ReSHAPING REGULATION

POWERING FROM THE FUTURE

By Laura Sandys, Dr Jeff Hardy
& Professor Richard Green

CHALLENGING IDEAS

Imperial College Business School

Grantham Institute
Climate Change and the Environment
An institute of Imperial College London

CATAPULT
Energy Systems

UK Power Networks
Delivering your energy

ACKNOWLEDGEMENTS

The authors would like to thank so many people who have contributed to this project both officially and unofficially. We would like to say a particular thank you to Catherine Brown, whose input as a former CEO of the Food Standards Agency helped shape the workshops around what has happened in other sectors.

This is a report that has engaged, listened and noted recommendations, advice and observations from over 230 people from across the sector and beyond. There were many exciting and challenging conversations, and we would like to thank everyone for attending our workshops and inputting to this document.

The authors would like to thank in particular those at the Energy Systems Catapult who financed, guided and supported the process, and to UK Power Networks for its input and funding assistance.

Those who funded or supported the process have no responsibilities for the outcomes or recommendations. However, we hope that they, like us, believe that this is a useful contribution to the future of a very exciting energy sector.

Laura Sandys, *CEO of Challenging Ideas*

Dr Jeff Hardy, Senior Research Fellow at the Grantham Institute, Imperial College London

Professor Richard Green, Alan and Sabine Howard Professor of Sustainable Energy Business at the Imperial College Business School

INTRODUCTION

"PLANNING *FROM* THE FUTURE"

> Culture eats strategy for breakfast, operational excellence for lunch and everything else for dinner
>
> Peter Drucker

This report aims to welcome the dynamism, opportunities and transformation that our energy sector can achieve through a new set of regulatory principles that embraces the changing nature of energy, technology and primarily consumers.

We did not want to examine incremental change or how to manage the "transition". Instead, we have designed our work around the destination rather than the journey. Planning *from* the Future.

We have unburdened ourselves of starting with the current system or incumbent thinking, and have aimed to shape the new system from a blank sheet of paper, taking into consideration the needs of the consumer through a set of guiding principles. Importantly, we have started with the plug rather than the power station.

In our second report, we will develop a roadmap of how to reach that destination from where we find ourselves today. We have highlighted the key projects on which our second report will focus.

Our recommendations require a culture shift that some of the existing players will embrace, but others will resist. Some companies will change their culture, their recruitment and their business models; others will hold on to their existing models for dear life.

This piece of work aims to complement the important and persuasive work being undertaken elsewhere, such as the Energy System Catapult's Future Power System Architecture project, the Energy Networks Association Open Networks project and the various Ofgem projects, including its work on Insights for Future Regulation.

1 EXECUTIVE SUMMARY

The UK has a global reputation for being at the forefront of energy regulation. This report aims to help shape a set of new regulatory principles that would govern all those involved in the production, supply, trading and consumption of our energy and its related infrastructure and systems. We are proposing a set of principles that could ensure our energy sector is fit for the future and that we retain our preeminent position as a leader in market regulation.

The current debate on energy policy appears to be captured by the term "transition", but few appear to have articulated where we are heading

> We are proposing a set of regulatory principles to ensure the UK retains its preeminent position as a leader in market regulation

or what we want to achieve, thereby making transition feel like the end game. This is resulting in incremental rather than systemic thinking that is creating significant policy and cost "drag", is constrained by incumbent thinking and does not draw sufficiently from drivers of change beyond the energy sector.

To this end, we propose that we drop the "trilemma" as a policy framework, as it has created a set of "trade-offs" that are no longer appropriate or desirable. In addition, policymakers must demand more calibration and definition of the very loosely used term "security of supply" that "haunts" all public policymaking.

Energy experts have been caught by the psychological need to identify the one "silver bullet" solution to the change in the electricity system. The future will deliver a much more diverse set of players, all with different backgrounds bringing new and varied solutions, turning an energy services sector from a set of greyscale products and services to a technicolour range of opportunities and consumer propositions.

These new players, playing a different game with new rules, will challenge current business practices and policy. Regulators will need to accommodate change – both the successes and failures.

Our report paints a picture of a future electricity system with data-driven optimisation at its heart. It describes a new consumer with a different relationship to energy. Energy system security might be more determined by cyber and data security than just supply security.

These inform our recommendations for a new set of regulatory priorities that sit at the heart of a facilitated market rather than a prescriptive and process-orientated regulatory model. Prescription is yesterday, facilitation is tomorrow, all judged against great consumer outcomes.

We propose four regulatory principles that underpin a future regulatory architecture:

- **Regulate for how consumers consume not how businesses are organised.**
- **Regulate for system optimisation to deliver the most productive, efficient and affordable system.**
- **Regulate to promote transparent, cost-reflective and open markets.**
- **Regulate for where security of the system is truly at risk.**

Alongside these, we make proposals on the nature of how we regulate, focusing on outcomes, not process.

In our second report, we will produce a roadmap for how to get from today to a future with a principles-based regulatory architecture. Throughout this document, we have identified recommendations for further work and research to inform this roadmap.

TODAY

What does electricity policy and regulation look like today?

1. RATIONALISE THE REGULATORY FRAMEWORK

One thing is clear: what we regulate for in the energy sector today is not what we need to regulate for tomorrow.

The regulatory map of the electricity system in Figure 1, developed in 2014 by the University of Exeter Energy Policy Group[1], depicts the institutional relationships that manage compliance, subsidies and market design. The overlap and underlap of responsibilities makes for a highly complex, confusing and sometimes contradictory system of managing the sector. Each element has been added to address a specific problem or a new mechanism, and there is no doubt a lot of cost and lost value through the proliferation of these mechanisms.

> To design a truly 21st century model for energy regulation, there needs to be a disciplined reassessment of the desirable outcomes and the levers required to deliver these as effectively and as simply as possible.

To design a truly 21st century model for energy regulation, there needs to be a disciplined reassessment of the desirable outcomes and the levers required to deliver these as effectively and as simply as possible.

Irritations in the system are often put down to an interfering regulator with anti-business regulations.
As with many other sectors, however, some so-called "regulations" are simply long-standing business practices, accepted behaviours, standards not rules, and have little to do with the statutory regulators. Accepted practices have been accused of being detrimental to consumers and slowing the energy transition[2].

In considering the regulatory approach to desirable energy system outcomes, it is crucial that we distinguish between statutory regulation and these industry codes and practices, and be much less casual in our description of what has created such a complex system. It is important that these "accepted" business practices are questioned and, if necessary, disrupted.

Despite a lot of activity around reform from Ofgem and other bodies, we need to reshape how we look at regulation in all its forms if we are to shape a market fit for purpose for the challenges and opportunities ahead.

RECOMMENDATIONS FOR STAGE TWO

- A review of all bodies currently regulating the energy sector with a clear ambition to rationalise, simplify and identify any "gaming" of the complexity.
- Clear identification of what are statutory and voluntary "regulations".
- Results tested by non-energy players assessing comprehension, sense and need.
- Lessons to be learnt from other business models and regulatory regimes: food regulation, telecoms, banking, data and logistics sectors.

[1] http://blogs.exeter.ac.uk/energy/2014/11/12/mapping-the-power-in-the-electricity-system

[2] http://projects.exeter.ac.uk/igov/new-thinking-a-new-development-in-code-governance

Institutional relationships in the electricity system

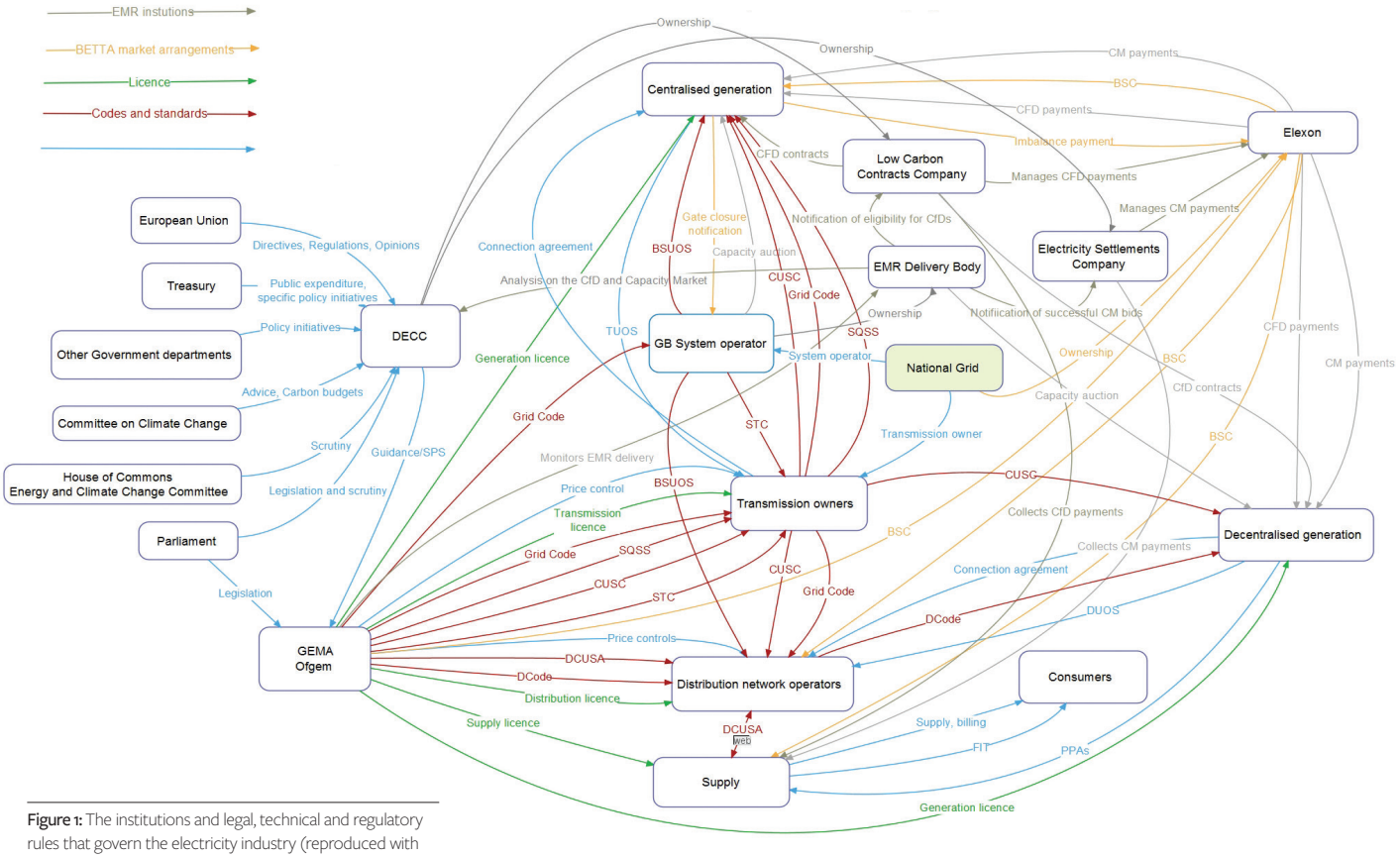


Figure 1: The institutions and legal, technical and regulatory rules that govern the electricity industry (reproduced with permission from Bridget Woodman's Exeter Energy Policy Group blog[4]). The Department of Energy and Climate Change (DECC) has now been replaced by the Department for Business, Energy, Industry and Skills (BEIS).

2. RESHAPE FUEL POVERTY

This is a misplaced responsibility given to the energy sector and should be removed from energy policy. Fuel poverty is not an energy problem, but either one of real poverty or of bad housing, and as a result should sit clearly within a different set of policy areas and departments.

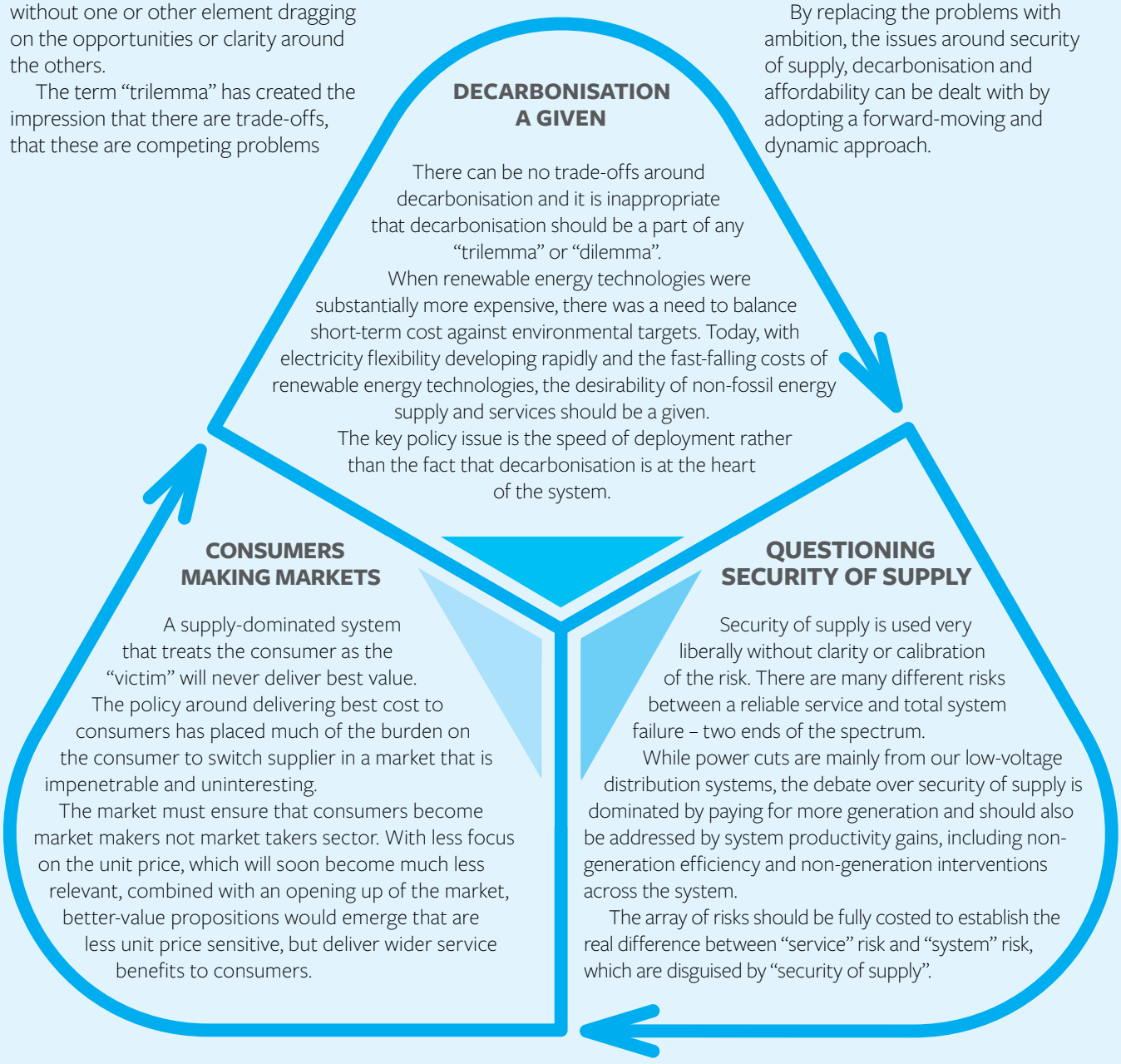
Placing the fuel poverty agenda within the energy sector has distorted the system and created ceilings and thresholds that have restricted some companies' development. To address those in fuel poverty, policy should be reallocated to both the Department of Work and Pensions and the Department of Communities and Local Government.

3. DROP THE TRILEMMA CUL-DE-SAC

The "trilemma" has sat at the heart of energy policy for 10 years – **security**, **decarbonisation** and **affordability**. These are all problems not ambitions for the sector and, as a result, policy has found it difficult to move forward without one or other element dragging on the opportunities or clarity around the others.

The term "trilemma" has created the impression that there are trade-offs, that these are competing problems rather than complementary ambitions, and it shapes an inherently zero-sum game. In reality, it is possible to achieve all three. Energy commentators each favour one or other of the three options thereby developing their own competing hierarchy. The trilemma is so baked into the system that policy appears to have to fit the paradigm even when new crucial elements emerge that are transformative and change the policy levers.

By replacing the problems with ambition, the issues around security of supply, decarbonisation and affordability can be dealt with by adopting a forward-moving and dynamic approach.



- There needs to be a deeper analysis of the term "security of supply", and a clearer distinction between "service" and "system" risk.
- Much greater analysis of the cost benefits of the different graduations of security of service needs to be undertaken and new measures around data risk will be required to assess security of the system.

TOMORROW

The opportunity for the future

The electricity system has been changing for the last 10 years, but the real change has only just begun. As the pace quickens, we are already seeing the impact of new ideas, new entrants and new technologies that no-one could have predicted five years ago.

Renewable energy is no longer marginal, but mainstream; distributed electricity generators, balancers and system service providers are multiplying; and non-energy players in the technology and data sectors now view energy as an exciting new market.

Consumers will be the key drivers acting as the crucial market makers rather than market takers of today. As connected consumers, they are likely to be serviced by new big data companies, demanding a new set of optimised outcomes that will throw up new issues around the definition of security of supply, such as cyber security.

Regulation must now allow for the easyJet model to emerge without the significant regulatory and business practice barriers that they had to overcome. We must facilitate change and trial new approaches without fear or favour to the existing players and allow for the real "value" rather than just cost of energy to be identified.

These new norms and developments, exciting as they are, are merely the start of a much deeper revolution at the heart of our energy system. If designed and managed well from the start, this could meet the needs of consumers, communities, businesses and policymakers.

There are three key elements we examine and for which we shape new regulatory objectives:

- **The consumer and how they will consume energy.**
- **The market and the public policy objectives desired for that market.**
- **The changing risks that will need to be addressed.**

Future consumers: invisible energy?

The largest change in consumer behaviour for decades is the digitalisation of all our lives. It will offer consumers and suppliers a revolutionary change in the granularity, specificity and accuracy of supply and demand, and derive value in optimising these for the benefit of the electricity system. The energy sector is still at the beginning of the journey to understand and respond to the implications of this digitally connected consumer revolution.

The energy sector has been engaging with consumers for decades, but is it listening to feedback? Most consumers are just not interested in energy and do not have the desire to spend their well-earned free time getting to understand energy. New, more exciting product and service providers will enthuse and excite the consumer around the overall service, potentially leaving the energy component practically invisible.

The prize for the electricity and wider energy sector is an optimised system that is designed around providing a service for the consumer and their behaviours rather than around current business structures.

In the future, there will be multiple consumer archetypes, masses of data, sophisticated data analytics and the potential – for example, through storage and smart devices – to divorce patterns of energy service consumption (when you take a hot shower) from electricity purchase (when you heated the water).

The market dominance within the energy sector could move from energy suppliers with consumer brands to consumer data companies, white goods companies or "in-home" digital helpers that will manage a wide range of in-home, in-business services, and will be able to optimise energy and other utility services. Take, for example, Alexa, who will order the groceries, change energy supplier, alert you when you are reaching your mobile phone usage limit and inform your service suppliers when you are going on holiday. Most of these actions will be taken with no intervention by the consumer – the automated home service.

> "Designed and built by engineers, bastardised by economists and muddled by marketers, the power industry continues to deliver one of the most successful consumer confusion programmes of all time."
>
> Ari Sargent, Founder of Powershop

In addition, local authorities or their agents are already delivering bundled service offers with integrated energy supply built into new housing, with balancing and distributed energy resources as part of the rental agreements.

These new service companies might well procure energy directly from producers or the wholesale market, and sell back valuable energy services such as customer demand flexibility to help optimise the system.

Future energy product and service offers will be varied – a mix of bundled, aggregated and blurred – and potentially invisible to the consumer.

Learning from other sectors: food consumer habits have changed beyond recognition

From shopping in multiple speciality stores, consumers now go to one shop for all their goods – from food to clothes, electronics and even household insurance. While the power of the physical retailer is already diminishing with the rise of internet shopping, in both instances consumers look for convenience over the perceived expertise in "siloed" retailing.

Once all homes had fridges and freezers, consumers were able to buy food when it suited them rather than on a daily basis. Might batteries offer similar flexibility?

No silver bullet

Future regulatory architecture needs to facilitate change, embrace the lack of uniformity, recognise success, and allow for and learn from failure. With the arrival into the energy system of so many factors unanticipated five years ago – digitalisation, decentralisation and new low-carbon and flexible technologies – energy policy must wean itself away from trying to design a "silver bullet" solution on which it has been reliant for so long.

The new dynamics will change the whole shape of the energy sector from one of a linear supply-driven system to a diverse, distributed and dynamic market that will no longer be determined by a few players.

> **Energy policy must wean itself away from trying to design a "silver bullet" solution it has been reliant on for so long.**

The change from the current "command and control" system design must resist embedding any specific element of the current regime that is not fit for purpose. Instead, it must promote the significant and productive opportunities from the new and rapidly changing shape of the sector.

With no silver bullet business models or technologies, but many different approaches with different routes to market, a different set of principles and approaches to regulate the dynamic changes is required.

Data is the game changer, and key to a productive and efficient energy system

1. CONSUMER DATA

Smart electricity and gas meters are a limited response to the data revolution. With the increased uptake of service providers in the home, the limited data flows from energy meters will not be able to retrieve the wider level of integrated and total information possible today in other sectors. In addition, the current protocols around access to energy data feel out of date and do not reflect the opportunities wider access could deliver to achieve better consumer value.

Evidence from other sectors tells us that new entrants could have almost complete customer behaviour patterns. The retail sector can achieve up to 80% just-in-time accuracy on energy consumption after a 24-month data set.

Through in-home or in-business aggregators, the data will not just be energy information, but full lifestyle data – from mobility needs through to wider consumer habits and rhythms. Other regulators and utility services are already interested in the value of the data across other consumer behaviours to further inform their specific service requirements. As with other sectors, value will not necessarily lie in the product sold, but the value of the full consumer data, and that will have a dramatic impact on how the energy sector operates.

Today, supply and demand for electricity is balanced at a national scale. While the National Grid is reasonably good at predicting demand in the short term (e.g. day to day), longer-term trends have proven much more difficult. Zooming into a more regional picture – the domain of Distribution Network Operators – there is a much cloudier picture of local demand and supply, which affects decisions taken on network investments. Better data on the real-time and future status of networks, assets, available supply and expected demand creates new opportunities for managing and optimising the electricity system in flexible and responsive ways. This should increase system productivity – for example, by allowing available low-carbon supply to flow to demand and reduce the need for investment in network and generation capacity, overcoming supply issues through demand-side flexibility.

Consumer data is highly valuable and central to a functioning 21st century energy system. However, as the most important asset within the energy sector, it needs to be protected from market capture, consumer data exploitation and cyber security.

The ability to "optimise" rather than just "supply" the system could be further refined and shaped though machine learning and artificial intelligence exploiting the wide range of consumer data beyond energy data from the in-house service providers.

This cumulative data is highly valuable and central to a functioning 21st century energy system. However, as the most important asset within the energy sector, it needs to be protected from market capture, consumer data exploitation and cyber security.

2. DATA-RICH SYSTEMS DELIVERING OPTIMISED ENERGY SERVICES

Managing complex demand and supply systems through data

The food sector can manage data sets across 30,000 different product categories, and shape a highly automated and optimised system of logistics "balancing" the production of food all the way through to its effective and timely dispatch to the supermarket. The complexities of procuring "just in time" from multiple sources, managing seasonal differences, distributing in the right transport mode, all to meet an immediate need at a certain point in the supermarket network, shows how sophisticated data analytics and logistics have become.

The ability to collate and predict demand at a totally different level of granularity through data will reshape the market, creating for the first time a real equality between supply and demand drivers. This changes the shape of the market design from a linear supply chain to a hub sitting between energy services and demand needs. The market should therefore balance system needs with two-way participation, which is a different model to the supply-driven market design of today.

Optimisation now becomes possible and desirable, with clarity about utilisation not just production of energy services. Productivity gains within the system to deliver better optimisation will be driven forward again, getting more from less for the benefit of the consumer.

> **"The efficiency of the electricity system has remained broadly unchanged. In real terms, we waste around 62% of the energy used to generate electricity every year."**
>
> Dr Tim Rotheray, Association for Decentralised Energy Director

To maximise the competition for system optimisation, a technology-agnostic level playing field for all potential system services is essential. Combined with access to data, transparency of the value of system services and the actions taken, and clear rules for participation, this new market will create competitive and open markets for all system services.

This leaves an open question on WHO or WHAT is responsible for electricity system optimisation. In the box opposite, we explore some of the emerging models of how this electricity orchestra could be conducted. The implications of these need to be further examined.

"By increasing the efficiency of the overall system, optimising capital allocation and creating new services for customers, grid edge technologies can unlock significant economic value for the industry, customers and society. Under the right regulatory model and targeted innovative business models, low-income households could participate and benefit from the value created by grid edge technologies."
World Economic Forum: The Future of Electricity

Possible optimisation models

There are multiple ways through which the orchestra of electricity system optimisation could be conducted. We explore four approaches below.

THROUGH A CONDUCTOR?

A conductor implies that a single organisation has oversight of the whole system, sufficient data (music) and decision-making ability to guide the orchestra through their interpretation of the piece. This is akin to proposals such as Future Power Systems Architecture Emblement Organisation and an Independent System Operator proposed by the IGov project, in which this central organisation acts as a sort of controlling mind, accessing data to optimise the electricity system from the top down.

AS DISCRETE SECTIONS?

Orchestra sections, in the absence of a single conductor, play their own parts of the symphony, playing with the same music (data) and rules (timing, volume) with transparency on what other sections are up to, including feedback – you are playing too loud! Regions, cities, towns and villages would have responsibility for their own actions, but also be part of the wider symphony. The interpretation of the music might be different each time the piece is played. Individual sections could have their own conductors such as a Ofgem's proposed Distribution System Operators, or perhaps rules alone are sufficiently clear to guide the sections.

AS INDIVIDUAL MUSICIANS?

Each musician would individually contribute to the orchestra with no conductor and independent of other musicians. To avoid a terrible racket, each musician would need common music, clear rules such as starting time, key and timing, and they would also need feedback on what the other musicians are doing through total transparency indicating where they could add value. It would be necessary to always know the state of the system, so that the value of local, peer-to-peer actions is clear, with common and clear rules for system participation.

AS INSTRUMENTS THAT PLAY THEMSELVES?

If there were no musicians, just instruments capable of playing autonomously, could you still make a symphony? The instruments would have access to, and could understand, the music, the rules (such as starting point, timing and key) and the different roles they can play, whether that be louder or quieter, then it could work. You could expose the instruments with data on lots of symphonies and use machine learning and artificial intelligence to develop a new composition based on the audience's needs. It would require embedding automated decision-making capability into all devices – from washing machines to large generators – and allowing all to participate in the system and realise the value of their actions.

RECOMMENDATIONS

A new set of regulatory principles

This report proposes a new set of high-level regulatory principles that can help provide the open environment to allow for a more productive, simple and superior power sector, delivering consumer value, attracting new players, and encouraging new low-carbon and cost-efficient technologies.

With new players, new consumer service providers and new data dominance across the system, consumer and system risk will lie in different places from today.

The objective of simplification is to create a framework that new entrants and non-energy players can understand and through which they can engage with the sector. In addition, with the value and dominance moving from the power station to data-driven system optimisation, new approaches to regulate the market will be required. Moving from an asset-based approach towards one more focused on data is something investors in the sector would need to understand and could change the shape of the current investment model.

The supply chains that then emerge will affect the 'value' of different sets of assets and do so with greater transparency. Costs should consequently be pressured downwards through waste reduction.

> The objective of simplification is to create a framework that new entrants and non-energy players can understand

We have developed four key principles that should guide the overall regulatory framework for a new shape of market design:

- **Regulate for how consumers consume not how businesses are organised.**
- **Regulate for system optimisation to deliver the most productive, efficient and affordable system.**
- **Regulate to promote transparent, cost-reflective and open markets.**
- **Regulate for where security of the system is truly at risk.**

Moving from an asset-based approach towards one more focused on data could change the shape of the current investment model.

PRINCIPLE 1: Regulate for how consumers consume, not how businesses are organised

Consumer protection

In a paper to Ofgem, the Energy Retail Association found that roughly half the total number of standard supply licence conditions that contain specific consumer protection provisions overlap with similar legal protections outside the licence, whether under primary or secondary legislation, European directives or common law.

If future digitally driven consumers are increasingly offered energy as part of a bundle of services rather than energy as a product itself, the need for energy regulation per se will be limited. Obligations to the consumer and risk from dominant players will come from new service providers rather than energy suppliers. Electricity could become invisible to consumers in a similar way to facilities such as sewage systems, digital fibre and rubbish collection. The only times when these facilities become evident to the consumer is when the systems in place fail or the service is substandard.

Consequently, the "invisible" energy sector would likely become a business-to-business (B2B) product supplying a consumer-facing product or service rather than as a consumer product itself. Therefore, energy supplier licences with obligations to the consumers could become unnecessary.

This is not to say that consumer regulation will not be important. It will be crucial and needs to be further strengthened, but will sit around the bundled product categories and data rights. The need for consumer regulation to support consumers in terms of redress and portability in relation to their data and service standards will be extremely important. It will be for the consumer-facing supplier to gain redress from the energy supplier if there is any failure to deliver the contracted service to their customers.

Consumers will need strong data protection that ensures that all benefits their data delivers to the "home-help" service provider are transparent and either acknowledged or passed onto the consumer. The personal data needs to belong to the individual and be portable. Consumers must be able to "fire" Alexa without penalties other than contractual obligations.

The regulation could sit within either a data regulator or an umbrella consumer regulator.

Key consumer regulation

- **Facilitate consumer choice** Avoid prescription of the consumer offer – no "energy" supplier licence.
- **Secure consumer rights through an umbrella consumer regulator** Ensure blurring of product categories does not undermine wider consumer rights – no longer energy rights, but overall service rights and overseen by an umbrella consumer regulator
- **Avoid consumer capture** Consumers can exercise choice of service providers without penalties beyond contractual obligations.
- **Deliver consumer benefits** Consumers are rewarded or charged for system benefits or demands that their actions deliver.
- **Appropriate consumer protection** Ensure effective regulatory protection for new vulnerabilities and disconnections.

RECOMMENDATIONS FOR STAGE TWO

- Develop a framework of consumer regulation that provides the right level of protection with regard to:
  - ► Bundled products and services.
  - ► Data protection and consumer approvals.
  - ► Vulnerabilities and service requirements.
  - ► How these consumer needs are met by other regulation or the need for a new consumer rights architecture.

Personal data needs to belong to the individual and be portable. Consumers must be able to "fire" Alexa without penalties other than contractual obligations.

PRINCIPLE 2: Regulate for system optimisation to deliver the most productive, efficient and affordable system

All participants will be incentivised to deliver as productive and efficient an energy system as possible, while minimising input and system costs. As with other sectors, market pressures should determine that less is used to deliver more. In addition, nothing within the system should preclude or create any incumbent drag on innovation or new business models entering the sector to deliver greater optimisation.

Cost reflectivity and transparency are crucial aspects of delivering a productive, efficient and affordable electricity system. As discussed previously, access to data provides a status of the electricity system, including all assets and actors prepared to take actions. In principle, in a system where there is complete transparency of status, solving system problems – such as imbalance, constraints, asset failure – becomes an optimisation challenge well suited to those developing clever algorithms. In addition, solutions may well be collaborations between several parties – for example, solving an imbalance problem may also resolve a local constraint – resulting in benefits for multiple parties. As such, it is crucial that there is a level playing field for all potential solutions to maximise innovation and allow for new responses to optimisation to be trialled.

In all cases, those that have caused problems and those that are providing solutions should face the transparent system cost/value of those actions. In principle, this should also include end consumers, which, particularly for most domestic consumers (bar those on Economy 7 or 10 tariffs), is a departure from today's situation where there is no value or penalty in consuming a unit of electricity at different times. As described in principle 1, we imagine futures where new service providers sit between the consumer and the system. These companies will work with their customers to create service propositions that meet customer and system needs, alongside the consumer protections stated in principle 1.

This changes the philosophy around the energy system, placing optimisation rather than supply and asset management as core to the value to both the customer and the system. It is for the supply chain to arrange itself in the most productive manner to ensure that it is making the best margins throughout the system while delivering an effective product.

The new valuable cumulative data drawn from the behaviour of consumers – business and domestic – will be the driver of optimisation, but the issue around whether this is a public asset needs to be considered. As this data is likely to be gathered from beyond energy consumption, the regulation of this optimising data needs to be considered across many different sectors not exclusive to energy.

Key market regulations

- **Incentivise optimisation** Design system rules to reward energy services, from generation through distribution and supply, that increase productivity and energy efficiency, reducing generating capacity and optimising system operation.
- **Penalise on the basis of system costs** Penalties reflect energy system cost – for example, for failure to deliver energy or for causing balancing or other energy system problems.
- **Contract law** The B2B relationships will be shaped by normal demand and supply contract law, with the system requiring data transparency from the "suppliers" providing supply and demand data across their customer base, and will pass on the penalties to any energy provider that doesn't deliver its contractual obligations.
- **Collective data is the asset** The regulation of the collective data will be crucial and its accessibility to market participants.
- **Data access licences** These will be needed to manage the security and confidentiality of the system.

RECOMMENDATIONS FOR STAGE TWO

- Develop the rules around optimisation and the incentives and penalties.
- Develop a set of optimisation metrics.
- Develop scenarios around big data management.
- There needs to be an assessment at what scale best optimisation can occur – i.e. is this local, regional or national data?

PRINCIPLE 3: Regulate to promote transparent, cost-reflective and open markets

We believe that open, transparent and fair markets are the way to achieve transparency of electricity system status, needs and potential solutions at any given time to facilitate system optimisation. We are not being explicit on market structure, as numerous structures could emerge.

In the future wholesale market, through data providing transparency on system status, it will be possible to understand national and local situations in terms of supply, demand and issues such as constraints affecting the movement of electricity. These constraints are likely to be increasingly local in nature due to the rapid rise of distributed generation, thus solutions should place more emphasis on local balancing and flexibility, and both demand and supply options. In addition, it is possible to bring the closure of the wholesale market closer to real time, which allows more of the balancing actions to be undertaken in the wholesale market.

> We believe that more open, transparent and fair markets are the way to achieve transparency of the electricity system status.

Market and electricity system data will need to be simple, transparent and accessible via clear and simple market rules to those who can offer valuable products and services. This will drive price discovery through competition between system service providers striving to identify cost-reflective optimisation opportunities. Avoiding prescription or technology bias will bring future-proofing to new approaches.

Significantly increasing the level of transparency of system "needs" will provide equality for demand as well as supply responses, offering benefits to consumers who want to participate either directly in the commercial sector or through intermediaries in the domestic sector.

Key market mechanism

- **Transparent data** Transparency of system "needs" will offer greater price discovery and innovation, driven by clear and common standards for the quality and timeliness of the data.
- **Technology neutrality** While decarbonisation must be at the heart of all generation services, generation per se must compete equally with new responses as yet not developed, driving innovation and new product and services development. Regulation must therefore be technologically neutral, opening up the market to new innovation and valuing services that optimise the system.
- **Flexible purchase agreements** Through open markets with differential purchase periods, smaller and more nimble entrants would be able to participate

RECOMMENDATIONS FOR STAGE TWO

- Identify comparable data "clearing" platforms that could be utilised across the energy sector to drive open markets and price discovery.
- The shape of the market with a balancing/clearing house of cumulative data needs to be trialled and stress tested.
- Identify the key requirements around an accessible system design that offers transparency to deliver open markets.

PRINCIPLE 4: Regulate for where security of the system is truly at risk

The security of the system needs to be managed and costed to reflect real and changing risk, but with a new focus on data and cyber security. Regulation should distinguish between security of "service" and the security of the "system".

We need to recognise that consumers of all sorts might achieve a "secure" service from beyond the system and that might be more cost-effective.

Total system failure is, of course, another matter and needs to be reappraised not just in terms of energy supply to the system, but through accommodating a new and crucial dimension of cyber resilience and data security. There are excellent measures in place to address black start provision and these measures should be maintained as an integral part of the security of the system.

The supply "insurance" around system failure should be looked at again and pressures should be designed to build greater resilience across the "normal" operating system to reduce the cost of the system "insurance policy".

None of these disruptive changes will avoid the need for contingencies to deliver supply at periods of significant peak. However, the data-rich system will be able to more accurately calculate these needs through greater analytical assessment of data will be able to reduce stand-by needs. Regulation should reflect this tap ering and incentivise greater resilience before standby requirements are called upon.

> The IEA states the reserve margin metric that we use "is not well suited to taking into account the capacity of variable renewable energy".

Key security regulation

- **Security of supply** There needs to be a much more detailed cost/benefit analysis of where risk lies within the system and a decoupling of security of service versus security of the system.
- **Use of system** Not all energy is equal, so cost-reflective use of system charges for generation and interconnection are needed, and these could develop into a demand hierarchy.
- **Drive for productivity gains** Regulation should be incentivising system productivity gains as an equally effective response to capacity issues.
- **Data security** This will be key to the overall resilience and security of the energy system.
- **Good coordination** This is essential between system operators to ensure efficient actions and planning.

RECOMMENDATIONS FOR STAGE TWO

- Develop new principles around the term "security of supply" based on an assessment of system risk and cost benefit.
- Build a more explicit hierarchy and lexicon around security of "services" and security of the "system".
- Identify new metrics to assess system supply security, moving away from margin reserve that doesn't really reflect the security of supply risks around renewable energy supply.

The nature of energy regulation

HOW WE SHOULD REGULATE

While the principles above should shape the regulation outcomes, it is as important to propose how regulation itself should be shaped.

Each body and regulatory mechanism currently in place needs to be audited against the new set of regulatory principles, and rationalisation can be encouraged with a clear sense of hierarchy. In addition, there is a very big difference between "economic", "safety" and "standards" regulation.

As shown at the start of this report, the current regulatory regime has been inundated with codes of practice that have added increased complexity to the system and further disincentivised innovation and new entrants. There are technical and safety standards that are absolute. However, the "business practice" codes should deliver "floors", allowing for business practice to embrace new ways of delivering innovation and improvements rather than simply preserving current practices. This underpins the objective of not regulating processes, but creating incentives to deliver outcomes. As companies adopt new and improved practices, these innovations then become the new "floor".

> Regulation should incentivise and penalise for outcomes not manage processes

In the area of monopolies, such as distribution network operators, regulation needs to be complemented by aggressive transparency and subjected to detailed information disclosure, delivering off the back of the key regulatory principles.

The nature of regulation

- **Outcome not process regulation** Regulation should incentivise and penalise for outcomes, not manage processes other than in relation to the safety of the system.
- **Limiting energy regulation** Energy regulation should only be necessary where other existing regulation, contractual law and consumer rights cannot deliver the same outcome or be lightly amended to consider energy needs.
- **Facilitate consumer choice** Regulation should enable new business models to be trialled, succeed and even fail, while maintaining very strong consumer rights.
- **Regulatory distinction** Regulation needs to be broken down into statutory requirements and business practice, and companies should be encouraged to question business practices that have no legal standing.
- **Reform of code protocols** Codes or guidelines should be reformed, simplified and transposed into standard "floors", not "ceilings, and be able to be challenged by new entrants and innovation.
- **Managed socialised costs** Regulation may be needed for some key socialised costs that do not fall out of the open market, from energy-efficiency measures through to vulnerable customers and inequities.
- **Interoperability and security** The ability of all data to interact will deliver best outcomes, but will need to be protected from cyber and data failures.

Contact & Connect

LAURA SANDYS

laura@challenging-ideas.com

@Laura_Sandys

in/LauraSandys

www.challenging-ideas.com

JEFF HARDY

jeff.hardy@imperial.ac.uk

@jjeh102

in/jeffhardy1

www.imperial.ac.uk/grantham

ENERGY SYSTEMS CATAPULT

communications@es.catapult.org.uk

@EnergySysCat

https://es.catapult.org.uk

GRANTHAM INSTITUTE

www.imperial.ac.uk/grantham

IMPERIAL BUSINESS SCHOOL

www.imperial.ac.uk/business-school

UK POWER NETWORKS

futuresmart.ukpowernetworks.co.uk

@ukpowernetworks

CHALLENGING IDEAS

Imperial College Business School

Grantham Institute
Climate Change and the Environment
An institute of Imperial College London

CATAPULT
Energy Systems

UK Power Networks
Delivering your energy