need to do even more in order to meet targets.

Not selected for case study: Medium-high assessed likelihood. Some EV relevant issues are captured in chapters on new pricing models (Chapter 3) and storage (Chapter 5). Not selected for case study due to overlaps with other chosen areas.

Relevant trends: Electric vehicles, storage, smart meters, climate change and decarbonisation

16. Ageing society

In an ageing society, energy market regulations may need to change to match wider changes in society. With more people in their late 60s remaining in the labour market, and old age decreasingly correlated with low wealth/income, and the simple increase in numbers of over 65s policy support measures, such as the Winter Fuel Payment, may need to be targeted more precisely at groups with characteristics of vulnerability to ensure those who need the most help receive it. Similarly, eligibility for other regulatory measures, such as the Priority Register Service, may need adapting to ensure those with specific needs continue to be protected.

It is reasonable to expect that future pensioners will not face some of the barriers to engagement faced by current pensioners such as digital exclusion and legacy attitudes from the pre-competition era. However a continuing prevalence of age-related health conditions would mean a larger proportion of consumers who face barriers to engagement due to conditions such as dementia or sensory impairment and for whom the maintenance of supply is a health and safety issue

Not selected for case study: Impact mostly focused on policy and regulation, with less direct impact on practices in the market or consumer behaviour.

Relevant trends: Ageing, austerity

17. Transfer of policy costs from industry to households

Political desires to shield large industrial users from rising energy costs could see a transfer of costs from industry to households. Recent high-profile issues with British steelworks could be echoed with other industrial sectors and facilities as the need to decarbonise industry bites.

Not selected for case study: While consumer impacts could be high, they manifest as pass-through costs with little ability for consumers to influence.

Relevant trends: Climate change and decarbonisation, trade and globalisation

Rating the disruptions

We selected 4 potential disruptions to explore in more detail. The selection was based on 2 main criteria:

- How **likely** is it that the specific disruptions will occur at a scale that would impact at least a sizeable minority of consumers over the next decade?
- To **what degree** are the disruptions likely to cause specific consumer protection issues?

The 17 disruptions were ranked against these criteria. The results can be seen in Figure 2.1.

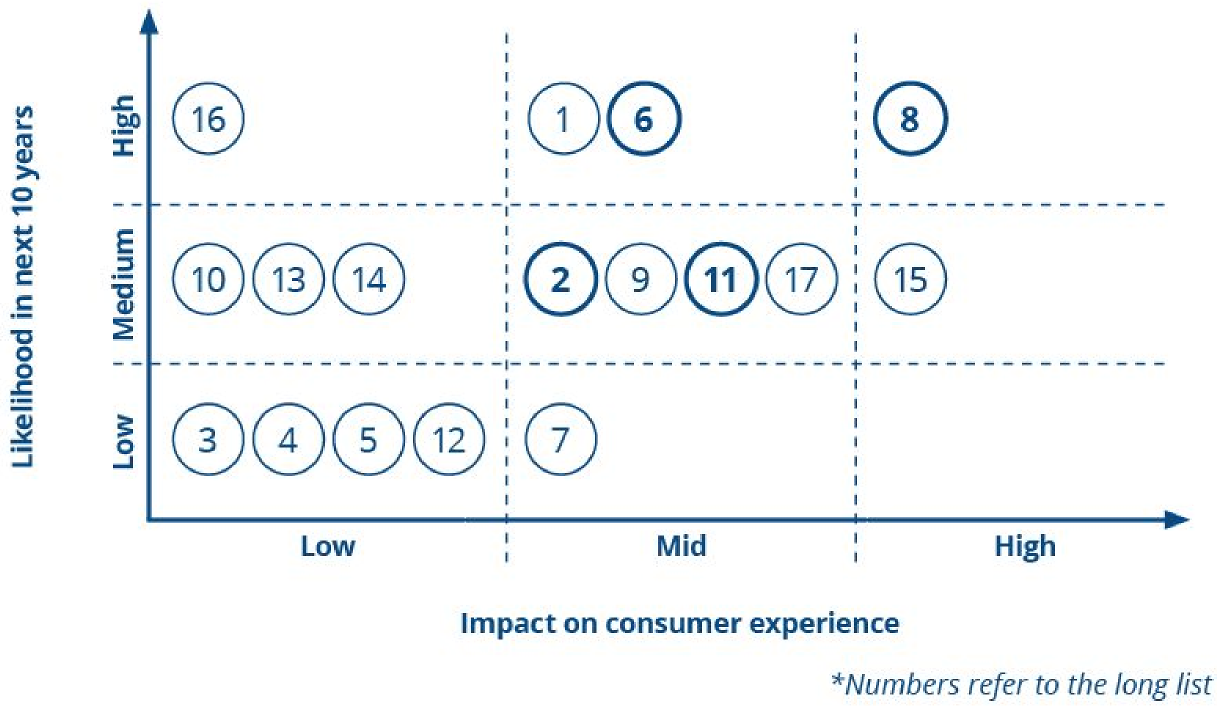


Figure 2.1 Assessing the disruptions

This left us with 8 disruptions in the upper right part of the grid. Of these, we then considered which are likely to have consumer implications that are complex and multifaceted, and have not been currently covered by other Citizens Advice research.

On this basis, 4 topics were selected for case studies:

- new pricing models
- intermediaries
- storage
- modernised transmission and distribution charging

The following chapters discuss the consumer implications of the disruptions and raise questions for policy makers.

3: New pricing models

Summary

Technological and consumer trends could give rise to new pricing models, which may serve some consumers better.

The impact of new models will vary according to consumer segment, with ToU tariffs having the biggest impact, and index-linked pricing and benchmark pricing bringing potential benefits to some groups of consumers.

Policy questions include potential barriers to new pricing models and the distributional variations between different consumer segments.

Introduction

The way energy prices are calculated plays a key role in shaping the consumer experience, and in driving engagement, or the lack of it, in energy markets. It defines how much consumers pay and can have an impact on how much energy is used and when.

This chapter lays out the challenges of current pricing models and examines how new technology and changing consumer preferences could alter energy pricing in the future. It discusses the viability of potential new pricing models and how they would affect different consumer segments. Finally, it raises some pertinent questions for researchers, policy makers and regulators.

Downsides of current pricing models

Energy in Britain is largely priced in proportion to the quantity used, measured by a single unit rate (£/kWh), supplemented by a fixed standing charge.[2] It is generally paid for after use, although 16% of consumers pre-pay. Tariffs can be either fixed or variable, with a premium usually paid for dedicated green energy tariffs. With fixed tariffs, suppliers guarantee standing charges and unit rates for a fixed period of time (usually 1 or 2 years). Standard variable tariff unit rates can be decreased or increased with 30 days notice, at the supplier's discretion. Around 70% of households are on standard variable tariffs (p. 375).

Several aspects of these pricing models are unsatisfactory:

[2] Economy 7 and other similar tariff schemes offer two-rate pricing, for 'peak' and 'off-peak' usage. 14% of customer accounts are Economy 7, and a further 3% use other restricted meter types (p. 437).

- Standard variable tariffs, which account for around 70% of the market, have failed to reflect changes in wholesale markets. Wholesale price reductions do not get passed through to SVT consumers, nor is there a transparent link between the tariff and wholesale prices.

- Fixed tariffs are consistently cheaper than variable tariffs (Figure 3.1), but when fixed tariffs end, consumers are automatically moved to standard variable tariffs. Consumers must stay active to remain on the best deal.

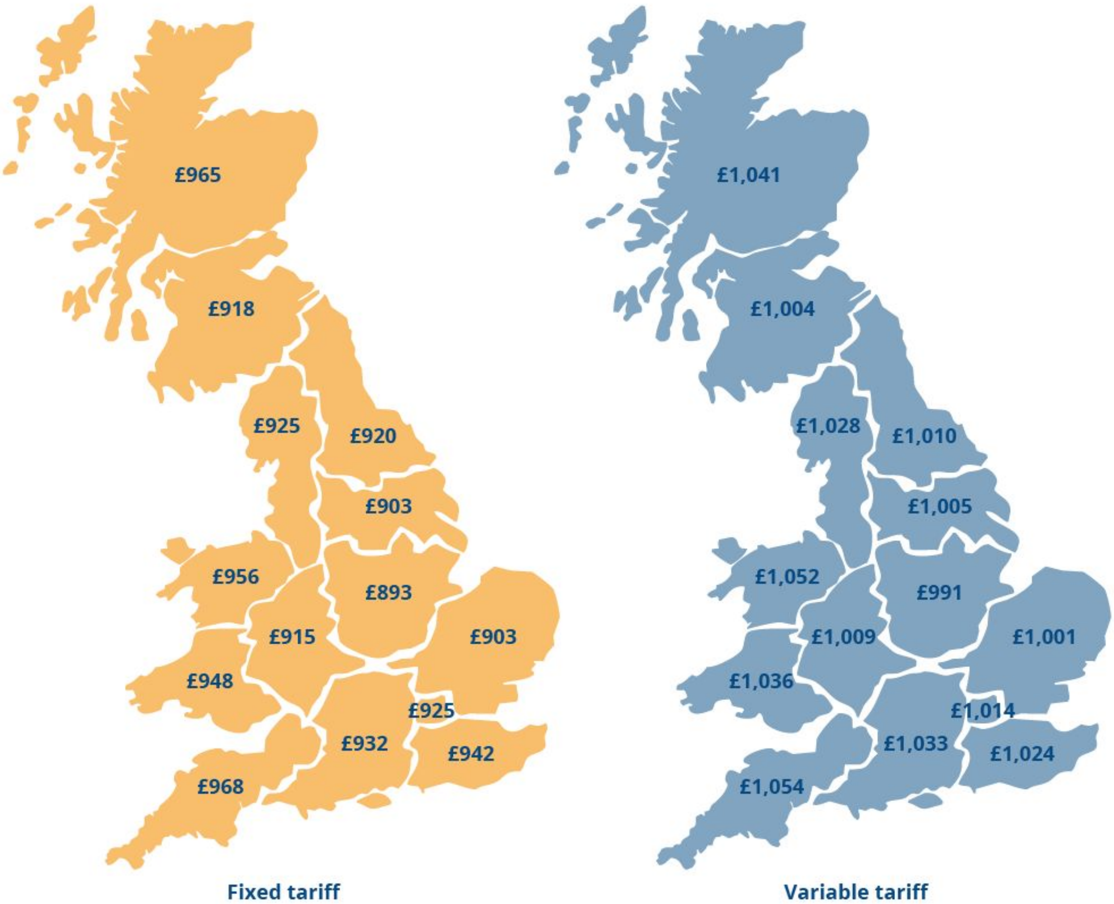


Figure 3.1: Typical fixed and variable energy bills by region

- Consumers on existing time of use tariffs such as Economy 7 often do not understand their tariff, or pay more than they would on a standard arrangement. [Consumer Focus research from 2012] found that 38% of consumers "have no storage heating and do not use any appliances at off peak rates, meaning they get no real benefit from the tariff they are on – indeed they are likely to be paying more for their electricity annually as a result."

- Without half-hourly settlement, energy suppliers have no incentive to offer more sophisticated or complex time-varying tariffs. This should change as settlement is reformed in coming years.

- Having a wide variety of pricing structures and tariff designs has historically led to confusion among consumers, and did not have a significant impact on switching behaviour or consumer satisfaction.

New pricing models

Smart meters, intended to be installed in all homes by 2020, allow energy usage to be monitored, managed and billed more frequently and accurately. This, together with advancements in data analytics, will allow energy suppliers to create more sophisticated pricing models.

The aftermath of the Competition and Markets Authority's investigation into the energy market could see a proliferation of new tariff offerings. Existing market players, now freed from Ofgem's '4 tariff rule', have the opportunity to devise new pricing models. New entrants, potentially emboldened by other elements of the CMA's proposals intended to lower barriers to entry, may be able to introduce deals that established incumbents shy away from. Smart meter deployment should help both, by being able to record and convey energy pricing and consumption information to a much more detailed degree than conventional meters.

While the 6 large energy firms' current tariff structures are profitable (too profitable, according to the CMA, which has offered an extensive set of remedies to increase competition), they will need to adjust to the new circumstances. Furthermore, recent months have seen consumers continuing to switch away from the old incumbents and towards new entrants.

Both new and old companies will need to pay attention to billing systems to handle the more sophisticated data requirements implied by more elaborate pricing models. Among the 6 large energy firms, SSE will be the last supplier to introduce a new billing system, and it is due to be in place by 2018-19. The big suppliers have already been through the considerable pain of system transition to get ready for the introduction of smart metering.

Smaller players have the greatest incentives to use new pricing models to gain market share. They do not suffer from the low levels of consumer trust seen with incumbents, potentially increasing consumer goodwill towards innovation. Additionally, new entrants have no legacy systems and may come with strong digital and analytics capabilities built in other sectors (eg online retail). These would enable them to develop new systems and channels (eg mobile apps) suitable for innovative pricing models. However, this is likely at best to be uneven - 'supplier in a box' systems designed to allow for easy entry into the market are less flexible, and as new entrants approach outgrowth of this infrastructure, they will face significant challenges. Other new entrants have made the simplicity, rather than the sophistication, of their pricing models their intended selling point. With smaller, newer players much more able to specialise and target market niches, a greater spread of approaches would be expected.

The following section details plausible pricing models. Case studies from both the energy sector and other industries are included where relevant.

Time of use tariffs

Time of use tariffs offer consumers different prices depending when in the day they use electricity. As steps are taken to decarbonise UK energy supplies, with more electricity coming from weather-dependent sources like solar and wind, it is thought there will be increasing value from encouraging consumers to use more electricity at times when it is abundant, and less when it is scarce. The programme to deploy smart meters which is currently underway is a necessary first step on the road to wider use of time of use charging.

There are, however, challenges. Time of use (ToU) tariffs may lead to adverse selection problems, as they would be most attractive to consumers who are most engaged with their energy use and who that use more energy during off-peak periods. For the majority of consumers, whose energy use is split between peak and off-peak periods, the additional complexity of ToU tariffs may limit their attractiveness.

Voluntary ToU could have significant impacts on which consumers pay the highest costs. If ToU is voluntary, it is reasonable to assume that those who adopt it will largely be those who stand to benefit, indicating that they may not need to load shift significantly, or can do so easily. If the former is true, voluntary ToU may not yield the shifts in timing of demand desired to help manage fluctuating supply. If the latter, and a significant number of consumers adopt ToU tariffs to avoid some fixed costs, then those costs could end up transferred on to the remainder of the consumer base, creating unavoidable price rises for consumers who are unable to shift their electricity consumption.

ToU tariffs could also impose challenges for other aspects of the existing marketplace. A wide variety of ToU tariffs tailored to the needs of individual consumers will make price comparison far more challenging than it is today, and so could unintentionally impede competition. If there is a wide selection of ToU time bands offered by suppliers, it could be very difficult for consumers to meaningfully compare price.

Fixed or dynamic time of use tariffs

Time of use tariffs can be designed with differing degrees of complexity. The simplest form, as is used in current Economy 7 tariffs, is to designate a ‘peak’ period with a different price from ‘off peak’ times. More elaborate variants can increase the number of price intervals, or the frequency that prices change. In the most complex versions, prices fluctuate constantly in response to real-time market conditions, reflecting the scarcity or abundance of generation at any given time. Fixed ToU (where prices and the times at which prices change are known in advance) and dynamic ToU (where prices move in accordance with market conditions) each have some advantages and some disadvantages, both in relation to each other and in comparison to non-ToU tariff structures.

The use of variable tariffs for 'peak' and 'off-peak' periods aims to provide incentives for energy consumers to smooth energy consumption over the course of the day. This reduces the level of capital expenditure required to maintain the peak capacity of the grid, creating savings for suppliers and consumers. It has also been used historically to facilitate electric heating in parts of the country away from gas grids (as well as to provide for a consistent demand for less flexible baseload generation). Economy 7 is a fixed time of use tariff standard which accounts for 13% of the market today. British Gas's FreeTime tariff, which offers free electricity use from 9am to 5pm on either Saturdays or Sunday to smart meter consumers, is a different approach to fixed ToU.

Dynamic ToU tariffs have all the challenges of potential adverse selection as mentioned above, but real time pricing also has the potential to cause significant consumer confusion, due to its lack of predictability. Such unpredictability may also make it more difficult for consumers to effectively change their behaviour should they wish to shift power use in response to tariff changes. It is difficult to envisage dynamic ToU being an attractive consumer offer without widespread availability of automation. The need for consumers to be aware of, and respond to, wholesale market conditions in real time is otherwise likely to be too high a hurdle for all but a dedicated minority to engage with.

In addition, implementation would require significantly more complexity for suppliers' IT systems, increasing the likelihood of errors in measurement and billing. In analogous consumer markets, the trend has been towards simpler pricing structures (for example, there has been a marked decline of ToU tariffs in competitive telecoms markets) because this is what consumers want. For ToU to take off, it will have to overcome consumers' desire for simpler structures

Subscription

In contrast to ToU tariff designs, which imply more complex tariff design than is presently the norm, a variety of 'subscription' pricing models have been proposed, with the potential to simplify things further for energy consumers. As will be seen in the descriptions of the different proposals, though, sometimes this simplicity comes with a price.

Unlimited subscription

The introduction of a fixed monthly energy bill regardless of energy usage would most likely require consumers to trade off certainty for higher cost. Given the typical seasonal variation in household energy demand and the lack of consumer incentives to limit energy usage, cost smoothing of this type would require suppliers to take a on certain amount of risk (ie the risk that wholesale prices will increase over this period), for which they will expect a return.

Some consumers may still prioritise increased foresight and simplicity for their energy expenditure and these consumers may be interested in the model. It is also possible that policy makers may erect barriers to prevent tacitly encouraging unconstrained energy use.

Unlimited subscriptions models have become increasingly prevalent in the United States in recent years.[3] In the UK, E.On's Staywarm tariff, which was closed in 2013, was a special energy purchasing scheme for houses where someone aged 60 or over lived. Electricity and gas was supplied at one fixed price all year round regardless of how much was used (within limits). A contemporary example of the pricing model is Green Star Energy's 'Unlimited Tariff' (Box 1).

Box 1: Green Star Energy's Unlimited Tariff promises consumers can 'use as much gas and energy as they like'

Green Star Energy's Unlimited Tariff, launched in September 2015, offers residential consumers in the UK unlimited use of energy for a fixed monthly rate over 12 months. Three tariff options are offered based on the size of the consumer's residence. In return for providing consumers with greater certainty, prices are set approximately 14% higher than Green Star's fixed tariff rate, providing some test of the proposition that consumers are willing to pay for greater predictability (we do not have access to publicly available figures on how many customers have taken up this offer to date). Green Star Energy asks for previous consumption to calculate price. It also reserves the right to shift the consumer to a standard tariff if the consumer exceeds the maximum annual limit of energy consumption.

Tiered subscription

A tiered version of the subscription model would enable the consumer to pick between different annual allowances for energy sold at fixed prices. Exceeding the allowance could result in a extra charges. It would be similar to bundles of minutes, texts and data used in the mobile telecom industry.

The model may be attractive to suppliers, who would be better able to segment consumers. The model also offers extra revenue streams from energy use over and above the set allowance. However, tiered subscriptions appear less compelling from a consumer's point of view. Multiple tiers would also increase complexity, especially given the monthly

[3] Just Energy (multiple states), Georgia Power, and Reliant Energy (Texas) all offer variants of unlimited subscription pricing.

allowance would need to be adjusted for seasonal variations. In addition, consumers' relatively limited ability to change overall use patterns means choice would be restricted (unlike, for example, in mobile telecoms).

Advance purchase

Advance payment for 'energy units' intended for future use may emerge as a viable pricing model following the introduction of smart meters. This would have many similarities to the current prepayment model, but rather than being constrained by meter type, customers on non prepayment smart meters could purchase a certain quantity of energy from one firm, at a given price, and then draw this down over time as they consume energy. In theory, the next time they top up they would be free to buy credit from any firm in the market.

This pricing model faces significant hurdles in the current regulatory environment. In particular, the question of what happens to a consumer when their stock is drawn down would need considerable thought. Would they have to be moved to another enduring tariff, and if so at what rate? Would advance purchase suppliers by necessity have to also offer more conventional tariffs to be used in case of this type of situation? Would it have to be combined with a form of direct debit to be used if and when consumers fail to top up their accounts when the purchased supply was depleted, and/or with an offer of 'emergency credit', similar to that granted to current pre-payment meter users?[4] What prompts might be desirable or necessary to ensure customers are given sufficient warning when their supply is about to be depleted?

Consumers using such a model could benefit from increased certainty regarding the cost of energy usage and from savings if energy units are purchased at a discount. While the prepay market has historically been characterised by low levels of competition, advance purchase freed from the constraints of fixed metering infrastructure could be a market with more competitive pressure.

Another beneficial effect might be a greater focus on energy efficiency, if consumers' increased attention to energy usage were to lead to improved awareness. This model would allow customers to "shop around" for good deals, which providers may choose to offer if they know they are likely to have excess supply.

Suppliers could gain market share, in particular from consumers who want increased clarity of cost and who are already conscious of their energy use. However, they would face a considerably more challenging environment in which to manage forward purchases of energy. Hedging strategies could become much more difficult to manage if demand is very

[4] British Gas prepayment meters have £5 of emergency credit available in case customers are unable to top up.

unpredictable. A possible consequence of this would be much greater sensitivity to spot market prices, and as a result possibly higher prices for consumers.

This model has been well received in New Zealand and Australia (Box 2), indicating it could provide a viable alternative to pre-payment meters in the UK. However, if it requires consumers to spend significant additional time purchasing and managing energy, this will limit its ability to expand beyond an engaged niche of consumers.

Box 2: Advance purchase of 'powerpacks'

In September 2016, Scottish Power announced a new product to be launched on to the market. PowerUp allows Scottish Power customers to buy energy in packages lasting from one day to a month, up to 180 days, up front at a set price, and to track their usage using a new app. While at time of writing some key details (such as the price) were not yet available, the structure of PowerUp has several similarities with products offered in Australia and New Zealand.

Powershop offers advance purchase of electricity to roughly 115,000 consumers in Australia and New Zealand. Electricity units are sold as 'powerpacks' with 4 tariff options:

- Top-up packs: advance purchase of electricity that can be used immediately.
- Future packs: advance purchase of future electricity to help level out annual energy expenditure
- Special packs: promotional packs at discounted prices
- Green packs: electricity with certified carbon offset or generated from renewable sources

Once consumers have purchased a 'powerpack' they can receive an estimate of how many days it will last, and monitor their energy usage either online or via a mobile app. If consumers forget to top up, Powershop automatically tops up the account, with no penalty charges, for which a payment is taken using direct debit. To ensure pricing is competitive, consumers are guaranteed savings in the first year. After 12 months bills are reviewed to ensure the promised savings have been achieved.

The use of competitive pricing, a strong positive brand and digital platforms have driven high consumer satisfaction rates. Powershop was second in the 2015 Consumer NZ power provider consumer satisfaction rankings (94%), with consistent rankings over 90% since it launched in New Zealand in 2009. It has had similar success in Australia, where in 2015 it topped the ranking in Greenpeace Australia's Green Electricity Guide for the second year in a row.

Benchmark pricing

Benchmark pricing promotes competition because it is based on the concept of 'price match', similar to that seen at major supermarkets and department stores. The model could help consumers cut bills without continually shopping around for the best deal.

However, when this has been tried in the past, a number of problems arose. Suppliers used to cherry pick the basket of tariffs they were comparing against, so, for example, some small suppliers would compare against 6 large energy firms firms and ignore their small supplier rivals. Similarly, 6 large energy firms firms would compare against other members of the 6 large energy firms and ignore small supplier challengers. This resulted in a lot of confusing messages out there about who was actually cheapest. Now that there are 41 suppliers competing (at time of writing, with 4 more preparing to launch), and independent suppliers have taken significant market share, a much more robust basket of tariffs would need to be used as a comparison. This is achievable, but there would need to be checks on what goes into the basket, to avoid a series of Advertising Standards complaints which would do more harm than good for customer trust.

A potential downside of the model is that it places greater administrative demand on suppliers, associated with notifying consumers about price changes more frequently. Also, in the longer term the model could lead to price convergence and price stickiness. Finally, it is worth noting that in recent months most supermarkets have stopped offering similar programmes, highlighting the complexity of managing the schemes and the perceived lack of consumer interest in deals of those kinds.

Index-linked pricing

Index-linked pricing would be similar to current variable tariffs, but with additional transparency around when prices change. It has some benefits for consumers and suppliers, but also carries clear risks.

For consumers, it would offer a more transparent variable tariff, ensuring prices rise and fall in line with the wholesale market and potentially leading to lower average bills.

For suppliers, there would be a potential reputational benefit arising from greater transparency and faithful tracking of the wholesale market. The model would also limit exposure to wholesale price volatility, with fluctuations passed on to consumers. Index-linking would be potentially beneficial to consumers in a falling commodities market (as has been observed for the last couple of years), but would risk making the impact of price rises more acute in a rising market, as the cushion provided by supplier hedging behaviour would be taken away. An external index could weaken pressure on firms to purchase wholesale energy efficiently and to act competitively in wholesale markets.

Index-linked pricing would be structured in ways similar to variable rate mortgages (Box 3). It is worth noting that an average monthly index may be best suited for this tariff (rather than daily), given the mandatory 30-day tariff change notice period.

Box 3: Tracker mortgages could provide a model for index-linked pricing in the energy sector

There are two types of variable rate mortgage: standard variable and tracker. The former is linked to the lender's own standard variable rate, which is priced independently and can vary across lenders. It is similar to standard variable tariffs in the energy market. In contrast, tracker mortgages charge the Bank of England's base rate plus a spread. They are transparent and pass on the full effect of any base rate cuts or increase to the consumer. These could form a template for an index-linked energy tariff.

There are, however, two factors to consider which may make the index more difficult to calculate than the mortgage equivalent. It will be more difficult to agree a wholesale price for electricity, given both its volatility and the wider base of input costs, which encompass variable commodity prices, and fixed and variable policy and network costs. There is currently no standard rate, and Ofgem's efforts in the past to create a benchmark have been troubled.

Implications of new pricing models for types of consumers

This report uses an adapted version of an existing consumer segmentation to study the implications of new pricing models. This section uses the seven archetypes identified in the Household Electricity Usage Study (HEUS). The study, funded partly by the Department of Energy and Climate Change, monitored electricity consumption for 250 households across England from 2010 to 2011. The segments are based on the interaction of energy use patterns, social grade and attitudes to technology.

Box 4: Descriptions of clusters identified in the HEUS

1. **Profligate potential** (7%) – these are high occupancy, low social grade households with the highest levels of electricity consumption and large numbers of inefficient appliances. While their beliefs may be relatively green, they are failing to put these into action and exhibit, by far, the greatest scope for appliance efficiency improvement.

2. **Thrifty values** (25%) – this cluster consists of small, relatively low social grade households with few appliances and low levels of electricity use. Conservative electricity consumption is accompanied by non-green attitudes, indicating that the frugal focus of these households derives from cost-conscious values rather than environmental conservation.

3. **Lavish lifestyles** (9%) – these are affluent households with the highest social grades and largest building floor areas. While they possess green beliefs, this is not reflected in their actions, which are characterised by high electricity use and many appliances.

4. **Modern living** (10%) – the small, predominately single occupant households in this cluster live in newly built homes and have medium to high social grades. These households use low levels of electricity, which is well-aligned with their green actions and small household sizes.

5. **Practical considerations** (20%) – these medium to high social grade households have the highest occupancy levels, yet still manage to constrain their total electricity usage to medium levels. The households have the lowest electricity use per person, reflecting the judicious use of electricity in densely occupied (ie lowest floor area per occupant) households with relatively green beliefs.

6. **Off-peak users** (19%) – these medium social grade households consume a small fraction of their total electricity use during the peak-time period. These households possess predominantly retired respondents, which is linked to their off-peak electricity usage patterns.

7. **Peak-time users** (10%) – this cluster exhibits high levels of electricity use with a high fraction of this occurring during the peak-time period. These households have, by far, the highest peak shifting and fuel switching potential savings available, though their relatively non-green actions appear to be inhibiting the extent to which these are currently being realised.

Figure 3.4 shows the impacts of these pricing models on each consumer segment along two dimensions: *financial* and *non-financial* impact. *Financial impact* looks at whether energy bills would be likely to rise, remain the same or fall for consumers in the given segment, for each pricing model. The *non-financial impact* looks at whether there is any effect on the following 3 areas:

- Does the pricing model allow consumers to continue consuming energy the way they do now?
- Does the model provide certainty and transparency for consumers regarding their energy bills?
- Time and effort required to monitor and manage energy purchase and usage?

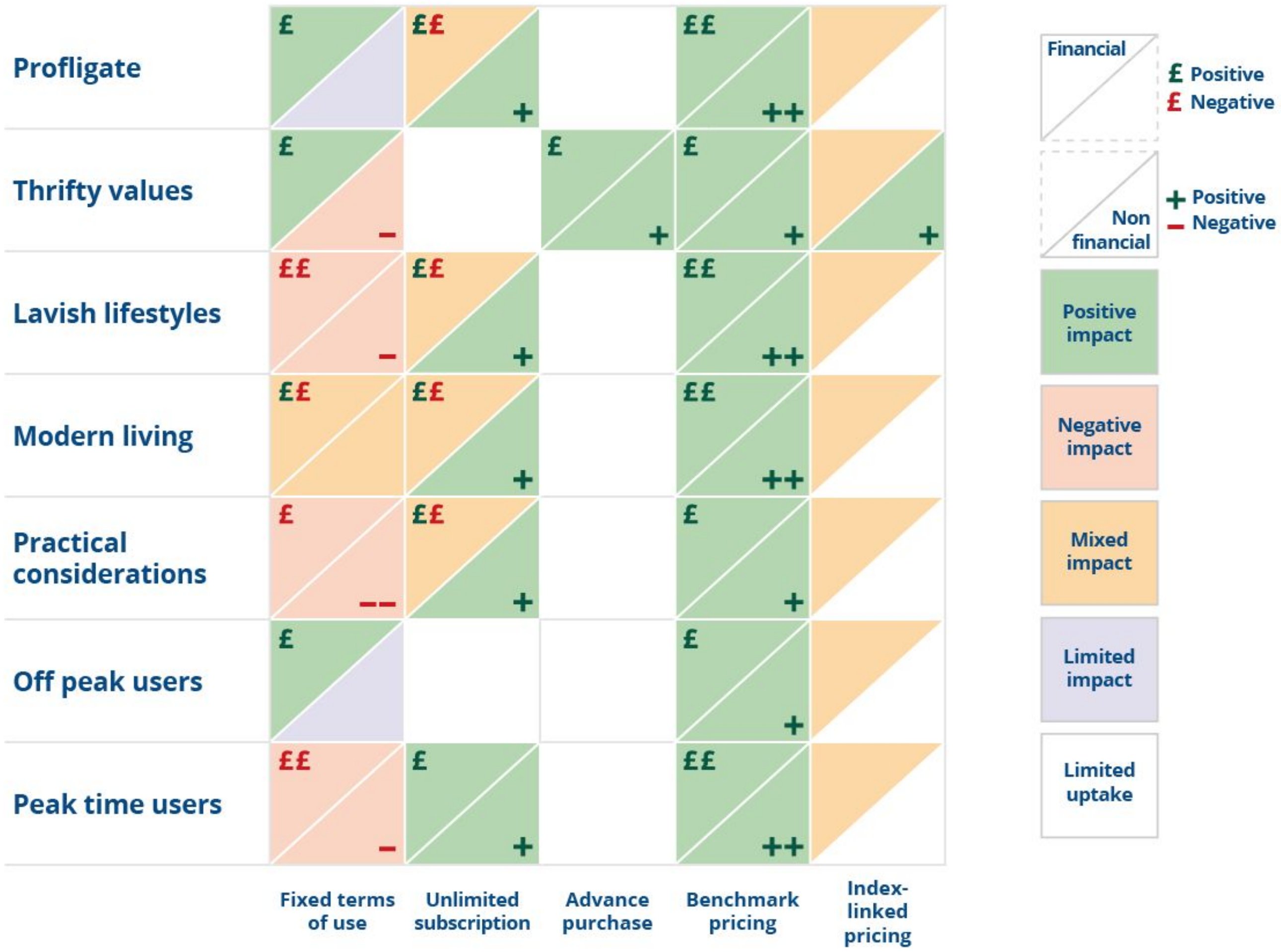


Figure 3.4: Overview of consumer implications for each pricing model. Citizens Advice analysis.

Time of Use tariffs

Fixed ToU tariffs are likely to cause undesirable effects for certain consumer segments, either in the form of higher bills or required changes to lifestyle.

For households that face difficulties in changing their peak-time energy use, ToU tariffs could result in higher energy bills. Families with children, who are less able to change the times they do things, are likely to fall under this category; especially those in the Practical Considerations group. People with disabilities and older people, who are more likely to be at home throughout the day, are also likely to be limited in their ability to change their energy consumption patterns. Lavish Lifestyles and Peak-Time Users, who have high levels of peak usage, are also likely to be negatively financially affected. In contrast, cost-conscious Thrifty Values are likely to be more responsive to behavioural incentives, leading to lower energy bills but greater inconvenience.

Consumers that will benefit overall are those who mostly use energy during off-peak periods, such as Profligate Potential, older members of Modern Living and Off-Peak Users.

An interesting development of the introduction of ToU tariffs could be that more tech-savvy consumers, such as from the Modern Living segment, might embrace the 'connected Home' to mitigate negative financial impacts (see Box 4). Similarly, automation may help mitigate the very high levels of complexity associated with variable time of use tariffs.

Box 5: Connected home utility management systems optimise energy use in response to ToU tariffs for those able to invest

The connected home brings together appliances, security, entertainment and utilities to allow central and automatic control. Two of the biggest players in the UK market are Nest, which was acquired by Google in 2014, and Hive, owned by British Gas. These smart thermostat brands, and their corresponding ecosystems, already claim to deliver energy savings of 20% to 30% (though these claims are difficult to verify due to limited access to commercial data). For some electrically heated homes, these savings could increase following a potential introduction of ToU tariffs. In addition a connected home system would enable greater control over energy use than standard smart meters. For example, direct load control would entail automatic switching on/off of appliances according to peak and off-peak periods. The complexity of such systems, and the high up-front cost is likely to mean that uptake would be concentrated among wealthier and more tech-savvy consumers.

Unlimited subscription

Consumer segments with low energy usage (Thrifty Values and Modern Living) are unlikely to switch to this pricing model, due to a substantial difference between the subscription fee and their current energy bills. Consumers with medium to high energy bills may see positive non-financial effects in the form of greater certainty regarding expenditure, while reducing any worries about usage. The expected financial impact could be positive or negative, although given that the business case entails suppliers charging a premium in exchange for certainty, it is more likely to be negative. There is a considerable risk that some consumers sign up to this pricing model under the false impression that it is cheaper. When implementing new regulatory principles, Ofgem will need to be alert to the way claims about this type of tariff are portrayed in marketing materials.

Advance purchase

If the regulatory issues around transitional arrangements at the end of advance purchase agreements highlighted earlier in the chapter can be resolved, advance purchase has the potential to bring both financial and non-financial benefits to consumers that choose to switch. These comprise lower energy bills, greater certainty and reduced volatility of energy expenditure over the year. However, uptake is likely to be limited because it requires higher levels of engagement and investment of time than most consumers are willing to offer at present. The two segments most likely to take up this pricing model are those that are cost-conscious and hence willing to commit time towards buying energy (Thrifty Values) and those that may prefer digital channels to purchase energy, such as the Modern Living segment.

Benchmark pricing and index-linked pricing

Though not without their own problems (as highlighted earlier in the chapter) benchmark pricing and index-linked pricing appear relatively balanced in their impacts on different classes of consumers. For benchmark pricing, benefits consist of energy bill savings and peace of mind, resulting from a competitive tariff without the need to switch repeatedly. Particular groups who would benefit most are those facing the highest energy bills (Profligate Potential, Lavish Lifestyle and Peak-Time Users and Unrestrained Users) and those least likely to have switched in the recent past.

Under index-linked pricing, consumers benefit from possible satisfaction from increased pricing transparency. However, that is traded off against a greater exposure to commodity price risk, which household consumers are unlikely to be well placed to address. As with benchmark pricing, the segments with the highest energy bills will benefit disproportionately in a falling market, but will be the most exposed to price rises should they occur. It is not clear from the survey whether any user types are better placed than others to manage this risk. Consumers that are most cost conscious (ie, Thrifty Values) may benefit in non-financial terms, as benchmarking makes the job of remaining on relatively cheaper deals less work. Tackling how consumer uptake can be maximised is a key challenge for the latter two models.

Increasing consumer switching

It is assumed in assessing the impact of pricing models that consumers will at least consider new tariffs and decide whether they appeal to them. However, the CMA investigation has highlighted substantial levels of disengagement. For example, 34% of consumers have never considered switching supplier. For new pricing models to make a difference for a significant number of consumers, switching will need to increase. If consumers do switch, they are disproportionately likely to switch to smaller players; the firms more likely to offer novel pricing models. In 2015, 40% of all switches were from a large supplier to smaller supplier. If switching rates do not increase further, there will continue to be the effect that innovations in the market lead to benefits accruing to an active minority, while the absence of competitive pressure on sticky customers will see them bearing an ever greater share of the costs of the market as a whole. New pricing options could increase switching by appealing to previously disengaged customers - however, there is little evidence to provide confidence that this will be the case. Following the CMA investigation's conclusion, we are likely to see the proposition tested in the marketplace.

Questions for policy consideration

As can be seen from Figure 3.4, some new pricing models could potentially bring either cost or convenience benefits to a different of consumer segments. However, there are also major barriers to more innovative models being implemented. Important concerns must be addressed by policy makers and regulators.

How should pricing innovation be weighed against consumer protections?

In principle, innovation in pricing models should be welcome for all consumers. The marketplace offers a way to test the attractiveness of companies' offerings, and those which cannot attract enough customers will fall by the wayside. However, in practice there are notable hurdles in the way of each of the pricing models identified in this Chapter. Loosening regulations to enable new entry and tariff innovation may imply weakening some existing protections. The challenge for the market, and for Ofgem, is to have a regulatory environment flexible enough to accommodate these innovations without them leading to the kinds of problems previously observed in the energy sector. The move towards principles-based regulation is a first step along this pathway. But it is not yet clear how Ofgem's principles might deal with the questions raised, for example, by the end of an advanced purchase scheme as described earlier.

What can be done to support development and adoption of new pricing models in general?

There are several basic principles which are likely to aid introduction of disruptive new pricing models, although all fall into the realm of 'easier said than done'. Lower barriers to entry are widely sought in policy circles, and are likely to aid pricing innovation as new entrants may be more likely to offer innovative pricing models.

Despite considerable efforts spent on persuading consumers to switch, and the sizable rewards to those who do so, it remains clear that many consumers are disengaged and reluctant to switch energy supplier. The introduction of smart meters, will likely increase consumer awareness of energy costs and could act as a catalyst to promote switching.

The adoption of new pricing models should be enhanced by faster switching, as is currently being developed.

Are there specific reforms required to support the development of individual pricing models?

Some of the potential pricing models outlined in this chapter may require regulatory or policy changes.

The current requirement of 30 days advance notice before price changes are adopted is potentially an obstacle to more flexible index-linked pricing. Consumers who wish to sign up for these kinds of tariffs could be allowed to waive the application of this regulation in regard to their own energy supply.

Index-linked pricing would require additional transparency of wholesale energy prices in the market. The creation of a published wholesale electricity price index might facilitate development. Although such a development would undoubtedly be contentious, indices have already been developed to allow for the contracts for difference renewable energy support policy to be implemented, and so indices with official standing do exist.

How can time of use tariffs be structured in a way that maximises positive incentives and minimises financial and non-financial costs to consumers?

The introduction of smart meters, and the resulting potential for creating time of use (ToU) tariffs, merits special consideration. One of the main attractions of smart meters is their ability to collect data on energy consumption, helping utilities offer price incentives to reduce peak load. They will help smooth overall energy consumption and reduce the need for costly investment in generation and transmission capacity.

At the same time, ToU tariffs pose some significant challenges. As described in this chapter, dynamic ToU tariffs are likely to be confusing to consumers and the incentives they bring may be weakened as a result.

Different consumers will have different willingness to shift consumption in response to price signals and system needs. The potential for confusion, particularly in response to fully dynamic time of use tariffs, is high, and can only be partially mitigated with automating technologies. Policymakers must give greater consideration to the question of how far energy policy should push consumers to change behaviour. Analysis of ToU tariffs that only looks at the financial rewards and penalties misses out the non-financial value that we expect consumers to place on not adapting their behaviour (eg not having to think about when they have dinner each night). If the purpose of ToU tariffs is to reduce costs, we should not dismiss the idea that consumers might prefer to pay a higher cost rather than have to change their behaviour.

Fixed ToU tariffs also raise important questions, which should be considered before the smart meter rollout is complete. For example, different consumer groups may have varying abilities to shift energy consumption. It is worth considering in particular how vulnerable households, whose ability to switch may be limited, can be protected from potentially higher energy costs (eg, perhaps through exempting households below a certain level of energy usage from ToU tariffs), or by protecting a certain volume of energy usage from being considered peak/off-peak — namely, that amount of energy required for 'essential' activities and that cannot reasonably be moved.

A broader question for consideration is how the setting of peak and off-peak periods under a ToU system would impact not just overall usage but also the degree of inconvenience the incentivised lifestyle changes may cause to families.

Possible useful research in this area might include:

1. **What percentage of peak usage is movable?** This would inform what fixed ToU tariffs can do to manage peak demand as well as inform what level of energy usage might be protected as essential.

2. **Which ToU models are likely to assist in demand and generation management most?** It would be valuable to understand whether the gains come principally from managing intermittent generation (for which dynamic tariffs would carry greater value) or from managing peak demand (which might be enabled by fixed ToU tariffs).

3. **What are the unintended consequences for consumers of ToU tariffs?** For example, are there health and safety impacts that could follow from trying to change consumers' behaviours in these ways (eg increased damp in homes from lower energy usage). Are there unappraised benefits that could accrue to consumers in the form of cost savings?

4. **What can be learned from the international experience of ToU tariffs**? In particular, understand whether there are particular tariff designs that are more attractive for consumers.

5. **What are the impacts on the whole consumer base?** If voluntary time-of-use tariffs are made available, at what level of market penetration do significant costs begin to be smeared across the rest of the consumer base?

6. **Do consumers understand ToU tariffs?** User test exemplar ToU tariffs to work out how consumers would understand or interact with them.

4: Energy retail intermediaries

Summary

Technology supports the emergence of new intermediaries in the energy sector.

Intermediaries enable consumers to reduce energy bills by making it easier to find and switch to more favourable tariffs.

More sophisticated intermediaries may analyse smart meter data to offer consumers advice on how to reduce or change energy consumption.

Regulators should consider the barriers to entry for new entrants and the potential risks to consumers.

Introduction

Intermediaries provide a link between consumers and retailers. In general, they help consumers navigate their options, using experience and analysis to help them make better purchasing decisions.

Technology is enabling a new type of low-cost intermediary, which can replace incumbents in some industries and create a new role in others (Box 5).

Box 5: Mint is creating a role for intermediaries in finance

Mint Software Inc. is an intermediary in the US financial industry, which aims to provide free personal finance solutions to consumers. Mint has developed a personal finance online and mobile app, which provides consumer analysis and simplifies switching suppliers. The software tracks personal finances (bills, bank accounts and credit cards) in real time, in addition to analysing thousands of checking, savings, credit card and brokerage offers. These are combined to generate tailored recommendations that provide access to the best deals based on the consumer lifestyles. A key strength of Mint's business case is that is leverages regulation to enable it to connect to any US financial institution, maximising choice for consumers. In addition, it offers a user-friendly interface available on multiple platforms.

Technology and consumer trends facilitate intermediaries in energy

The roll-out of smart meters to every household by 2020 will enable energy data to be easily collected and used by third parties such as intermediaries.[5] Low cost data processing should enable intermediaries to process data quickly and cheaply and provide users with insights on energy usage that could help them consume more efficiently and cheaply.

While technology enables intermediaries, it also supports consumer preferences. Consumers are increasingly looking to shop through digital interfaces and an intermediary is often to be able to provide a superior consumer experience through those channels. Consumers are also looking for services that simplify their lives, and intermediaries can automate many actions and use data to aid decision making.

The combination of technology and consumer trends suggests the influence of intermediaries in energy markets will expand in the coming period.

Box 6: Several intermediaries already operate in the energy sector

Flipper, **swuto.** and **Loop** are examples of new tech players acting as intermediaries and providing analysis to help consumers switch suppliers.

Flipper, launched in 2015, charges an annual fee of £25 to automatically switch consumers to the cheapest available tariff. Switching takes place if consumers can save 10% - this normally occurs one or two times a year. In contrast, **swuto.** is a free service offering “one button” switching for consumers, rather than automatic switching. The analysis is run once a day, and most consumers can expect to be offered a cheaper deal every three to four months. While Flipper provides automatic switching for consumers who prioritise convenience, swuto. would appeal to consumers who are less comfortable with handing over control over switching or are more cost-conscious.

Both companies pull consumers’ energy usage information directly from their online account with the current supplier, and use algorithms to offer the best deals. Currently, consumers’ energy data is based on manual meter readings. The intermediaries are likely to be able to offer more sophisticated analyses following the introduction of smart meters.

Loop Energy Saver could serve as a potential model for intermediaries once smart meters are introduced, as it currently uses its own technology to replicate smart meter functions. Launched in April 2015, Loop currently has roughly 5000 users and charges

[5] The Data Communications Company (DCC), acting as a gatekeeper of consumers’ energy data, will help consumers easily provide the data to intermediaries.

£2.99 for a monthly subscription, or £49.99 one-off lifetime subscription. Subscription includes the cost of the device. Loop provides a simple device that attaches to consumers' gas and electricity meters and sends usage data via a broadband router. This enables the company to constantly track how much energy consumers use and how much it costs, and offer consumers switching options to save money based on the usage data, through a partnership with uSwitch.com.

Consumers can access real-time and historic energy analysis presented in easy-to-read graphs online or via a phone app. Because Loop is a voluntary sign-up service, it has been able to charge consumers for access to the data it collects. Consumers will be able to access their own energy data (As collected by smart meters) without a charge.

Additional features of Loop include:

- weekly updates summarising energy use over the past 7 days
- benchmarking against households of a similar size and specification to indicate high or low energy use
- budgeting feature which allows consumers to set targets for consumption

The energy intermediary business model

The growth of intermediaries will rely on a viable business model. Below are outlined some potential operating models, informed by case studies of intermediaries in other sectors and nascent intermediaries in the energy sector (Box 7). Key intermediary services will focus on helping consumers switch to the cheapest deal and analyse energy use:

- **Subscription**: consumers pay a regular or one-off fee for the service.

- **Switching commission**: intermediaries would earn a commission from suppliers for every person switched, using the same business model as price comparison websites.
- **Advertising**: intermediaries sell advertising space on the platform, targeted based on consumer data provided.

- **Energy related sales**: service could suggest energy efficiency of DG products based on analysis of energy use and earn either commission for passing to a retailer or sell the products directly themselves.

The prices for energy services are likely to have to be relatively small per consumer, given the general low engagement level of consumers. Some existing services charge a subscription fee of £2.99 per month (Box 7), and switching commissions are ~£30 per fuel switched. Given those limited opportunities, most are likely to be delivered online or through a mobile app, with minimal employee-led customer service.

A potential evolution could be a combined intermediary that provides a similar service for energy, telecoms, television, insurance and others, enabling consumers to manage and switch all their bills on one platform.

Consumer benefits

The primary benefits of intermediaries will be cost and convenience. If implemented successfully, intermediaries should make it easier for consumers to reduce the price they pay for energy, the time spent searching, and potentially the quantity they consume. In practice this means helping consumers find the cheapest energy tariff, reduce the time they spend using electrical appliances, and improve the energy efficiency of appliances. If ToU tariffs are introduced they could also help consumers shift energy use to less expensive times of day.

Energy tariffs

70% of consumers are currently on 'default' standard variable tariffs, despite the availability of cheaper fixed rate deals, with an average potential saving of ~£160 achievable for dual fuel consumers (p. 130). Intermediaries could help consumers capture those savings by making switching simpler. As a basic initial service, intermediaries could analyse smart meter data and latest tariff deals to indicate each time a cheaper tariff becomes available. A development could be storing consumer information to make it easy to switch "at the click of a button". To increase convenience they could automatically switch consumers if a cheaper tariff becomes available. This would of course require pre-authorisation.

Enabling easy switching through one portal also opens up the possibility of controlling multiple households at once. This may be of interest for rental property landlords with multiple homes but could also allow households to manage energy of behalf of others – eg, with permission, one family member could be granted control to switch the energy supplier of several households, including for example elderly parents. This could increase the level of switching, especially for over 65s, which is the least likely age group to switch. However protections will need to keep pace with the technical possibilities, to prevent this becoming an area of harm for the tenants or relatives who have relinquished control to another person.

While consumers currently save significant sums of money from switching, it should be noted that savings could decrease as switching becomes easier. If switching levels were to significantly increase, the differential between the cheapest tariffs and standard tariffs would likely narrow. How these savings are presented to consumers will be crucial, presenting realistic assessment of savings ensuring they take account of termination fees.

Box 7: Collective switching

In a collective switch, a group of consumers are brought together by an organiser, to buy a single energy tariff for the entire group. By combining the bargaining power of many households, the collective switch should be able to attract better offers from energy suppliers than an individual householder might, saving money for all members of the group. Usually, households can sign up to a scheme before a deal is negotiated, but have the opportunity to withdraw once a final tariff offer is arranged if it does not meet expectations.

Collective switching has seen occasional popularity in the UK in recent years. Both 2012 and 2014 saw more than 300,000 customers take part in collective switching schemes. However, recruiting customers has proven to be challenging for collective switch organisers, as they must expend time and effort to locate sufficient numbers of customers to make a good deal worthwhile, but without yet having a concrete offer to make.

In several US states (Massachusetts, Ohio, Rhode Island, New Jersey, and California), however, rather than running opt-in collective switches, towns have been given the power to organise opt-out collective switches for their residents. All residential customers within the area who are not already served by an energy retailer are automatically included in the programme unless they opt-out within 30 days of the start of the switch. At the start of 2012, just 8% of Illinois electricity consumers had switched away from their default supplier, but by the end of that year, 38% had.

Energy use

With access to consumers' energy use data from smart meters, intermediaries could analyse and provide advice on how to reduce or change energy consumption to benefit consumers. Energy use such as leaving lights on during the day could be flagged by the intermediary, and potentially remotely switched off. Other lifestyle data available on a user's smartphone, such as location, could be combined to generate smart suggestions that would help consumers cut unnecessary usage.

Consumers' overall level of energy use could also be benchmarked versus households of a similar size and character, indicating to the consumers whether energy efficiency improvements could be made. The intermediary could then suggest or directly sell energy efficiency improvements, eg, boiler or loft insulation, calculating the likely financial return. Precise calculations would require more than smart meter data, so consumers would need a quote from an installer or retailer to more accurately calculate the return – the intermediary role would be to provide the “nudge” to help consumers consider the purchase. Given that many energy efficiency improvements have high returns (loft insulation typically £130-250 a year) this could be of significant benefit to consumers, although it would not resolve the hassle factor often identified as the biggest barrier to energy efficiency improvements.

If ToU tariffs are introduced (Chapter 3) there would be an opportunity for intermediaries to offer services that help consumers minimise their peak time usage. The application could alert consumers in real-time if they use a lot of power at peak times. It could also provide analysis to help consumers change their behaviour.

Across all these services, easier tariff switching is most likely to provide the biggest benefits for the largest number of consumers. The other benefits require a greater degree of consumer engagement, which would likely make them less relevant for the majority of consumers, but could still be of interest and value to the more engaged part of the market.

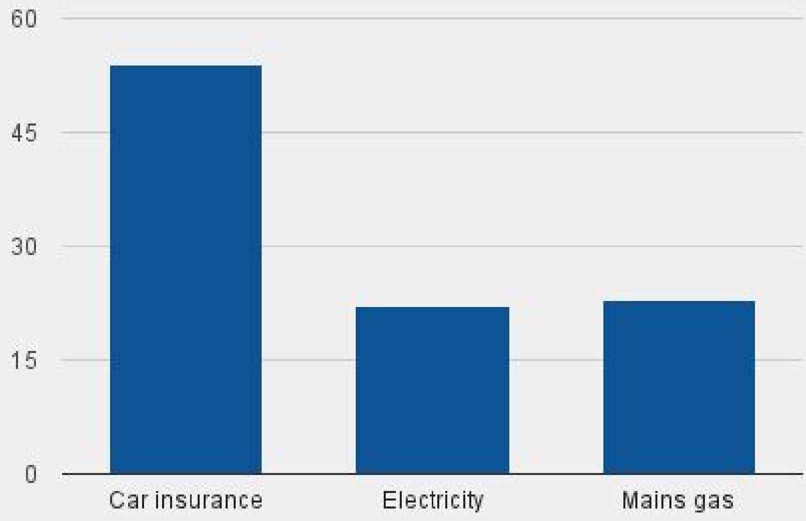
Barriers to entry

Given the potential benefits for consumers offered by increased intermediation, it is worth considering the potential barriers to the growth of intermediaries.

A core benefit of intermediaries and part of their appeal is reduced effort for consumers to switch. Regulation or energy supplier policies that create administrative effort for consumers could act as a barrier to switching managed by an intermediary. This spans the range from very basic actions like having to cancel direct debits when switching or create login details with a new supplier, to more complex issues regarding data ownership, or interactions with government support schemes for energy efficiency or renewable generation.

Box 7: UK car insurance - high levels of switching

Low levels of consumer engagement and switching in the energy sector is a key challenge for policy makers. The UK car insurance market demonstrates that it is possible to engage consumers and achieve high levels of switching. Consumers are currently three times more likely to switch their car insurance provider than their electricity and mains gas supplier (see figure). Similarly, consumer engagement in the car insurance market is much higher, reflected by the high proportion of users that shop around.



Percentage of users that shopped around in 12 months (2013/14). Citizens Advice research.

Price comparison websites (PCWs) in the car insurance market play an important role in driving consumer switching, with over half of UK consumers that conduct online research when purchasing car insurance using PCWs. The huge growth of PCWs in the car insurance market has been driven by high levels of advertising spend, with the four major price comparison websites spending £100m a year advertising on television and other traditional media, and even more advertising on Google. This has shifted value in the industry to consumers by promoting price competition among providers and encouraging providers to compete by pushing to improve customer experience.

However, fundamental differences between the market restrict the transferability of these experiences. As an essential service, it is hard to conceive of a way to create hard-and-fast expiration dates for supply that would not leave significantly harm customers. There is also no viable reason for replicating the status of uninsured drivers in the energy market. It is illegal to drive without insurance - it will never be illegal not to have an electricity provider.

The car insurance market and the growth of PCWs in this sector offer some possible lessons for the energy market:

- A regular, annual renewal for energy contracts could promote shopping around and switching. Ofgem may want to trial sending its Annual Energy Statement to households shortly before fixed term contracts expire, rather than the schedule it currently operates.

- High levels of marketing spend by PCWs generate consumer pull, with more consumers leveraging the platforms. Marketing by new intermediaries in the energy sector could help promote switching.

Intermediaries require the ability to arbitrage between high and low prices to make money. If conventional suppliers behave in a more competitive way, in particular by reducing the highest SVT tariffs, this would erode the gains from switching (and by implication from intermediaries) while improving matters for many consumers. Intermediaries may be a part of a more competitive and consumer friendly marketplace, but it is also possible for the same benefits to accrue to consumers without intermediaries' involvement. Which way the market goes is impossible to predict, but regulators will need to be prepared if intermediaries do start to thrive.

Intermediaries will have to overcome the industry-wide problems of low trust. Not only will they have to establish trusting relationships with consumers, but they will (under some business models) be signing those consumers up to any of a number of suppliers. If those suppliers are mistrusted, or consumers fear being switched to a less trusted supplier, it could impede the flexibility which is the purpose of intermediation.

Questions for policy consideration

In a market where switching can be rapid, frequent, and which features very low or zero transaction costs, many of the standard concepts of energy retail become meaningless or change beyond recognition. Counting switches will inform little if the same customers can be automatically switched on a daily basis. If a customer sticks with one intermediary in perpetuity, but that intermediary arranges that they buy power from dozens of different suppliers over the course of a year, can that consumer be said to have switched or not? Likewise, if suppliers react to the development of intermediaries by levelling off price offers, such that the gains from switching erode to nothing, will consumers have gained or lost from that change?

The marketplace enabled by technology and intermediation business models will need new approaches to these questions. Established stakeholders, including Citizens Advice as well as government and the regulator will need to think carefully about how to approach these fundamental questions. Other, practical considerations will also arise.

In the coming year, Ofgem will be consulting on reform to the confidence code for third-party intermediaries, and on models of regulation for intermediaries in domestic and non-domestic markets. Citizens Advice will be contributing to the upcoming review, incorporating work on:

How can regulators and policy makers encourage the development of intermediaries?

Increased intermediary activity has the potential to benefit energy consumers, but currently their impact is behind that seen in other markets, such as insurance.

Technology will be a key driver of the development of intermediaries, and the effect will be enhanced with the arrival of smart meters across the UK. Ensuring open access to data from smart meters, without compromising consumers' ownership of their data (initiatives are already in progress) will be critical to overcoming potential barriers to entry.

Ofgem's Confidence Code (which currently only accredits price comparison services) could be adapted to accommodate other forms of intermediary. This would also give intermediaries into industry procedures where Confidence Code accreditation is a requirement.

Offsetting the potential downside of intermediaries

While intermediaries have the potential to increase consumer choice and promote switching, there are also potential concerns around their role.

One is that intermediaries that offer automatic switching may switch consumers to sub-optimal tariffs. That may be because of faulty software or programming, or because consumers have changed their pattern of usage. Policy makers should consider what protection is necessary to avoid and compensate for erroneous switches.

5: Widespread adoption of storage

Summary

The pace of development and deployment of new electricity storage technologies is accelerating and the solutions could play an important role in a flexible, lower-carbon electricity system.

Storage will become increasingly relevant as demand for electricity increases while the electrical grid incorporates more intermittent renewable sources of generation.

Storage could bring multiple benefits for consumers, mitigating the need for altering consumption and facilitating more cost-effective use of renewable energy.

Introduction

Energy storage has gained increased prominence as one of the technologies that may play an important, and novel, role in the energy market. It has gained recent attention thanks to new products such as Tesla's Powerwall, as well as its deployment as a component of electric vehicles. This chapter outlines key trends that may shape the impact of energy storage and describes how new uses may work. It explores the impact and discusses possible routes to adoption. Finally, the chapter sets out questions for policy makers and regulators that remain unresolved.

Battery storage is gaining momentum

The development of new electricity storage technologies is accelerating, with batteries becoming the dominant form of storage. Lithium–ion (Li-on) battery costs have fallen between 6-8% per year over the past seven years. Increased renewables generation and innovations in the consumer electronics sector (eg, smartphones) are increasing demand for battery storage. Industry predictions are bullish - lithium battery prices are expected to drop by roughly 50% over the next 5 years, while flow battery costs could decline by 40% and lead batteries by 25%.

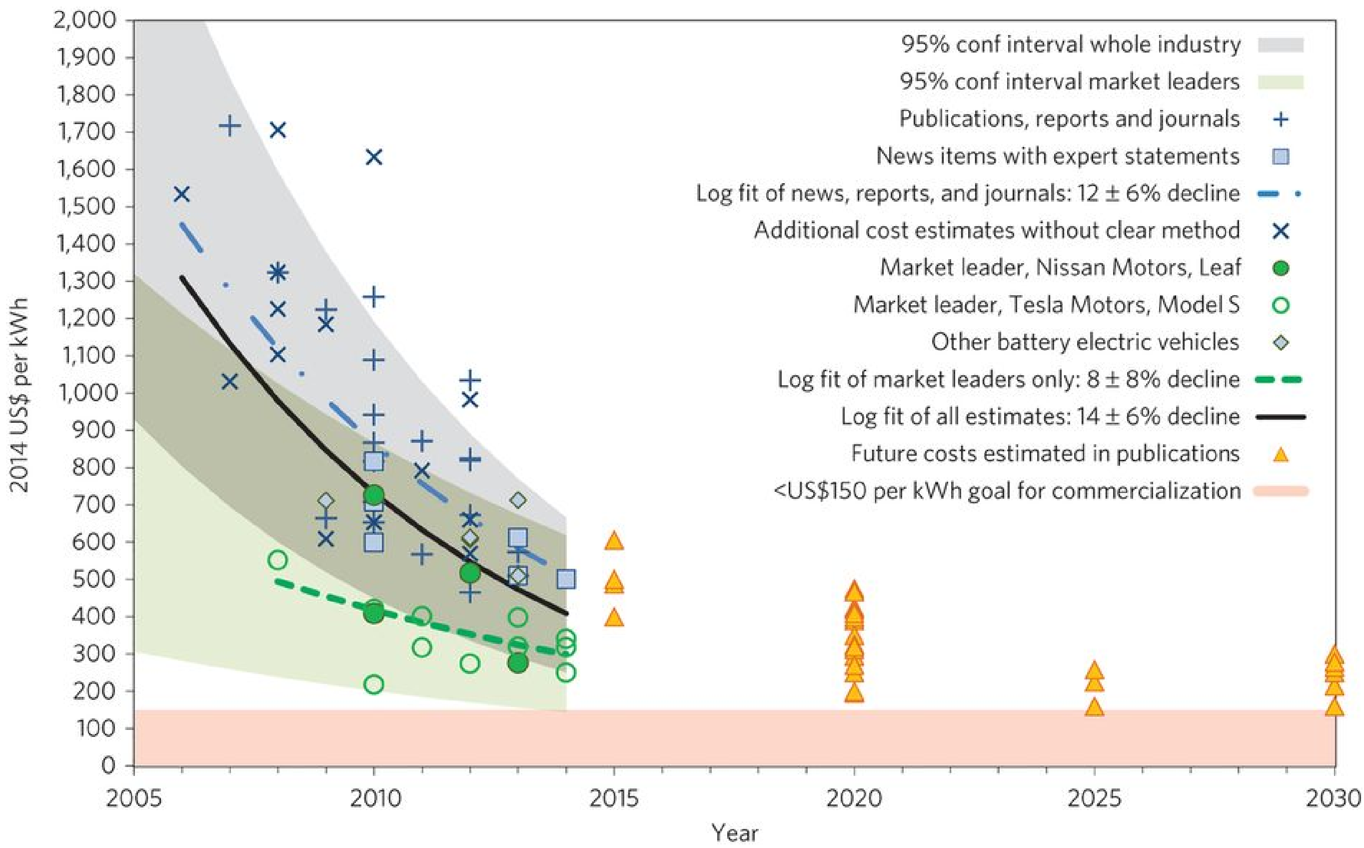
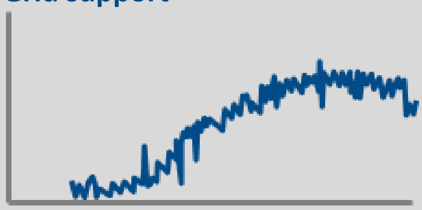


Figure 5.1: The costs of battery storage are falling

Other changes in the energy sector are expanding the potential uses of battery storage. First, the use of intermittent renewable energy is increasing, as the UK bids to meet its ambitious de-carbonisation targets by 2050. Second, there is unprecedented growth in demand for electric vehicles, with demand for pure electric vehicles and plug-in hybrids rising 48% and 133% respectively in 2015. A range of possible applications of more battery storage is outlined in Figure 5.2.

Application	Description
Grid support 	• Maintain reliability and increase efficiency by balancing generation and load on the electric grid • Frequency regulation, operating support • Fast response times required • High cycle times required
Household and system-wide load shifting	• Supports storage of power when it can be generated most readily (eg, sunny days, off-peak times) for use when most needed (eg, peak power times). • Short term: balancing across peak/off-peak periods of the day, driven by the grid's capacity constraints • Households with distributed generation can use self-generated power when grid power most costly, rather than when generated.

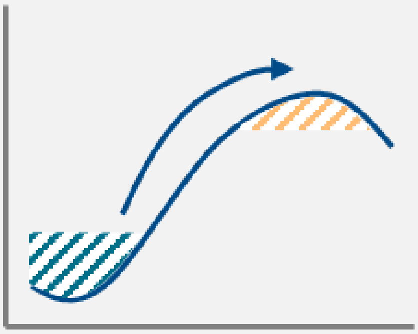
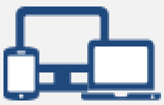
	• Longer term: balancing across unpredictable supply as a result of greater variable renewable energy • Typical storage times: hours to days • High cycle life, regular use
Off-grid households 	• Facilitate households with distributed generation which eventually choose to be self-sufficient, and not connected to the grid • Relatively low cycle life, irregular use
Industrial off-grid and backup 	• Energy for structures/buildings not connected to the grid (eg, telecom towers, remote villages) • Industries that require backup energy supply (either due to poor grid quality, or carry out highly important functions, eg, hospitals) • Relatively low cycle life, irregular use
Electric vehicles: mobility 	• Batteries required to provide power for HEV, PHEV, BEV, electric two-wheeler • High energy density and power density required • New models allow re-selling of electricity from vehicle batteries back to the grid.
Consumer electronics 	• Batteries for laptops, cell phones and other electrical appliances • Lithium-ion batteries most commonly used

Figure 5.2: Key applications of more storage

Load shifting is the most important potential future application of storage

These applications will affect household consumers to different degrees. Applications to support grid functions and renewables balancing will be largely invisible to consumers, although their implications for other parts of the energy sector could still be transformative and lead to some savings in terms of energy system costs. Household off-grid applications could have a direct impact, but it is unlikely a significant portion of households will move off-grid in the foreseeable future.

For now, the main reason it is useful to smooth out energy is because of changes in demand over the course of a day or a week. Batteries can store energy when demand for energy is low, such as at night, to be used when demand is higher, such as first thing in the morning. In the long run, however, load shifting is more about smoothing out ups and downs in the energy supply. For example, energy from solar panels can be stored when the sun is shining, and then be used at night.

Consumer implications of demand-driven load shifting

Capacity margins have been dropping over recent years, causing National Grid to intervene more and more frequently using a variety of methods. This mainly consists of efforts to boost supply availability, but also aims to reduce demand during peak times. One approach currently being considered is the introduction of time of use (ToU) tariffs (Chapter 3). By varying the energy retail price depending on the time/day, the tariffs would provide consumers with an incentive to move demand away from peak times. However, if low-cost storage at scale were available, this could help manage the situation without the need for consumers to make perhaps difficult choices around when they consume energy. In this way, commercialised storage potentially competes with time of use charging as a method of addressing the same load time management problems. This could be achieved by either centralised or household storage.

Centralised storage to achieve peak load shifting would enable excess electricity to be generated at off-peak periods and stored for later distribution to households during peak periods. It could act either as an alternative to the introduction of ToU tariffs, or to reduce the price differential between peak and off-peak periods under ToU tariffs. This would reduce the need for consumers to change energy consumption patterns. Still, they may face higher bills if the investment costs of storage are passed on. In a market environment one might only expect storage to prevail if cheaper than the next best alternative, but given the current complex state of energy procurement, it is far from clear how many market investment signals remain.

By contrast, distributed storage would be a way for consumers to mitigate the effects of ToU tariffs. Implementation would involve the installation of household storage batteries that consumers could charge up during off-peak periods for use during peak periods. Unlike centralised storage, benefits would be limited to consumers able to afford the installation of storage, and would only be realised in a future where sizable price variation was commonplace. This would mean that benefits would be unequally distributed, and likely concentrated amongst wealthier consumers.

Alternatively, utility companies or third parties could offer to install storage for consumers as part of a 'buy now pay later' scheme. However, this would bring with it risks of consumers struggling to calculate whether the scheme would be economical. Transparency around pricing of such schemes would be critical. Reliance on distributed storage would also increase consumers' exposure to price and regulatory risk, as the pay-off would depend on the differential between peak and off-peak tariffs, which may be subject to change as a result of changes in government policy or market conditions. Ultimately the test for storage as a commercial proposition, and for customers who may consider buying into it, is whether storage can do the same job of managing the timing of electricity demand and supply more economically than other options. There is no way of knowing yet whether this will be the case. The focus for policy at this stage should be oriented towards enabling measures that allow it to compete, rather than supplying financial incentives that are not subjected to competitive pressure.

Consumer implications of supply-driven load shifting

A further potential application for storage is combining it with renewable energy sources. It is important for any home generating their own energy, as it means they can get better use out of that energy, as and when they need it. It could further improve the economics of solar PV systems, allowing the value of generated power to be increased, and thus improving the relative balance of costs and benefits. Load shifting may also help to ensure that the increase in intermittent renewable energy at the utility level contributes to a reliable electricity supply to UK households.

If solar PV costs continue to fall, or supply costs rise for consumers who have already installed PV panels, those consumers may see better returns if they install batteries to store excess electricity for later use, rather than selling it back to the grid. This will depend on the tariff structures in place. As with distributed storage in the event of demand-driven load shifting, consumers would then face greater regulatory risk, because distributed storage is profitable for households only in certain price environments. There would need to be sufficient savings from the cost of electricity that didn't have to bought from the grid, to cover the (considerable) costs of the storage unit. The more retail electricity prices rise, or the further the costs of storage and/or solar PV fall, the more attractive this will be.

Storage via electric vehicles

Electric Vehicles (EVs) could also be utilised as distributed storage EVs could be used in two ways as sources of storage. Firstly, households could use the batteries in EVs as storage of electricity for household consumption. Secondly, EVs could be connected to the grid via a smart plug, and be discharged and charged remotely as per the needs of the grid, for which EV owners would receive payment in exchange. However, there are multiple barriers to EVs being used for storage. Consumers may not want to make them available, as it could lead to faster degradation of the EV battery. Reassurance would be needed that the EV would have sufficient charge in time for the next journey. EV owners who may want the vehicle to be available in unexpected situations may prefer to keep the charge topped up at all times than rely on scheduled charging overnight. Also, the need for storage is likely to be highest during the early evening when EVs are at their lowest level of charge following the evening commute. Finally, as with time of use and other storage applications, sufficient price differentials would need to exist, and tariffs would need to be on the market to utilise them, in order for it to be worth using an EV in this way.

Questions for policy consideration

In many ways the policy and regulatory concerns raised by increased deployment of energy storage are similar to those relating to new sources of energy, including renewables.

Centralized development of storage is largely beneficial as it helps facilitate supply-driven load shifting. The key unknowns for consumers are the cost of building out the infrastructure and how much consumers will be required to pay. Those reflect the issues seen in other forms of **energy infrastructure investment** and related concerns over **efficiency and equity**.

In the more immediate future, distributed storage raises questions consumer exposure to regulatory risk. The business case for consumer investment in energy storage will be driven by ToU tariffs, and will therefore be sensitive to any changes in those tariffs (eg, if the difference between peak tariff and off-peak tariff changes substantially the business case will also change). Over time, if large numbers of households invest in storage, load shifting will occur and the rationale for ToU pricing will erode, potentially undermining the business case for storage investment.

5 areas for potential future research are:

- **Household applications for electricity storage:** The emergence of a new class of consumer products designed to take advantage of the opportunities of electricity storage potentially creates a new set of consumer-protection concerns. Just as new rules and codes of conduct have been developed to provide consumers with the confidence to enter the burgeoning solar PV market, so a similar set of protections may be required when it comes to dedicated storage products, or those which combine storage in other products, such as electric vehicles.

  Storage might also enable households to reduce considerably their reliance on supplies drawn from conventional power grids. This in turn has implications for how consumers (both those with and without possible storage products) pay for the electricity distribution and transmission networks.

- **Electricity retail markets and storage:** To fully exploit the potential of the new products reaching consumers' homes, suppliers may begin to offer new tariffs and services. The possibilities created by the development of smart grids, and of moves towards 'time of use' tariffs whereby electricity prices vary throughout the day reflecting changing supply and demand patterns, become even more complex when combined with storage. Understanding these connections will ensure that new tariffs are designed in ways that allow consumers who want to take advantage of new technologies have the opportunity to do so, without simply transferring costs to those less able to afford new technologies.

- **Network applications for electricity storage:** Network costs account for 23% of an average dual-fuel energy bill (about 27% of an electricity bill). Some of the potential applications for storage could reduce the costs faced by networks to upgrade or maintain their networks. However, monopoly networks are subject to tight restrictions about what they may and may not do, and currently they may not provide storage. Ensuring that storage solutions are deployed in a cost-effective manner, and in ways that serve to reduce consumers' bills may require modifying the roles of distribution networks.

- **Electricity storage and electricity generation:** As generation of electricity in the UK depends more on weather-dependent generation (most prominently wind generation), the more useful technologies that can enable better alignment of electricity demand with the times that weather is conducive to generation. Storage is potentially one of the ways that could occur. However, at present policy does little to nurture these applications, and in some cases may actively discourage them. Storage could allow renewable generation to operate in a way which more accurately reflects its effects on system management and which ensures it is paid amounts which reflect the differing value of power at different times.

- **The impact of electricity storage on decarbonisation and security of supply policy:** The UK has in place stringent targets for decarbonisation, and needs to achieve them while maintaining reliable supplies. These imperatives have led to an expanding set of policies, designed to bring about new types of generation and reduce demand. However, these policies have been designed in ways which make it difficult or impossible to incorporate electricity storage. This anomalous treatment of storage may need to be resolved if it is to be able to compete on an even playing field against technologies which are more easily supported by existing policies. This needs to be done in a way which does not impose excessive costs on consumers, and which ensures storage is only brought forward where it is the most cost-effective option.

6: Re-allocation of network costs

Summary

If the uptake of distributed generation (DG) such as solar panels continues to increase, the allocation of transmission and distribution (T&D) costs will be increasingly inequitable under current tariff structures.

If charging methods remain unchanged, less well-off households will pay an increasing share of the costs of sustaining Britain's energy networks.

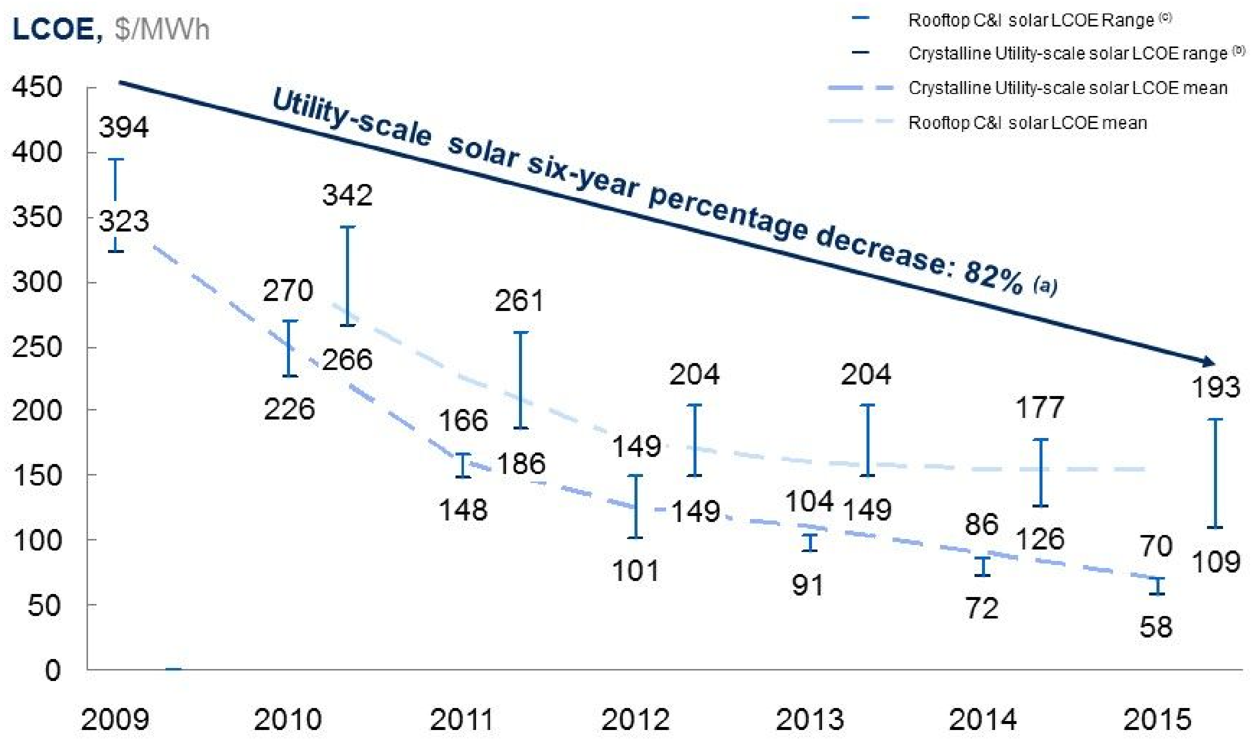
Changing the allocation of T&D costs could reduce energy savings for consumers who have invested in DG, and the later the changes are made more consumers will be potentially affected.

Introduction

Increasing take up of distributed power generation (DG), particularly rooftop solar panels, is disrupting the established model of centralised generation, transmission and distribution in many parts of the world. By enabling consumers to generate electricity at home, consumers reduce the amount of electricity they need to draw from the grid. At present, the costs of transmission and distribution (T&D) networks are paid via a small standing charge and a larger unit charge, in proportion to the net amount of electricity supplied. As households with DG reduce their consumption of grid electricity, these costs are transferred to the remaining (ie non-DG owning) households. This chapter will explore issues it raises about how T&D costs are allocated, along with the potential impact on consumers.

New technologies and government policy are enabling distributed generation

The cost of producing electricity at the household level continues to fall, primarily driven by the decreasing costs of solar photovoltaic (PV) electricity (Figure 6.1). Other, less widely prevalent DG technologies include micro-wind, hydropower, and combined heat and power (CHP), which generates electricity at the same time as producing heat from a household



boiler.

Figure 6.1: Falling cost of solar PV electricity. Levelised cost of Solar PV electricity over time, US average (2009-2015) Source: Lazard

Until recently, conditions for the deployment of solar PV in the UK have been relatively favourable. A generous subsidy regime (feed in tariff) led to an increase in installed solar capacity from 0.03GW at the start of 2010 to 9.52GW by March 2016. However, the start of 2016 has seen the government drastically reduce the rates on offer for solar PV installers. It remains to be seen whether reductions in the cost of panels can continue, such that the sector is able to continue to develop at the new, much lower, level of support.

Could DG become mainstream?

For DG to become mainstream, the cost of DG technologies such as solar PV will need to continue to fall, so far as to make it financially viable for a majority of households. By implication, this degree of cost reduction will remove the need for the technology to be subsidised. Each household would need enough storage to supply their needs during times when renewables are not producing, eg, solar PV during the night, and also provide for higher demand during winter. Solar panels and storage would achieve the same status as other consumer products, from televisions to washing machines, that went from niche products owned largely by the very wealthy, to commonplace everyday items of household furniture. This looks at present to be a long way off, but such speculation is fraught with difficulty - a reminder of Alexander Graham Bell's famous prediction that "one day, there will be a telephone in every town".

The effect of distributed generation on consumers

When a household installs DG technology, its consumption of electricity from the grid falls. Under present pricing systems, its contribution to investment and maintenance in the T&D network reduces proportionally. However, unless these consumers are generating enough energy, and have the means to store that energy for usage when the sun is not shining, they will still rely on electricity from the distribution system to some extent. For this reason, utility companies often argue that rooftop solar panels do not necessarily reduce the costs of providing the distribution system to these consumers. These consumers are therefore potentially being under-charged. Because there is a fixed amount of revenue that must be recovered from consumers to deliver the distribution system, this cost is imposed on the remaining consumers — potentially including low-income consumers. Not only are non-DG households paying the direct costs of funding the feed in tariff programme, but they are also asked to bear an increased share of the system costs. Cuts to the feed in tariff have constrained the direct costs, but if solar continues to get cheaper and remains viable at the new FIT rates, indirect costs will be shifted away from solar adopters.

The report considers three illustrative cases of DG uptake that demonstrate the increasing. These are not meant as forecasts, but simply illustrate the differing implications of increasing adoption rates.

Case A: Niche product

In Scenario A, growth in DG is modest and it remains a niche product installed by mainly higher-income households and those that are eco-conscious. Falling FIT subsidies slow the rate of deployment considerably from levels seen during the springs of 2014 and 2015. The impacts on cost allocation remain broadly the same as those observed today.

Case B: Mainstream product

In Scenario B, further progress in reducing the costs of solar units means that the pace of deployment is maintained or slightly increased. While many householders are still unable to enter the market (for example, those in the rental sector), solar becomes commonplace among owner occupiers with sufficient roof space. These homes remain connected to the grid for back-up power for when DG does not cover their needs. This scenario creates moderate pressure for tariff design reform.

Case C: Grid defection

In this scenario, cheaper electricity storage is combined with low cost solar and/or other forms of backup generation to enable some households to disconnect from the grid completely. (While seemingly far-fetched today, in sunnier climates including parts of Australia and the American southwest, this phenomenon is beginning to emerge. After another decade of technology cost reductions, it may reach the margins of viability in the

UK, especially for rural households or those with lots of land).

Questions for policy consideration

If regulators believe DG will reach only a low level of penetration, such as in Case A, then a new charging formula may not be necessary. However, if increased penetration to Case B, or even at the extremes, Case C, becomes plausible then, to avoid a regulatory ‘overhang’, a change would be better implemented sooner rather than later.

Citizens Advice has published an accompanying report [‘The tariff transition’](), looking into distribution tariff reform in more detail, which:

- Summarises the current debate about electricity and gas distribution tariffs in Great Britain and identify key concerns with current arrangements
- Identifies drivers for change, such as the smart meter rollout and distributed generation
- Reviews British and relevant international literature and experience on electricity distribution tariff design
- Undertakes a series of interviews with key industry and regulatory stakeholders
- Dynamically models the impacts of different tariff designs on consumers’ bills and behaviour

We recommended that, given the profound technological change the electricity distribution system is undergoing, that electricity distribution tariff reform should be led by technological change and its potential impact on consumers. Gas distribution, in contrast, has fewer technological drivers, so there may be a case for considering reforms separately.

We found that for most consumers, well-designed tariff reforms will not lead to significant bill changes. However, for a minority of consumers at the extreme end of the distribution, there will be significant bill changes which need to be addressed.

Crucial to the success of reform will be an effective and considered transition plan, which mitigates the impacts on vulnerable consumers and successfully educates people about the changes. Greater understand of cost pass-through is also required: suppliers currently choose how distribution costs are passed through, but under new distribution tariff structures, this may not necessarily be the case.

In setting out a new direction for transmission and distribution tariff design policymakers will need to be able to answer:

- What are the bill impacts, particularly for low-income consumers? Policymakers will need to identify those significantly impacted by the new tariffs and to determine other important but sometimes overlooked factors, such as changes in monthly bill volatility

- What understanding can be formed of consumer understanding and acceptance of the new tariffs through market research?
- What will be the consumer response to the new tariff designs? Can this be tested using experimental pilots?
- Is there a consumer education plan that is informed by the research activities described above, that will improve the likelihood that the tariff is designed to be acceptable to consumers?
- Can the new tariff options be phased in gradually to reduce the bill impact that would otherwise be experienced by consumers and will give them time to adjust to the new tariff design?
- Can specific protections be introduced for vulnerable consumers? With any tariff transition, there is often a strong policy focus on ensuring that vulnerable consumers are not burdened with large bill increases

7: Next steps

Technological advances and changing behaviours will have a big impact on the UK energy market in the coming years.

There are likely to be significant benefits for consumers, but also important questions for policy makers and regulators.

This report set out key potential changes in energy supply and consumption and discusses the issues for stakeholders.

This year, Citizens Advice will focus on these ways to safeguard consumers:

How to reduce the number of ‘disengaged consumers’ and encourage switching

Consumers will only benefit from innovation if the market is efficient and people have real choice. Helping consumers switch provider is essential , as highlighted by the recent CMA proposals. We areworking with a wide range of stakeholders to think creatively about how to encourage switching and we will review policies that support switching.

How to help consumers navigate a set of increasingly complex market

Energy products are likely to be increasingly complicated, blurring the lines between historically separate markets for technology, financial services and energy. For example, solar panels could be combined with battery storage to give cost savings enhanced by time of use, all financed by a retailer and repaid by monthly instalment.

More intermediaries and new, innovative pricing models may make navigating the market more difficult for less technology-savvy consumers. Citizens Advice has an important role in continuing to help consumers understand products and to advocate for clarity and transparency of pricing and benefits.

How to ensure equitable access to the benefits of innovation

Many of the new ways to improve energy efficiency and reduce costs take the form of ‘invest to save’. The risk is that benefits will be limited to wealthier households that can invest. The effect could be amplified because many investments require (or at least are made much easier by) owning a property, and may exclude those who do not own their home.

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