POWER UP

The framework for a new era of UK energy distribution

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Executive summary

- As the new government considers its energy policy agenda, and in light of the Competition Markets Authority (CMA) review of electricity market competition, now is a good time to consider the effects of OFGEM's current regulatory framework on actual market outcomes for consumers. Current regulations undervalue the effect of innovation on the benefits that consumers enjoy. The CMA's provisional findings reflect an understanding of the beneficial potential of innovation.
- The Internet provides a striking example of such unanticipated benefits. Over the past 30 years the Internet has evolved into a platform around which countless new ideas, products, services, and relationships have grown that have changed our daily lives dramatically. These digital innovations are possible because the Internet provided a platform for "permissionless innovation". Permissionless innovation means an environment in which the default presumption, of both formal law and informal norms, is that individuals are free to create, experiment with, and learn about new ideas, products, and services. It is an environment in which experimentation is given the benefit of the doubt. Such digital innovations are now affecting energy, entering the electricity industry and enabling dramatic changes in how we produce, consume, and monitor electricity and in the environmental impact of electricity consumption. Energy policy should allow

retail electricity market structures that foster such experimentation and trial-and-error learning.

- In contrast to the Internet, the economic regulation of the electricity industry is a permission-based system grounded in natural monopoly theory. In our dynamic economy with pervasive innovation and technological change, this static regulatory theory cannot capture the potential benefits of innovation or the effects (positive or negative) of regulation on innovation's capacity to generate consumer benefits. OFGEM's recent Retail Market Reform (RMR) and the CMA investigation of its potential anti-competitive effects provide an example of this mismatch. OFGEM is operating with a flawed theory of competition, believing that they have the knowledge required to enable prices to reach average costs in these markets and the knowledge required to grant permission to those capable to doing so to benefit consumers. The CMA's provisional findings dispute this theory of competition; in keeping with the CMA's recommendation, OFGEM should abandon its RMR tariff simplification regulations.
- The new government's emphasis should be on policies that reduce barriers to innovation. Economic and environmental benefits can be aligned. Waves of innovation are affecting society as a whole, including the electricity industry, most notably in digital smart grid technologies and in distributed energy resources and storage. These myriad innovations will enable dramatic changes in the production, consumption, and monitoring of electricity, as well as changes in energy efficiency and the environmental impact of electricity consumption.
- For electricity policy to facilitate what is socially beneficial, it should focus on clear, transparent, and physical rules for the operation of the grid, on reducing entry barriers that prevent producer and consumer experimentation and learning, and on enabling a legal and technological environment in which consumers

can use competition and technology to protect themselves. Great Britain's electricity regulation does a better job of this than most countries, but could do better by incorporating a focus on enabling experimentation into their regulatory design considerations.

1. The context

May's general election saw a Conservative party victory. In laying out their policy priorities, the new government has indicated some incremental changes to the energy policies they crafted during the coalition government. This government's energy policy is likely to include a broad approach to decarbonisation (nuclear, fracking, offshore wind) along with other incremental policy changes. (Tindale 2015) There is also some concern that a Conservative government will reduce its support for environmental policy, as indicated by its announcement curtailing subsidies for onshore wind power (Independent 2015).[1]

The new government inherits an ongoing Competition Markets Authority (CMA) investigation into pricing and market power in retail electricity markets. Consumer concerns over high energy bills and potential exercise of market power by the six largest vertically-integrated retail suppliers, in conjunction with regulatory changes at OFGEM that have affected the retail market's competitiveness, motivated this investigation. The CMA issued its preliminary findings and proposed remedies in July, which will be finalised later this year.

1 For a summary of reactions and predictions relating to energy policy under the new government, see Carbon Breif (2015)

As the new government begins to consider its policy agenda, and in light of the CMA review of electricity market competition, now is a good time to consider the effects of the current regulatory framework on actual market outcomes for consumers. One crucial aspect of consumer benefit that is underappreciated is the effect of innovation on the benefits that consumers enjoy.

Facing this context, this paper argues that the new government's emphasis should be on policies that reduce barriers to innovation. Economic and environmental benefits can be aligned. Waves of innovation are affecting society as whole, including the electricity industry, most notably in digital smart grid technologies and in distributed energy resources and storage. These myriad innovations will enable dramatic changes in the production, consumption, and monitoring of electricity, as well as changes in the environmental impact of electricity consumption.

Smart grid technologies embedded in the electricity distribution network enable automated outage notification, fault detection and repair, and routing of current flows around faults to maintain service. They also enable the interconnection of increasingly heterogeneous devices, owned and operated by different types and sizes of agents. A homeowner can own an electric vehicle, enabling both consumption and generation of electricity.

Some of the most compelling examples of innovation aligning economic and environmental incentives are from the evolution of the connected home. Imagine, for example, digital sensors that enable preset and automated lighting, heating, air conditioning, or refrigerator changes as electricity prices change, or when renewable power becomes available.

Research from the Groupe Speciale Mobile Association (GSMA) indicates that four factors combine to form a foundation for the connected home:

- The spread of mobile broadband networks,
- Falling hardware costs,
- New business models,
- The pervasiveness of smartphones. (GSMA 2015, p. 4)

Technology enthusiasts are already implementing connected home technologies, including smart grid technologies like digital electricity meters and programmable thermostats that can both send and receive data (e.g., Nest), developed by international companies like Samsung, Apple, Google, Orange, and Cisco. (GSMA 2015, pp. 6-7)

In a survey of technology enthusiasts, one-quarter of those surveyed in the UK have already installed a digital electricity meter, and similar percentages have installed Internet-connected home security systems, lighting systems, thermostats, washing machines, or health monitors. (GSMA 2015, p. 8) Consumers who have done so are saving money on their energy bills:

> *… 49% of technology enthusiasts in the UK, 46% in Germany, 42% in the US and 40% in Japan already own a connected energy solution, such as a smart meter, a thermostat or lighting system. Of the respondents who own a connected energy solution, 72% said they are saving money on their utility bills. The average (mean) monthly estimated saving in the US was $80, in the UK $77 (£50), in Japan $31 (¥3786) and in Germany, $95 (€80). (GSMA 2015, p. 10)*

Consumers can use connected home technologies to reduce waste, which improves energy efficiency by simultaneously saving money and conserving energy.

This alignment of economic and environmental values requires intelligent end-use devices, which are increasingly feasible and cost-effective as the costs of information technology fall. It also requires broadband to the home; in 2014, only 76% of UK households had fixed broadband Internet connections. (ONS 2014)

Such digital smart grid technologies, including end-use devices, provide increasingly feature-rich, mobile ways to create consumer awareness about electricity consumption, electricity expenditure and the environmental impact of that consumption. They also provide ways to change electricity consumption, either manually or automatically, in the home or remotely. Digital electricity meters and transactive end-use technologies allow consumers to automate their responses to changes in prices over time. These technologies will make time-differentiated dynamic pricing more possible and attractive to consumers, especially if they can automate their responses to these price signals. Digital technology also enables fixed "green energy" products to evolve into transactions and contracts that enable consumers to tailor their "green-gray mix" to their budgets, which may enable more consumers to buy energy according to their environmental preferences given their budgets.

Another example of energy in the connected home is distributed generation, such as solar photovoltaic panels on the roof. Digital technology enables the customer to automate appliance use to vary electricity use depending on output, thereby reducing the use of energy overall and reducing the use of fossil-fuel-generated power. If an open retail market existed, the customer could sell excess generation from the rooftop panels to willing buyers. Transactive technologies like digital meters and programmable communicating thermostats and device controllers enable consumers to automate decisions about whether or when to offer excess generation for sale. Digital technologies make such an open, decentralized, interconnected retail market possible at the edge of the distribution network where it was not possible before.

In the traditional, linear electricity value chain, large generators send energy to end-use customers via high-voltage transmission and low-voltage distribution networks intermediated by transformers. With smart grid technologies, multi-directional connection and current flow in a distribution network are now possible, and can occur in ways that do not destabilize the network and cause outages. These new opportunities can have beneficial economic and environmental impacts, but regulation may inadvertently establish barriers to the types of innovation at the edge of the distribution network that have been so valuable at the edge of the Internet.

Today's technological dynamism and its application to energy generation and consumption has transformative potential, due largely to its powerful decentralizing forces. Vint Cerf (2012) and Adam Thierer (2014), among others, have shown that the exponential growth of products, services, and value creation around the Internet have occurred because the Internet has been a platform for "permissionless innovation" – where the default presumption is that individuals can create new products and services, and consumers can experiment with them, without having to ask approval in advance.

Technological innovation is an evolutionary process, a discovery process with details that no one can anticipate. Learning what, if any, of these digital energy innovations consumers find valuable requires experimentation. Experimentation, failure and error correction through markets and coordinated via price signals enables producers and consumers to discover and create mutual value.

As the new Conservative government crafts its energy policy, they should create a legal and policy framework that facilitates permissionless innovation around the edge of the distribution network. They can do so by

- Reducing barriers to innovation;
- Reducing retail market entry barriers;
- Consumer protection based on demonstrable harm rather than on precaution; and
- Focusing regulatory effort on digital security.

This framework emphasizes competition and choice as means of simultaneously enabling economic well-being and environmental quality – a prosperous and cleaner future.

2. Competition through innovation

ENRTREPRENEURSHIP AND EXPERIMENTATION THEORY: SCHUMPETER AND KIRZNER

The economic regulation of the electricity industry is a permission-based system grounded in natural monopoly theory. This model describes an industry with decreasing marginal costs of producing a specific product. Both the definition of the product and the demand for it are given and unchanging. The model suggests that the natural equilibrating tendency in a rivalrous market with multiple competitors is to charge a price that does not cover the substantial fixed costs. Designers of this model argued in the 1890s that economic regulation should thus create an entry barrier, grant a monopoly, and stipulate that the firm's profits will be a cost-plus rate of return on assets. The regulator has the information about the firm's costs to enable him/her to determine what that rate of return should be. Such regulation will lead to the provision of that given product to those given consumers at the lowest feasible cost. Traditional regulatory procedures focus regulators and the regulated on providing a narrowly defined, generic, highly reliable service at the lowest possible cost.

Thus, economic regulation itself defines the boundaries of the market and the product. It accommodates demand growth simply by scaling up permitted infrastructure investment. As long as the industry is economically and technologically static, and growth occurs only as a scaling up of existing products and services, the regulatory model should be unchanged as well amplification effects

Regulatory models premised on cost recovery fail under pervasive economic and technological change—Schumpeterian creative destruction. Technological and economic dynamism characterizes the market environment of the early 21st century. As Joseph Schumpeter (1934, 1942) put it, value arises through the collapse of product and service definitions, and market boundaries. Traditional economic regulation is designed to curtail such value-creating innovation and evolution.

Entrepreneurship theory suggests a more dynamic theory of competition by highlighting two aspects of how entrepreneurs create value for consumers. Joseph Schumpeter's (1934, p. 65) pioneering analysis examined how disruptive innovation creates economic growth via individuals who create "new combinations" of materials and forces, leading to change away from economic equilibrium. Individuals discover these "combinations" by experimentation. Existing producers differ from these experimenters in their tendency to initiate growth-generating change by participating only in existing markets, producing only existing goods and services, using existing techniques at marginally lower prices.

Schumpeter enumerates five mechanisms for creating dynamic change in markets:

1. introducing a new good or service, or adding new features to an existing one,

2. introducing new production technology or methods,
3. opening new markets,
4. capturing new sources of raw materials,
5. new methods of industrial organization. (1934, p. 75)

Competition in free-enterprise societies is a process of creative destruction, with new combinations and ideas making previous ones obsolete. (1942, p. 84) Dynamic competition often takes the form of product differentiation and bundling to compete for the market. Rivalry occurs among differentiated products; innovators and entrepreneurs change market definitions and boundaries by creating new products and services as well as new bundles of products and services. That dynamic discovery of new value propositions necessarily takes place in an experimentation process in which different producers interact, as do old and new combinations, to meet the market test of consumer value creation.

Schumpeter's disruptive innovator finds its complement in the activity of Israel Kirzner's (1978, 2009) alert, aware, entrepreneur. The "entrepreneur-as-equilibrator" (2009, p. 147) uses differential alertness to profit, at least speculatively, from an existing opportunity to create value. Differential alertness is awareness of a business opportunity that is otherwise underappreciated. This entrepreneur is not Schumpeter's "disruptive creator" but instead engages in trial-and-error, playing a coordinating role by adapting to underlying changing conditions. Commercializing new products and services, as well as new bundles of products and service, is an example of "equilibrating entrepreneurship" as Kirzner understood it.

These ideas of entrepreneurship and experimentation are relevant to regulatory institutions and institutional change in electric power because decentralized coordination through market processes offers forward-looking coordination of behavior that is not available to central authorities, including regulators, no matter their expertise. Markets offer agents of all types the opportunities and incentives to make profitable discoveries through experimentation. Regulation as it is currently practiced does not.

3. Why innovation?

Energy policy under the new government should focus on innovation as the best feasible approach to address concerns about both consumer energy bills and long-run environmental quality. A conceptual framework for innovation will help us think about the policy implications of such innovation for the British electricity industry. This framework prioritizes the policy objective of facilitating dynamic, forward-looking innovation in a cost-effective and resilient way, which means looking for dimensions of policy that reduce barriers to innovation but do not necessarily "pick winners" or subsidize specific technologies that may or may not be economically and environmentally sustainable.

Economic history demonstrates how research, development, and commercialization of new technologies, products, and services necessarily involve duplication of efforts, false starts, and dead ends. (Mokyr, 2010) One of the most potent dynamic benefits that market processes generate is the trial-and-error learning that can lead to a new product's success or failure. Commercial enterprise is a system of profit and loss, and failures and false starts in markets lead to error correction—the costs of failures are more than balanced out by the benefits of learning which innovations are really worth it.

Progress toward cleaner and more energy efficient electricity is rarely predetermined or linear. Policymakers striving toward the objective of cleaner and economical electricity have to balance attempting to accelerate innovation while not wasting taxpayer resources, and they have to achieve that balance in the face of their epistemic and cognitive limits — they cannot replicate the diffuse private knowledge that exists and is created in the interactions of individual agents in the economy, both in the processes of exchange and the processes of research and development.

For those reasons, the conceptual benchmark in this analysis is the extent to which energy policy fosters experimentation. Experimentation creates social learning, generating knowledge that did not exist before. It means trial-and-error discovery in the face of the unknown, and is the hallmark of how market processes create value in a dynamic rather than a static sense. (Kiesling, 2014) An entrepreneur developing a new product or service and bringing it to market is an act of experimentation. A consumer walking in to a store, exploring what mobile communication devices are available, what features they have or lack, and their prices, is an act of experimentation. When enough consumers choose a specific product and enjoy consumer surplus from that choice, the producer profits; when consumers do not choose a product, or choose it and don't end up getting consumer surplus, the producer makes a loss. Error correction involves the producer either changing the production process and price, changing the product, or leaving the market.

PERMISSIONLESS INNOVATION AND THE INTERNET

Over the past 30 years the Internet has evolved into a platform around which countless new ideas, products, services, and relationships have grown that have changed our daily lives dramatically. In fact, the Internet has become such a meaningful and pervasive part of life that people hardly give it a moment's thought, expecting new and better products, versions, and value propositions to evolve almost constantly.

Vint Cerf, one of the original creators of the Internet, attributes this pace and impact of innovation to the network's bottom-up creation, and its nature as a platform for permissionless innovation:

> *When I helped to develop the open standards that computers use to communicate with one another across the Net, I hoped for but could not predict how it would blossom and how much human ingenuity it would unleash. What secret sauce powered its success? The Net prospered precisely because governments — for the most part — allowed the Internet to grow organically, with civil society, academia, private sector and voluntary standards bodies collaborating on development, operation and governance. (Cerf 2012)*

Permissionless innovation means an environment in which the default presumption, of both formal law and informal norms, is that individuals are free to create, experiment with, and learn about new ideas, products, and services. It is an environment in which experimentation is given the benefit of the doubt. In the Internet context, Adam Thierer describes permissionless innovation as:

> *… the general freedom to experiment and learn through ongoing trial-and-error experimentation … the tinkering and continuous exploration that takes place at multiple levels — from professional designers to amateur coders; from big content creators to dorm-room bloggers; from nationwide communications and broadband infrastructure providers to small community network-builders. (Thierer 2014, pp. 1-3)*

The Internet's open architecture (open communication protocols and interoperability) makes creating new devices and applications layered on top of the Internet easy and inexpensive within the context of technical rules and commercial law. As Leslie Daigle noted last year on the 25th anniversary of the World Wide Web:

> *Sir Tim Berners-Lee did not have to ask a central authority whether or not he could write a client-server hypertext system. He wrote it; others who found the possibilities interesting downloaded clients and servers and started using it. (Daigle 2014)*

Existing legal structures and communication standards still prevail, but within that institutional framework, any individual can create a new device, a new application, or a new business, as long as their creation abides by technical protocols and commercial law. Similarly, within that institutional framework, consumers can experiment with these diverse offerings, using and purchasing the ones that they value the most. Permissionless innovation in such a transparent and open environment has created billions of pounds worth of value. In the past five years, general-purpose digital technologies have expanded greatly and been increasingly integrated into our daily lives. 2.0 billion users worldwide connect to the Internet daily, and across 13 major countries, the Internet accounts for 3.4 percent of GDP. (McKinsey Global Institute 2011, p. 11)

Three primary reasons explain why permissionless innovation creates such beneficial dynamism and value:

1. it helps in mitigating the knowledge problem,
2. it builds resiliency in the face of uncertainty about unknown and changing conditions,

3. it undercuts the ability of rent-seeking incumbent interests to maintain a status-quo that can benefit them at a cost to others.

One of the most important reasons why an environment for permissionless innovation is valuable is because it enables the experimentation and learning that can mitigate the knowledge problem. Neither regulators nor other market participants have access to the knowledge influencing individual decisions made about production or consumption. In dynamic markets with diffuse private knowledge, neither entrepreneurs nor policy makers can know a priori which goods and services will succeed with consumers and at what prices. Similarly, consumers' preferences are not fixed and known, either to others or even to themselves. Consumers learn their preferences through the process of evaluating available choices in a marketplace, and analyze the relative value of those tradeoffs over time. The set of available consumer choices itself changes due to entrepreneurial activity.

Even the most benign, well-intentioned group of government administrators with the most powerful computer possible cannot access that knowledge, because it is dispersed in the minds of individuals, and they do not even create that knowledge until they are in a context where they have to consider making a choice. Experimentation makes learning possible and creates knowledge that would not otherwise exist, including the knowledge embedded in new products, services, and value propositions. (Kiesling 2015)

Knowing what future we are creating from today's actions is almost impossible, particularly knowing specific outcomes that will happen. An environment that fosters trial-and-error learning is more likely than others to enable people to adapt to these unknown and changing conditions, and to find ways to improve well-being and living standards. No one can anticipate future uses of technology, and the only way to find them is to allow people to experiment, not to rely on selection and approval by a regulated monopoly or by a regulatory authority.

Finally, permissionless innovation fosters creativity and advancement without obstacles from rent-seeking incumbents or prior claimants. Public choice theory suggests that incumbents have strong incentives to create entry barriers, and to lobby for policies that will allow entry barriers to persist, in order to make their market less rivalrous. Less rivalrous markets mean less consumer protection through competition, and less innovation that can have substantial economic and environmental benefit.

By contrast, economic regulation is a permission-based system. Permission means having to ask for explicit approval of regulators and government authorities in advance of bringing a new product, service, app, or other value proposition to market. In electricity, the form and extent of economic regulation may act as a permission barrier, preventing such unexpected benefits from arising. In the electricity industry, permission to enter the industry is often denied — legal entry barriers that protect the incumbent's economies of scale.

In electricity, economies of scale in generation decreased in the 1980s with the invention of the combined-cycle gas turbine generator, but the earliest regulatory changes liberalizing wholesale power markets came almost a decade later (particularly in Britain and the U.S.). In the timescale of current technological innovation, a decade is a very long time for regulatory lag to persist.

Arguments in favor of regulatory permission typically rely on safety, reliability, and anticipatory consumer protection, and in an industry like electricity, such physical and economic regulations will always have an important role. But one fundamental consequence of regulatory barriers to innovation is an opportunity cost: it forecloses the experimentation, learning, and innovation that could yield more beneficial products, services, and value propositions (during the lag).

Tort law has less of a stifling effect on innovation as Eli Dourado observes:

> *Our regulatory system is permission-based. Either the specifications for permitted products and services are published in advance, or firms seek special permission to offer a product or service. This regulation has the same effect on entrepreneurship in the real world that many online regulations would have on Internet innovation. It raises the cost of starting or running a business or non-business venture, and therefore it discourages activities that benefit society.*
>
> *The alternative to permission-based regulation is centuries old and well tested — the common law of tort. Under tort law, instead of asking for permission to introduce a potentially dangerous product, a firm must pay for the damages its dangerous product creates if it is found liable in court. Brilliantly, the tort system operates retrospectively — there must be actual damages before it steps in to stop the potentially dangerous activity. It is restitution-based, not permission-based. This creates an incentive to make safe products, and it keeps the barriers to starting a company or rolling out a product low. (Dourado 2013)*

Increasingly, as smart grid technologies proliferate in the distribution network (including digital meters, rolling out in Great Britain in 2016), distributed energy resources become cheaper and more energy efficient, and the "Internet of things" smart appliances enable the "connected home", permission-based regulation will limit how much innovation actually occurs at the retail edge of the distribution network. The potential economic and environmental value from digitally-enabled residential energy innovation will raise the opportunity cost of permission-based regulation, because the value of what could happen that regulators are not allowing to be discovered will be higher than in the traditional "electricity as a commodity" view of this market.

4. Electricity distribution and smart grid technologies

MARKET STRUCTURE AND REGULATORY ENVIRONMENT

The current market structure in retail electricity distribution is an outgrowth of the 1990 privatisation of the vertically-integrated electricity industry. For most of the past century, all of the transactions in the vertical supply chain in electricity, from generation, to high-voltage transmission, to low-voltage distribution, to retail customer service, were performed by a single vertically-integrated utility. By 1990, technological change in electricity generation had made wholesale electricity markets feasible, so the privatization legislation required commercial separation of generation owners from transmission and distribution wires owners. National Grid owns and operates the high-voltage transmission network, and 14 distribution network operators (DNOs) own and operate the regional distribution systems in Britain (OFGEM 2015).

The DNOs have operated under incentive regulation since 1990, first under a system called RPI-X that used price benchmarking to regulate distribution charges (Pollitt 2014a). Generators selling into wholesale markets and retail suppliers selling to end-use customers do not face such price cap regulation. The energy regulator, OFGEM, does monitor energy and retail prices, though, particularly since its revised incentive regulation, RIIO, was issued in 2010. RIIO focuses on the incentives DNOs have to innovate and to provide output quality to consumers (Pollitt 2014b).

In most regions, the DNO sells both wires/network distribution service and the energy that the DNO transports to customers. Independent retail suppliers can enter these regional markets and compete with the DNO in the sales of energy, although the distribution service continues to be provided by the DNO. Such competition, grounded in rivalry, has created value for consumers, largely by offering pricing discounts (CMA 2015b).

Existing regulations, premised on the existing electricity network, can erect barriers to the beneficial experimentation and discovery that emerges in market processes. Some of the current issues at stake in the Competition and Markets Authority (CMA) review of UK energy markets illustrate this point. The CMA is investigating whether "any feature, or combination of features, of each relevant market prevents, restricts or distorts competition in connection with the supply or acquisition of any goods or services in the United Kingdom or a part of the United Kingdom", in this case with respect to both wholesale and retail electricity markets (2015b). One question in their investigation is whether or not OFGEM regulation in retail markets is restricting or distorting competition, specifically by acting as a barrier to innovation and entry.[2]

In 2008 OFGEM issued regulatory changes affecting retail electricity markets in Great Britain meant to reduce entry barriers and challenges facing energy retailers that were trying to engage customer interest. These changes initially promoted some independent supplier entry in retail markets, and as competition ensued, the number and variety of residential/domestic product offerings expanded – fixed price, dual fuel (electric and gas), renewable energy, time of use.

In 2013 OFGEM's concern that this rivalrous marketplace with differentiated products confused consumers led them to institute Retail Market Reform (RMR) regulations on the number and type of products that retail suppliers could offer. Each product (or "tariff") had to be priced using a two-part structure, fixed and per-kWh variable, although they allowed the fixed charge to be zero. A non-discrimination requirement meant that any discount offered to one customer had to be offered to all, thus undercutting a retailer's ability to engage in price discrimination that could be welfare-enhancing. Finally, each retail supplier was only allowed to offer four products, no more. OFGEM's justification for this regulation was that limits on the number of product offerings simplified the alternatives facing consumers and would facilitate their comparison shopping and switching due to lower search costs.

OFGEM's regulations have brought some criticism, most notably from former regulator Stephen Littlechild, who testified in the CMA review that "The RMR had also restricted consumer choice and suppliers' ability to innovate. … Simple tariffs which did not allow for innovation in the way that complex tariffs did were less attractive

2 Theory of harm 5, CMA 2015b, p. 7

to customers." (CMA 2015a, p. 3) Moreover, OFGEM considered a substantial share of residential consumers to be "sticky", or inertial, which could create opportunities for incumbents to exercise market power and raise prices. Dr. Littlechild contends, in contrast, that

> *Many 'sticky' energy customers did not want to spend a lot of time searching for better tariffs and switching. In this sense, they were similar to customers in all other markets. If companies tried to exploit 'sticky' customers by raising prices, they would find it hard to do so without raising prices to more active customers that they might lose, and their rivals would be encouraged to offer better deals to attract those customers. If the aim was to protect consumers by encouraging them to engage in the market, suppliers and switching sites knew better how to do that than OFGEM did. (CMA 2015a, p. 6)*

In a 2014 joint report from OFGEM and the Department of Energy and Climate Change (DECC), OFGEM and DECC laid out a plan for responding to industry and consumer complaints and to reduce entry barriers to independent retail suppliers. Regarding the RMR simplified tariffs, OFGEM noted that independent suppliers were concerned that the regulations stifled their ability to offer innovative products. OFGEM's response to this concern was:

> *The RMR rules allow suppliers to offer up to four core tariffs per fuel and per meter type. This means up to four 'Time of Use' tariffs are also permitted. In addition, the RMR rules allow for derogations from specific rules. Our guidance sets out that we will consider derogations to allow for pilot schemes for innovative products. We have already granted a number of derogations for innovative products and are considering more requests. In the light of our experience, we are trying to speed up the derogation process and*

considering the need for clearer guidance on the information that suppliers need to submit." (DECC/OFGEM 2014, p. 16) [emphasis added]

The CMA analysis also includes an investigation of the industry codes—the regulations and norms that govern UK electricity production. Depending on the type of retailer (independent or vertically integrated), OFGEM may require the retailer to adopt up to seven industry codes for the types of activities that the retailer would be required to perform (e.g., balance and settlement, distribution, distribution connection, use of system). While these codes provide clear terms on which firms use and operate the distribution network, independent supplier complaints have prompted the CMA to analyse whether the codes are sufficiently complex to act as an entry barrier.

The presumption in OFGEM's RMR and the complex set of industry codes is that they will promote competition and protect consumers by erecting a permission process. Their regulations constrain the actions of both producers and consumers by substituting their own judgement for that of producers and consumers, and requiring producers to receive approval before entering the market.

These events indicate that OFGEM is operating with a flawed theory of competition, believing that they have the knowledge required to enable prices to reach average costs in these markets and the knowledge required to grant permission to those capable to doing so to benefit consumers. Their actions contradict the argument that, as Stephen Littlechild notes, competition "... was a rivalrous discovery process taking place over time. Competition was not a state of perfectly informed customers all paying the same price for the same product ... The competitive market process as a discovery mechanism was better placed to find out the best way for consumers to handle uncertain and possibly rising prices than for OFGEM to prescribe the way." (CMA 2015a, p. 2, p. 4)

Traditional regulatory procedures focus regulators and the regulated on providing a narrowly-defined, generic, highly reliable service at the lowest possible long-term cost, with an expected outcome of customers all paying the same price for the same product. As long as things stay static, this model will do a decent job of providing that generic service. We experienced this success through static-ness with the policy focus on electrification through the 20th century.

OFGEM's RMR simplifications represent a return to a static concept of regulation, even though it is in a nominally competitive retail market. These regulatory simplifications do not take advantage of the digital technologies that consumers may find valuable for home energy management, nor do they create an institutional framework in which retail suppliers are more likely to bring such technologies to market to offer to consumers. Those limitations also mean that technology entrepreneurs are less likely to work on creating more and better such technologies.

In July the CMA issued its preliminary findings (2015c) and proposed remedies (2015d) in the energy markets investigation. With respect to retail electricity markets, adverse effects on competition (AECs) arise from several aspects of regulation, consumer behavior, and technology.

The preliminary findings identify OFGEM's prohibition on price discrimination and the RMR tariff simplification as regulatory decisions creating an AEC (2015c, pp. 33-34). The proposed remedy is to eliminate the RMR restrictions limiting each supplier to four tariffs (2015d, p. 15).

Consumer behavior, in particular the inertia of disengaged customers, prompted the investigation. The CMA estimates that these customers could save 14-22 percent by switching, and that they disproportionately are older, lower income, or living in rented housing with a prepayment meter; many may also be confused using the Internet for transactions (2015c, pp. 27-28). One proposed remedy is to design a default tariff available only to those customers, so as to minimise the distortion of the market (2015d, p. 32).

Two aspects of existing technologies restrain retail competition: the limited information to consumers from traditional meters, and the restrictions on information and tariffs available to those with prepayment meters (2015c, p. 29). The CMA anticipate that the smart meter rollout in 2016 will mitigate several of the technology barriers to innovation in retail markets (2015d, p. 11, p. 19). They also propose as a remedy that the DSOs commence their smart meter rollout by first replacing prepayment meters, which could encourage consumer experimentation and have beneficial distributional consequences (2015d, p. 21).

THE NEXT TECHNOLOGICAL WAVE: DIGITAL SMART GRID AND DISTRIBUTED ENERGY RESOURCES

The innovations in digital communication technology that have already transformed our daily lives have been a consequence of decentralized coordination through markets, not top-down centralized control. The iPhone, for example, is a combination of ingenuity and innovation from the U.S. (and South Korea, through Apple's licensing arrangements with Samsung) with components and labour from China and other countries. On the demand side, it is available for purchase through retail stores or online. None of the parties in this extensive value chain has a personal relationship with the other parties; this is a system of impersonal exchange, and yet, those parties work together to create vast amounts of value. A consumer's decision to purchase an iPhone at a particular price communicates valuable information to the retailer, to Apple, and to Apple's suppliers – all using a system of price signals in market processes to coordinate their individual, private actions.

Our understanding of this is grounded in Hayek's (1945) work on the use of knowledge in society, where he argues that prices serve as a focal coordinating device for the choices of millions of actors with diffuse private knowledge about preferences, opportunity costs, and the circumstances of time and place. Prices provide knowledge surrogates, communicating aggregated aspects of diffuse private knowledge in ways that help individuals make production and consumption decisions for themselves given their own knowledge.

In electricity, technology evolution has taken the form of smart grids in all parts of the value chain – generation, transmission, distribution, and retail service. These smart grids enable:

- Transactive coordination of the system through individual transactions and exchanges;
- Distributed resource interconnection;
- The ability of a resource/agent to be either a producer or consumer of electricity, or both;
- Demand response to dynamic pricing; and
- Distribution system automation by the wires company, leading to better service reliability. (Kiesling 2010)

The potential ways that smart grid capabilities can create value are large, and they transcend the traditional utility-provided "plain vanilla" electricity generation and delivery value proposition. One example of this optimisation is how dynamic pricing induces consumers to shift consumption away from expensive peak hours, which leads to a reduced need for expensive infrastructure investment that is built to meet peaks and then sits idle for substantial portions of the year.

Despite the fact that the value chain in electricity is more complicated in some ways – due both to the physics of current flow in an alternating-current system with little storage, and to its history of retail rate regulation – such decentralized coordination is increasingly possible in the electric power industry because of the forces created by digital technology.

Imagine a market with rival retailers competing to serve customers by offering them menus of contracts from which to choose; these provide different products and services, depending on

- the form of pricing and how it varies over time (fixed, time of use, real time),
- the type of generation resource (green/grey mix),
- the other goods and services with which the electricity service is bundled (security, health monitoring, entertainment),
- and other potentially valuable product dimensions that we cannot conceive of today, but that entrepreneurs will strive to create through these retail market incentives.

This technology-enabled decentralized coordination is desirable because it connects the values and preferences of hundreds of thousands of consumers to the production and investment decisions of generators, using a system of price signals in market processes to coordinate the decisions of all of the parties involved in the consumption of electricity by retail consumers. This leads to economic efficiency, and can induce consumers to reduce their electricity use, leading to reduced resource use and reduced environmental impacts from electricity consumption.

5. Policy implications

Today's digital innovations will change how we produce and consume electricity. In particular, advances in digital communication technology over the past 20 years can both improve efficiency and give customers the tools to reduce their own electricity demand. They enable remote sensing and fault detection within the distribution network, as well as greater intelligence capabilities within substations to deter outages or to detect them and limit their duration. From the retail consumer's perspective, such technologies create the possibility for a connected home that gives the consumer user-friendly current information and access to a variety of activities in the home – heating and cooling, lighting, appliances, home entertainment, home security, laundry, home health care. This transactive technology and variety of retail products and services can allow price-responsive appliances to trade in real-time retail markets, because the consumer can program his/her preferences into the trigger price settings of the appliances.

Policymakers interested in cleaner, economical electricity should aim to influence the innovation process to achieve their policy objectives. A problem of more prescriptive policies is that they limit experimentation. Policies that stipulate specific technologies that will be eligible for subsidies may induce growth in those technologies, but there is an unseen opportunity cost: the other technologies that could have been developed. Policies imposing technology mandates stifle this dynamic experimentation process before it has even started, substituting policymaker judgment for the judgments of all of the producers and consumers subject to their control. That imposition may yield some production economies of scale in the chosen technology, but at a cost of cutting off possibly beneficial exploration. Thus we can evaluate energy policies based on the extent to which they foster the kind of decentralized experimentation.

The technological dynamism of the 21st century is a broad expansion of general-purpose technologies with powerful decentralizing forces. One thing they are changing is the opportunity cost of electricity regulation. In the past, few alternatives existed to the distribution grid and standard electricity service that sells electricity as a homogeneous commodity. In that context the opportunity cost of regulation is relatively low. As digital and distributed energy technologies have evolved, more alternatives are available or could be available through entrepreneurial action. Consumers could prefer those alternatives, if they had opportunities to experiment with in-home devices that could automate appliance responses to electricity price changes, or a retailer bundling home energy management with home security, or residential rooftop solar. The only way producers have incentives to create and consumers to try new options is through markets.

The idea that permissionless innovation promotes widespread improvements in well-being should be a guiding principle as we think about regulation and market design in retail energy markets. Legal entry barriers, the bureaucratic procedures for cost recovery, the status-quo bias and risk aversion of both regulators and the regulated, all undermine the processes that enable innovations to yield both consumer benefits and producer profits in a future environment generated by new opportunities. Regulations that enshrine pre-approval, create entry barriers, or dictate business models limit the trial-and-error learning opportunities through market processes that benefit society.

This process of producer and consumer experimentation and learning is the essence of how we create value through exchange and market processes. What Adam Thierer and Internet pioneer Vint Cerf calls permissionless innovation, what writer Matt Ridley calls ideas having sex (ASI 2012) — these are the processes by which we humans create, strive, learn, adapt, and thrive. Regulations that produce barriers to innovation have a negative impact on welfare by not allowing these evolutionary processes to occur.

For electricity policy to facilitate what is socially beneficial, it should focus on clear, transparent, and physical rules for the operation of the grid, on reducing entry barriers that prevent producer and consumer experimentation and learning, and on enabling a legal and technological environment in which consumers can use competition and technology to protect themselves. Great Britain's electricity regulation does a better job of this than most countries, but could do better by incorporating a focus on enabling experimentation into their regulatory design considerations. The CMA review and final findings may, and should, highlight the importance of enabling experimentation through permissionless innovation.

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