

## Paper details

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<b>Category</b>	Energy policy, Gas, Electricity, Energy Demand, Energy and Environment, Energy Security, Renewables
<b>Keywords / tags</b>	Regulation, Consumers, Innovation, Flexible, Transformation

## Abstract

1. We're standing at the edge of a deep and wide-ranging transformation in the energy system, moving from a largely centralised, carbon-intense model to one which will be increasingly carbon-constrained, smart, flexible and decentralised. Innovation's role in this transformation likely means that the energy system of tomorrow will be as unfamiliar to us as today's information technologies would be to the early internet pioneers. The nature and scale of this transformation will bring new challenges to how the sector is regulated.
2. Regulatory arrangements have evolved to protect consumers' interests in a traditional utility shaped energy archetype (Ofgem, 2013). The unprecedented pressures on the system arguably demand a more agile, adaptable and flexible regulatory framework. It must be capable of maintaining a delicate balance between meeting the needs of today's consumers now and tomorrow's consumers in uncertain and unknown futures.
3. This paper provides a perspective on how innovation is manifesting in the transforming energy system and how the regulatory regime is adapting to accommodate greater innovation. It sets out Ofgem's plans to create an Innovation Hub to engage with innovative businesses to better understand their motivations, needs and implications for consumers and regulatory arrangements.

## How is innovation affecting the energy system?

4. Innovation is "the application of knowledge to the production of goods and services. It means improved product and service quality and enhanced process effectiveness" (DBIS, 2014). It's not just about new technologies, it's about combining existing technologies to deliver smarter, more efficient ways of doing things. Innovation is reaching across the energy landscape, remaking the traditional technologies, roles, business models and processes arrangements by which the sector is known. This paper considers the implications of these innovations for the consumers of today and those of tomorrow.
5. Innovation is changing how energy is generated and delivered to consumers. It is increasingly smaller scale with low-carbon generation such as onshore wind, hydro

and biomass entering the mix (DECC, 2016). There are more microgeneration technologies, such as solar PV on homes, and more heat pumps and district heat networks are being installed. At the same time, new storage technologies, active network management and demand-side / consumer responses are emerging. New sources of gas, including bio-methane, bio-synthetic natural gas and shale, are also emerging.

6. Innovation is also changing how consumers relate to and experience energy. Over 850,000 new generators (DBEIS, 2016) have come on-stream in recent years, many of them 'prosumers', producing and using their own power. Transport arrangements are shifting with electric, hydrogen and compressed natural gas vehicles appearing on our roads. Smart meters and in-house devices are being installed in our homes and will likely change the face of the retail market, allowing suppliers to provide new products, services and pricing options for consumers.
7. While the scale of these new facilities is not significant in overall generation terms, the impacts and consequences of these developments is already being felt across the energy system. It is the non-linear and disruptive potential of these innovations that deserves greater attention. The solar story is a case in point.

### *Solar PV – the impact of a disruptor*

8. The falling cost and rapid deployment of solar PV is already changing the energy system. Predictions were for solar capacity to reach 10MW by the mid - late 2020s at the earliest (National Grid, 2013). This was exceeded in mid-2016. Solar has changed the generation mix across GB and particularly in specific areas, such as South West England. It has led to system challenges, such as connection queues and power bottlenecks as well as leading to the genesis of the 'prosumer'. As well as a new energy sector actor, it has also led to the emergence of new business (such as rent-a-roof) and investment models.
9. Looking ahead, the deployment of storage technologies alongside solar PV and other small scale generation facilities will likely have even more and significant implications for the system and for consumers (IET, 2016).

### *Big Data – the disruptor of tomorrow?*

10. The collection, sharing and use of our personal data is already having profound impacts on every aspect of our lives. Looking ahead, our energy data and the scope of our connectedness will likely be the currencies through which households and businesses engage in energy markets as consumers, prosumers or even as providers of system services. Some consumers will likely be active in these future markets, others less so, choosing instead the services of intermediaries.
11. Whatever the route to participation, ensuring the security and protection of consumers' data is paramount. The greater interdependence of energy assets / services, and interactions with the internet of things, will be founded on countless and more complex data exchanges. As well as critical questions about consumer data ownership and protection, the increased volume and complexity of data transfers also raise challenging issues for system integrity. Real-time industry decisions and transactions will be founded on this data; all parties will need confidence in the data to enable the seamless interaction and integrity of the physical and virtual structures that make up the energy system. There is growing

interest in the potential of Blockchain technologies to provide the innovation that will allow for secure and instantaneous transactions.

12. A Blockchain is a de-centralised platform that tracks transactions automatically across a network. It provides the foundations of the Bitcoin currency. From an energy perspective, Grid Singularity (Grid Singularity, 2016) is using Blockchain for secure pay-as-you-go solar in developing countries. Trials are also underway to see how it can be used to meet the challenges of a smarter, more flexible, decentralised energy system, such as the Transactive micro-grid in Brooklyn (Rutkin, 2016). It could also conceivably allow consumers to engage on a peer-to-peer basis without involving third parties.

### Consumers' interest in innovation

13. Society has an inherent interest in innovation. Innovators create new goods, services and ways of doing things which respond to our immediate needs, our emerging needs and those needs we don't yet know about (Okpara, 2007). Likewise, we think consumers have an inherent interest in energy sector innovations. But innovations represent risks as well as opportunities. As energy is an essential service, Ofgem needs to make sure that all consumers can stand to gain from the results of innovation, be it lower bills, higher standards of service, environmental outcomes or receiving a more secure supply of energy.
14. Ofgem regulates to deliver five key outcomes for consumers; innovation is crucial in achieving improvements across all outcomes:
  - a) *Lower bills*  
Competitive pressures can force companies to innovate and provide more cost effective services to consumers. For example, smart meters will increase consumer awareness and encourage consumption when energy is cheaper and smarter networks can avoid expensive infrastructure.
  - b) *Better quality of service*  
Companies compete on price and service quality. Innovative and bespoke approaches to interacting with consumers (eg, mobile apps or support tailored to those most vulnerable) or developing better business and complaint management services can bring consumer benefit.
  - c) *Less environmental damage*  
Energy accounts for a considerable portion of global greenhouse gas emissions. Limiting the impacts of climate change is driving innovation in low-carbon energy technologies like renewables, and new ways in which we can use our energy more efficiently.
  - d) *Improved reliability and safety*  
For domestic consumers, energy is essential to their well-being; for commercial consumers, energy is a fundamental business input. Consumers benefit from innovations which maintain secure flows of energy (such as networks identifying, and fixing problems without outages) or from having storage to provide back-up supply when generators fail.
  - e) *Benefits for society as a whole*

Innovation is both collaborative and self-reinforcing. Innovations in the energy sector and likewise those in other sectors, have crossover and wider potential. Developments in energy storage are expected to have potentially disruptive impacts for transport, and drive further innovation in new means of travel, such as electric vehicles.

### *Risks of innovation*

15. Although innovation is vital to delivering the energy system of the future, innovations may have potentially harmful system and consumer impacts. These might involve risks to the whole consumer base or to specific groups. While these risks are not reasons to avoid innovation, they do require consideration and if necessary mitigation. Some consumer risks might arise from:
- a) Greater network instability arising from increasingly intermittent generation.
  - b) Additional costs to consumers where their money is used to support unsuccessful innovations.
  - c) Innovations which target specific consumer groups (types or locations) to the detriment of consumers in other areas or with other characteristics; for example, less technically engaged consumers not benefiting from smart services or products which might focus on a consumer's demand-side potential.
  - d) Innovations which enable greater consumer independence from the grid and the potential impact on other consumers reliant on the national electricity system.

### **Barriers to innovation**

#### *The innovation dilemma*

16. Notwithstanding the need for solutions to increasingly complex, interdependent and urgent questions, barriers to innovation and change can affect the emergence, diffusion and absorption of new technologies, business models, and ways of operating (GES, 2014). This tension can manifest in the ways individuals, organisations and societies approach change, with the desire for transformation tempered by (the often un-satisfiable) desire to know that the alternatives will meet our needs. Despite the arguably inherent benefits to consumers and industry, innovation in the energy sector has been historically limited both in scope and pace of change.

#### *Energy sector features*

17. The lack of innovation is in part due to some of the sector's characteristics:
- a) Product standardisation: one electron is the same as the next, limiting product differentiation.
  - b) Sectoral complexity: innovators and new entrants cite the architecture and complexity of sectoral and regulatory arrangements as barriers to entry / innovation.
  - c) High entry costs: for many parts of the supply chain, high capital costs and credit / collateral requirements are a barrier to entrants.

- d) High risk: the scale of innovation needed to deliver a low carbon energy sector is substantial, making it a risky prospect for investors / innovators.
- e) Homogenous business models: existing models are based on low-risk, low-margin returns, with incumbents less willing or able to adopt the risk approaches of other sectors (such as digital or pharmaceutical sectors).
- f) System inertia: product and business model homogeneity combined with the pace at which regulation and industry arrangements adapt.

### *Regulation: innovation hindrance or enabler?*

18. Existing regulatory arrangements have developed to protect consumers' interests according to a particular market archetype. The transformation facing the energy system suggests this archetype is already changing and will continue to do so at unprecedented speed. Innovators are already blurring the lines between the typical energy sector cast-list of generator, distributor, supplier and consumer and we're seeing the emergence of other actors: prosumers, aggregators, platforms, peer-to-peer and bundled service providers. Many of these innovators have value-streams not yet readily recognised by regulation and cut-across industry and market boundaries in ways that challenge current arrangements.
19. Ofgem believes that regulation will need to be more agile and adaptable to ensure consumers' interests in a changing energy landscape are realised and protected. Regulation must seek to maintain a delicate balance between meeting the needs of today's consumers now, and tomorrow's consumers in uncertain and unknown futures.

### **Innovation and regulation: towards flexible and agile regulation**

20. Ofgem's priority is to protect and make a positive difference for all energy consumers. We do this through developing and supervising markets. Well-functioning competitive markets put pressure on companies to find new, better ways of doing things. This is beneficial for consumers, although the benefits of markets can be spread unevenly. As energy is an essential service, we need to make sure that all consumers receive a fair deal, including those that are vulnerable or less engaged.
21. Some areas of the energy system are natural monopolies, where it is generally not possible to use competitive market forces to help deliver positive outcomes for consumers. In these situations, our principal regulatory tool is our power to set the outputs, obligations and incentives governing each company's price control framework.
22. We believe that innovation can have multiple benefits for present and particularly future consumers. It spans technologies, systems and business models simultaneously. While it brings benefits, it also involves some risk for consumers. It can be deterred by unnecessarily burdensome regulation and can be hampered by lack of coordination (eg, in developing supply chains).
23. Ofgem encourages industry to experiment whilst ensuring adequate consumer protection. Where regulation is a barrier, we seek to understand the issues and where possible, reduce or eliminate barriers or provide companies with greater flexibility. This can involve replacing prescriptive rules with standards of conduct, or

for licence holders providing derogations from rules. In assessing the potential impact of our decisions, we also seek to take into account the potential effects on innovation, such as the impact on new business models relative to traditional models.

24. Ultimately, we want a regulatory framework that anticipates and responds to energy system changes, delivering level playing fields for new and traditional technologies and business models. Some examples of how a more flexible and agile regulatory regime is being progressed, are presented below:

### [Network innovation](#)

25. The network companies (both gas and electricity and transmission and distribution network owners) are responsible for investing in and managing the nation's energy infrastructure. Their performance is governed by the RIIO (Revenue = Incentives + Innovation + Outputs) price control framework. Many elements of RIIO are designed to incentivise innovation, in particular:

- a) A longer price control period (8 years instead of 5) to encourage companies to take a longer term view.
- b) An efficiency incentive that means that companies and consumers share in any savings they achieve.
- c) A focus on 'totex' rather than just capital expenditure which means companies are equally rewarded for alternative solutions, such as demand-side response, rather than just traditional investment.

25. When implementing RIIO, we introduced an innovation stimulus package consisting of a Network Innovation Allowance (for smaller projects), an annual [Network Innovation Competition \(NIC\)](#) and the Innovation Roll-out Mechanism to fund the deployment of successful trials. The projects funded so far are diverse, from using household and industrial waste to produce pipeline quality gas for use in peoples' homes, to a new technique to reduce electricity losses at transformer substations.

26. During the previous electricity distribution price control ([DCPR5](#)), we operated the [Low-carbon Network Fund \(LCNF\)](#). Around £240m was allocated across 23 projects and we expect to see the results of LCNF projects rolled-out as business as usual. This autumn, we will publish an independent evaluation of the LCNF plan and will consult on the governance arrangements for NIC and NIA.

### [Flexibility](#)

27. Flexibility is a key feature of energy markets. It is the ability to modify generation or consumption patterns in reaction to signals (such as a price change). New sources of flexibility could help maintain a resilient, sustainable and affordable electricity system as the generation mix shifts to include more variable generation. Ofgem is working towards a joint call for evidence with BEIS, focused on developing a routemap for the realisation of smarter, flexible energy systems. It will set out our thinking on some key questions and seek stakeholder views and insights.

### [Future Retail Regulation](#)

28. We want a retail marketplace where innovation and discovery can happen and which new entrants can join more easily. In December 2015, we consulted on how a principles-based approach might operate in the domestic retail market. Supply licences which rely more on principles, and less on detailed prescriptive rules, will create room for innovation allowing suppliers to be more flexible in how they meet the needs of customers, including those in vulnerable situations.

### Half-hourly settlement (HHS)

29. The nature of electricity is such that generators may produce more or less energy than they have sold and customers may consume more or less energy than their supplier has purchased on their behalf. These discrepancies are reconciled through the 'settlement' process. Although electricity is bought and sold in half-hourly periods, most consumers are settled using estimates of average consumer profiles. This is because most sites do not have meters that can record half-hourly consumption.

30. Smart meters are a chance to make the settlement process more accurate and timely. Moving to HHS will let suppliers provide innovative products and help consumers move their demand to periods when electricity is cheaper. We intend for elective-HHS to be an option for all in 2017 and in June 2016 we announced our intention to launch a Significant Code Review for mandatory HHS.

## **Enabling innovation**

### *Supporting innovators through an Innovation Hub*

31. Innovators, especially those developing new technologies or looking to transfer approaches from other sectors, tell us that the architecture of the energy sector and regulatory arrangements are extremely complex. They also say that we could do more to support innovators, including providing accessible guidance, non-binding advice, opportunities to trial new ideas, and to feed innovators' views into policy.

32. As such, Ofgem is setting up a new Innovation Hub to support innovator businesses by providing fast, frank and informal feedback about their plans. The Hub is modelled on that developed by the [Financial Conduct Authority](#) and will be up and running by the end of this year. The aims of the Hub are to:

- a) Help innovators through the regulatory jungle.
- b) Help innovators assess the regulatory implications of their activities.
- c) Provide an efficient and consistent service in response to the increased volume, diversity and complexity of enquiries we get from innovator businesses.
- d) Enhance our awareness of new developments, their implications for consumers and regulatory arrangements.

33. The Hub will be for businesses looking to bring innovative services, products, technologies or ways of doing things to market, that don't readily fit with existing arrangements. To register for more information about the Hub: [innovation.hub@ofgem.gov.uk](mailto:innovation.hub@ofgem.gov.uk).

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