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DIRECTORATE FOR FINANCIAL AND ENTERPRISE AFFAIRS
COMPETITION COMMITTEE

Working Party No. 2 on Competition and Regulation

Executive Summary of the Hearing on Radical Innovation in the Electricity Sector

Annex to the Summary Record of the 63rd meeting of Working Party No 2

19 June 2017

This Executive Summary by the OECD Secretariat contains the key findings from the discussion held under Item III of the 63rd meeting of Working Party No. 2 on Competition and Regulation on 19 June 2017.

More documents related to this discussion can be found at www.oecd.org/daf/competition/radical-innovation-in-the-electricity-sector.htm

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Executive Summary of the Hearing on "Radical Innovation in the Electricity Sector" held at the 63rd meeting of Working Party No. 2 of the Competition Committee of the OECD

By The Secretariat*

From the discussion at the roundtable, the delegates' and experts' written submissions, several key points emerged:

1. The stimulus for the innovation that is disrupting the electricity sector is the rapid expansion in renewable electricity capacity, much of which is from small scale decentralised sources. There are a number of drivers behind this growth including the effectiveness of incentives created by environmental policy, rising electricity prices, and falling input costs. This is helping the world towards meeting the commitments made under the Paris Climate Agreement, however the intermittent nature of renewable generation is creating a challenge which threatens to increase the cost of energy for consumers and hence to obstruct the energy transition towards a low carbon economy.

The current disruption of the market begins with the appearance of renewable energy, much of which is decentralised in its nature. Traditionally power stations were small in number, large in size, powered by fossil fuels, and heavily reliant on a huge grid to send their electricity over long distances. In contrast, renewable generation is often small-scale, and distributed or scattered across a region. They include photovoltaic solar panels that households may install on their roof, or that farms and businesses might install on their land, as well as small wind turbines, small hydro-kinetic units, and small biomass, biogas, and geothermal energy generating units.

There are a number of drivers behind the growth of renewable distributed energy. Firstly, environmental policy has provided strong support for increasing the share of renewable electricity capacity, not only through centralised generation (fixed-tariff power purchasing agreements, PPAs) but also through consumer level initiatives such as net metering and feed-in tariffs, which have been important incentives for those considering becoming prosumers. Secondly, rising electricity prices have made it more attractive for consumers to begin generating their own electricity, both to reduce the quantity they purchase from the grid and in order to sell to the grid at a higher price. Thirdly, the cost of photovoltaic technology has fallen substantially. More generally for developing countries, small scale distributed generation is an attractive solution where the grid infrastructure is not in place to transport energy from centralised power stations into people's homes

However, the variability of renewable power sources such as solar and wind, be they distributed or otherwise, creates an intermittency problem that poses a challenge for the market. As renewable generation increases this challenge gets bigger by the year. Solar panels, for example, generate electricity approximately 10-30% of the time, i.e. during daylight hours on sunny days. Where solar and wind generation add significant capacity,

* This Executive Summary does not necessarily represent the consensus view of the Competition Committee. It does, however, encapsulate key points from the discussion, the delegates' written submissions, and the panellists' presentations.

over the course of a day this can have a big effect on the capacity the grid requires from other sources. As the share of renewables grows each year, the grid will need an increasingly large capacity that will be largely unused while renewable sources are generating. This underutilisation will have an efficiency cost, since it means grid operators need to invest in increasing the network's capacity so that peak demand can be covered and blackouts avoided. The investment in these capacity markets inevitably inflates consumer bills.

2. To address the intermittency issue and reduce costs for consumers, OECD countries are rolling out smart meter technology that allows consumers to monitor the energy they use. They are also increasingly moving towards adopting dynamic pricing that enables consumers (or third parties) to use the information generated by smart meters to help change behaviour and reduce costs. It is this dynamic pricing in wholesale and retail markets that is creating the business case for investment in a wide range of innovative business models.

Since the share of intermittent generation capacity is growing, the demand for non-intermittent generation, and the price of electricity are each becoming increasingly variable over the course of the day. These larger price swings mean consumers and retailers need more information on how usage changes over the day. Smart meters are therefore being rolled out in many OECD countries. Clarifying the consumers property right to their data in these meters, and hence their ability to easily share that data with third parties, is an important way in which to stimulate competition. It allows firms to identify consumer usage patterns and to offer products and price packages that either fit their existing pattern of use, or help them to change their pattern of use to obtain better value.

The increase in price swings throughout the day are also leading to dynamic retail pricing becoming more popular, for example in the US, New Zealand, Norway, and Estonia, and in the European Union where it will become mandatory from 2020 onwards for all firms to offer consumers an option to choose a dynamic price plan. Indeed, Spain and Denmark have already adopted dynamic pricing tariffs as a default option from which consumers need to opt-out of if they wish to pay a higher premium tariff that insures them against price variation. Whether or not consumers pay dynamic prices, or insure themselves against them, the variation in wholesale prices is gradually creating a stronger business case for a range of innovative business models that seek to help balance the market, and hence to profit from the avoided investment in inefficient underutilised capacity.

3. There are a wide range of innovative business models that are seeking to balance markets in more efficient ways. Which of these models will thrive remains unclear; however, it seems likely that one or perhaps a combination of these models will soon disrupt the traditional retail market.

One possibility is that business models that increase interconnectedness will thrive. These businesses might disintermediate supply chains and connect us directly, allowing users to sell the energy that they do not use (or attach little value to) through digital trading platforms, like an Airbnb for electricity. However, it would be important in such platforms to ensure that the costs of using the grid infrastructure and the costs of managing grid congestion are factored into the price.

Alternatively, firms might invest in ultra-high voltage direct current interconnections between the alternate current electricity grids. This could facilitate trade with those located in distant locations. However, another possibility is that business models that

facilitate the localisation of electricity markets might prosper. These models might allow consumers and local communities to become self-sufficient by generating, storing and trading their own electricity, enabling them to cut their costs by going off-grid.

In either case, as the Internet of Things develops and connectivity within the home grows, business models in which residential consumers become increasingly responsive to the changing price of electricity are likely to become more popular. This might involve the consumer responding themselves by setting their smart appliances (and electric vehicles) to respond to their dynamic tariff, or outsourcing the management of this response to a third party electricity service provider or demand aggregator.

Most likely, some combination of models involving demand response, storage, and trading will emerge to help governments negotiate the energy transition in the smoothest possible fashion.

4. Regulation needs to be proactive in facilitating entry and innovation, while at the same time remaining neutral between the different types of innovative business model that are emerging, and neutral when creating capacity markets. Regulators and Competition Agencies meanwhile need to watch carefully for signs of strategic entry deterrence by incumbent retailers and grid operators.

To facilitate innovation, regulators need to be proactive in putting in place the infrastructure that is required for innovation to happen. For example, smart meters to record data, the ability for consumers to easily share their data with third parties, and the default of a dynamic pricing tariff for consumers that do not actively choose to insure themselves against price variability.

Proactive regulation is also required to help facilitate new entry. For instance, setting up regulatory sandboxes to test the appropriate framework for innovative new business models has been successful in financial markets and is now spreading to energy markets as well (see Ofgem). Entry into the generation market can also be helped by providing prosumers with the right to two-way access to the distribution grid, and recognising that they do not require the same regulatory framework as large centralised generators, but rather a proportionate approach that is based on the risks that they create. For example, this should not include prosumers submitting demand forecasts to the network operator, or meeting universal service obligations.

At the same time, regulation needs to be competitively neutral, and must therefore avoid picking a favoured innovation and supporting it at the expense of rival innovations. For example, this includes refraining from: a) providing subsidies to residential demand aggregators; b) restricting access to wholesale and balancing markets; and c) setting up restrictive capacity markets that effectively subsidise coal generation.

Given the disruptive potential of this innovation, strategic entry deterrence by incumbent retailers and grid operators is also a risk. This means structural separation needs to be maintained between the natural monopoly of grid operation and the emerging competitive markets for storage, demand response and peer-to-peer trading. It also means maintaining a vigilant eye on the use by incumbents of industry codes as a means to block or delay changes that facilitate disruptive innovation (for instance moving to half-hourly settlements, or the authorised sharing of consumer data).

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Summary of Discussion of the Hearing on Radical Innovation in the Electricity Sector

Annex to the Summary Record of the 63rd meeting of Working Party No 2

19 June 2017

This document prepared by the OECD Secretariat is a detailed summary of the discussion held during the meeting of Working Party No 2 on 19 June 2017.

More documents related to this discussion can be found at www.oecd.org/daf/competition/radical-innovation-in-the-electricity-sector.htm

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Summary of Discussion on the Roundtable on Radical Innovation in the Electricity Sector

By the Secretariat

The **Chair** introduced the topic of the roundtable and noted that electricity had been discussed by the working party in the past and those discussions had led to the recommendation on structural separation. The Chair then introduced the expert panellists: Frank Wolak, Professor of Economics at Stanford; Saskia Lavrijssen, Professor of Economic Regulation and Governance of Network Industries at Tilberg University; Brian Motherway from the International Energy Agency; Lawrence Orsini from LO3 Energy, a start-up based in the US; Pallas Agterberg from Alliander, a Dutch distributor of energy; and Jean-Michel Trochet from EDF.

The Chair explained that the discussion would first look at the growing importance of prosumers (consumers who produce) and storage, and whether these require a change in the regulatory framework and pricing. It would then look at the role that demand aggregators, electricity service companies, peer-to-peer trading, and grid operators might play in the years to come.

The **secretariat** then made a presentation to provide some background on the electricity sector. These highlighted the growing contribution of renewables to global generation capacity, first from wind (2000 onwards) and then from solar (2010 onwards), the end of demand growth in OECD countries from 2005 onwards, and the need to increase renewables from 20 percent to 80 percent of generation in order to meet the 2° scenario in the Paris Agreement. The secretariat set out the intermittency problem that arises from solar power generation that is unavailable when grid demand peaks in the evening. They identified that the need to balance demand and supply across the day was driving much of the innovation that would be discussed today. For example, a storage based solution had become more likely as the cost of battery storage continued to rapidly fall. At the same time, super grids (ultra-high voltage direct current interconnections) that move electricity across continents were being built in some countries. They suggested that these different innovations implied different things for the grid. As a result the level and type of need for future investment in the grid would depend to a large degree on which of the different innovative solutions to the intermittency problem proved more popular with consumers, prosumers, and governments.

Professor Wolak began by explaining the situation in California, which he described as being on the bleeding edge of the new electricity sector. California has about 6 000 megawatts of distributed solar in the system and almost 14 000 megawatts of renewable wind and solar on the system and this is to meet a peak demand of 50 000 megawatts. It therefore has a lot of intermittent capacity, and this new development is putting a lot of stress on system operators, and while there are new technologies that can help address these issues, the business case for them is uncertain because of the pricing mechanisms

that are in place. This is going to make it more costly to transition to a low carbon electricity sector.

He said he would therefore focus on four pricing issues. Firstly, that firms participating in the wholesale electricity market know that how the prices are set is inconsistent with the reality of how the grid operates, and this allows them to take actions to exploit the divergence. For example, the configuration of the grid means that it does not have infinite transmission capacity, and so wholesale offers by generators cannot always be taken up. Hence the winner of an auction might find its offer not taken up and instead the grid operator would have to purchase from a higher priced seller whose offer it can take up. If generators know the grid will have to purchase from them they will raise their price, while a generator that knows its offer will not be taken up will reduce its price since it will often be compensated with the difference between the market price and its offer price. The solution is therefore to use locational marginal pricing to include the cost of operating constraints within the pricing system. This can create large discrepancies between areas but these can be removed by charging retailers a quantity-weighted average of the locational prices across a broader area. He also advised using multi-settlement mechanisms that set day-ahead prices so as to help scheduling and planning contingencies. He said this reduced costs by approximately 3 percent ($100m a year in California).

The second issue is the need to focus on local market power problems, which again can arise as a result of limitations of the grid. For instance if capacity into San Francisco is limited then a local generator can withhold capacity and raise the local price. This requires mitigation plans for when an opportunity to exert local market power arises, and this might be expected to happen more often as the percentage of intermittent renewables increases.

The third issue is that consumers as well as generators need to see the real-time prices. They do not need to pay the real-time price, but if they do not want to pay that price they have to buy out of paying that price. For example, consumers always have the option of whether to show up at the airport and buy a ticket on the day they want to fly. However, there would be a risk that this real time price might be an expensive one. As a result, most consumers do not do that. Instead they hedge that risk by purchasing the ticket in advance. We therefore need to expose customers to this default price the same way that generators face this default price, and customers can then buy their way out of it, and that is what is going to provide the business case for storage and all these technologies.

The fourth issue is the mechanism for ensuring long term resource adequacy. One approach is to pay for installed capacity, the alternative is to rely on the market price to incentivise people to hedge and sign long-term energy contracts. His preferred solution is bid-based capacity markets. These resolve the problem that if there is an offer cap, then generators that are rarely called upon will not, when they are called upon, be allowed to set an offer price high enough to cover their year-round costs. Hence, they will exit. This means you need to fill this residual capacity. One solution is to pay for 115% of the capacity you need at peak demand. But this creates too much capacity which then reduces energy prices, necessitates higher capacity payments, and wipes out the incentive to innovate.

Overall the key is to transition to efficient pricing that includes operating constraints in order to incentivise the investment in the right technologies in the right locations. The major competition policy challenge is distinguishing true scarcity from artificial scarcity and mitigating cases where market power arises.

Australia then described the regulatory structure of the Australian market and asked what the key public policy issues are that need to be addressed. It suggested that the most important one is to get the price signals right. This is key if we want people to make investment decisions in an efficient way for the overall benefit of society; if we want efficient usage; if we want people to charge their batteries at an efficient time and discharge those batteries at an efficient time; if we want them to install solar and other distributed resources when it is efficient to do so then it is important to get the price signals right. In Australia there is a liberalized wholesale market at the transmission network level which gives a price signal every 5 minutes. But the distribution networks, the low-voltage distribution networks, are not priced correctly and so improving the pricing on distribution networks is an important issues for Australia

According to the delegate from Australia, efficient distribution network pricing as being pricing that varies in time and space according to losses and congestion on the distribution network. In Australia, distribution networks are required to price in a cost-reflective manner, but this is not currently interpreted to mean dynamic pricing. It currently has a transmission system market operator, but in order to achieve efficient dynamic prices, a new distribution system market operator would need to be created. These efficient prices would differ from feed-in tariffs which are flat and do not reflect the conditions on the grid. Feed-in tariffs do not vary over time or by location and so prosumers do not have the right incentives to make decisions about exporting power onto the grid at the times that it is needed.

There has been some interest in Australia in establishing peer-to-peer trading in electricity, perhaps using block chain. However, while peer-to-peer trading would deliver more efficient prices that vary over time and location, it also needs to reflect congestion on the distribution grid. The pricing of this congestion on the transmission grid is currently set through a centralised market process. Therefore again it may be that a centralised distribution system market operator is needed to set the price for using the grid, even if peer-to-peer trading of units of energy then sits on top of that.

Another issue to highlight is that distribution networks would like to compete in innovative potentially competitive markets such as battery storage and demand response. Examples can be seen in Victoria and South Australia. However, WP2 has already done a lot of work on this issue and produced the structural separation recommendation, which tackles the problem of anti-competitive discrimination. The problem is that if the owner of the regulated monopoly network competes in these related competitive markets it can use its control over that monopoly service to discriminate in favour of its affiliate.

It concluded that radical innovation is placing the existing policy under pressure and policy makers are now under pressure to develop a flexible market-based response that can adapt over time. There are a number of issues that need to be addressed. Amongst the most important are distribution pricing and ensuring structural separation.

Professor Lavrijssen then made a presentation on how laws and regulations can deal with innovation in the energy sector. She said that EU law is based on the old market model with central energy plants fired by fossil fuels that supply energy at the demand of consumers and that the consumers are seen as passive users of energy and not active consumers that can produce energy, and supply it to the grid if there is a shortage, or store it in case there is too much energy on the grid. She noted that most laws are not yet up to these new challenges. Prosumers are not yet a legal concept, and aggregators are not granted access to flexibility markets. Prosumers may have to comply with certain restrictive burdens and requirements that treat them as if they were traditional suppliers,

and which may prevent them becoming active on the market. So the transition needs new rules and the European Commission has developed a vision on what that might look like and gathered a lot of input from member States, and this vision shows what a new energy law might look like. This might also be applied to countries beyond the EU.

There was a need to relieve regulatory burdens for instance on consumers selling onto the energy market, but also to define new roles and responsibilities. A big challenge will be the rise of intermittent energy produced by renewable energy sources which can cause congestion and imbalances, but also a lot of people may have electric vehicles and they may all want to charge their car when they arrive home from work. This may therefore create new problems and new challenges for distribution system operators (DSOs) who coordinate and maintain the balance of the local grid.

One of the things that could be done is that the role of DSOs could be extended. They often ensure the supply of energy is secure and reliable, but they could also be market facilitators who make sure that the flexibility that is connected to the local grids by solar panels or by load-charging units, can access a flexibility market where it can be traded, and the balance of the energy system can be kept. That would also require a redefinition of the relationships with the transmission system operator. In the Netherlands, the national transmission system operator is responsible for balancing demand and supply but if markets become more local this means that the DSO would also have responsibilities. These would then need to coordinate investment links amongst other things. There would also need to be contracts with consumers and DSOs.

The EU Commission has, she explained, acknowledged that consumers should be empowered and the new package of proposed rules will help consumers and prosumers to be more active in the energy system by stating their right to have an agreement with an independent aggregator, or to participate in a demand response programme. Furthermore, it entitles consumers and prosumers to a dynamic electricity contract. It also makes it clear that prosumers should not face unnecessary regulatory burdens; that they should have access to meter and real-time information about energy use and price in the market. Finally, the new package also recognises the roles of local energy communities, and in particular that that the member States should provide for a framework that entitles local energy communities to participate in flexible energy markets and trade on behalf of their members.

One thing to be careful to note is that many consumers will not be active and it will be difficult for them to understand a dynamic electricity contract. We should be careful of overloading them with information about new types of contracts and difficult pricing formulas because this may confuse consumers. Research suggests this can lead to consumers making bad decisions and not taking steps that are good for their own wellbeing. So we can expect benefits from these new rules but we should also take into account that consumers might not react in the way that we might hope.

In relation to the core tasks of the DSOs, she said that DSOs should not do tasks that can be done by others. However, if some services are important for consumers, and these are not being picked up by the market, then DSOs might step in. For example, in the EU there are exceptional circumstances in which DSOs can pick up some of these tasks.

In addition to efficiency considerations, there is also fairness. Some consumers do not have access to flexibility because they do not have the possibility to install solar panels. We should make sure that those consumers are not punished with higher tariffs because others have more access to flexibility or are in other areas. Finally, market power

problems can also arise, both in the supply markets but also in retail markets there might be problems caused by firms having exclusive access to a consumer's data.

The Chair asked whether net metering might replace feed-in tariffs.

Professor Lavrijssen explained that both give strong incentives for consumers to start producing their own energy, but that neither create incentives to flex their demand or supply and hence to help balance the market. She suggested that we might therefore expect that these would soon be abolished.

The Netherlands then gave a presentation. It described the challenge of the energy transition as being to help the market to accommodate the increasing share of electricity being generated by renewable energy sources which is more volatile and more decentralised than traditional generation.

Since less predictable renewables will play an increasing role in the generation mix in the future, it is important that supply and demand become more flexible. The Netherlands needs to improve the effectiveness of markets in setting the right price signals at all times. This includes allowing higher prices in times of scarcity to reflect the real-time value of electricity right at that moment. In addition, we need to provide equal access to all players, including new market players, and to create incentives for new investments.

The way forward is to establish DSOs to act as neutral market facilitators, and so the unbundling requirement for DSOs should be maintained or even enhanced. This means that DSOs are not allowed to own and manage storage and electronic charging infrastructure. Local energy communities in the Netherlands are a solid basis for investment in renewable production. However, it is important to preserve the benefits of a well-functioning market system in Europe and the Netherlands and so the Netherlands believes that local energy communities should be prevented from turning their backs on the market system, and in particular that they should be kept within the energy system for 3 reasons. First, that it believes that integration increases efficiency. Second, that keeping households connected to the grid helps finance the transmission and distribution grids. Third, it guarantees freedom of choice for consumers by preventing lock-in.

Data management is key in the energy transition. Flexible resources need to be able to compete on a level-playing field, and this can only be accomplished if all players in the markets, including aggregators and energy service companies, have access to the data they need. Therefore, non-discriminatory access to the data provided by millions of smart meters that have been rolled out is now in the public interest. This brings about new challenges with respect to the protection of the privacy of consumers. But access to this data will only be provided with the explicit consent of the owner of the data. However, we need to refrain from bothering them too much with the data they are generating. It is up to market parties to offer them interesting commercial propositions that do not impose a burden and that are financially attractive.

In terms of innovation, the authority has given permission to a supplier offering flexible hourly prices. It also allows peer-to-peer trading of renewable electricity by consumers, which is possible with an existing supply permit. They have also received a request to use DC in local grid operations.

In summary, the Netherlands is focused on improving market functioning based on the right incentives, especially in the short-term markets, intra-day and the balancing markets. They consider this much more effective than creating capacity markets. They are also looking to accommodate both centralized and decentralized production while

maintaining the benefits of the market system. A third key factor is to have a data management system with clear responsibilities that guarantee the availability of data to all parties who need them in the energy transition, while protecting the privacy of the consumer.

New Zealand explained that it has had a market since 1996 and from the outset it has had a locational marginal pricing market. The market has 250 nodes. Every injection and every exit point in the grid is a node so for every half hour they have 250 different prices reflecting the marginal value of either injecting or the marginal cost of taking electricity at that node. It does not have a capacity market but it does have futures and hedge markets. The amount of generation from renewable sources was 88% in the last quarter. The market has very big variations in prices during the day, between the evening peaks and the early hours of the morning and seasonal variations. Electricity is much more expensive in the winter than the rest of the year. New Zealand has a completely deregulated retailing market, with no price controls whatsoever, no default retailer or retail tariffs. It has about 30 retailers in total; a number of them are larger retailers, some of them are small scale generators. It has a centralized switching system, with high levels of switching, over 20% per annum, and the major generator retailers are losing market shares. Those that are gaining the most shares provide residential consumers and small scale consumers with spot wholesale prices.

The delegate from New Zealand suggested that having efficient prices for energy is important in a renewable system because location becomes so important. Pricing needs to reflect the relative value of producing in different places and the relative costs of consuming in different places. Transmission and distribution costs also need to be reflected in efficient prices. They argued that you need good price signals to encourage the adoption of new technology because without those variations in price, why would people buy batteries, without variations in price? The incentive to have photovoltaics or electric vehicles conserving energy by using system controls and so forth is not so great.

New Zealand has focused on local and system-wide market power issues. For example with location-based pricing it finds that generating firms do sometimes enjoy pivotal market positions where they are required in order to meet the demand and they can largely name their price. This requires mechanisms to ensure that it does not lead to inefficient prices while not stopping efficient (but still high) prices that are signalling the real resource scarcity. It also needs to mitigate the likelihood and impact of retailer default which increases as a result of highly variable prices. This means making sure firms can manage their positions, and being set up to ensure that when a retailer exits it does not affect consumers.

There is a cross comparison website run by the New Zealand Consumer Institute, the not-for-profit now called Consumer New Zealand. They run a website but there are other potential providers who do it as well. The website provides people with the ability to go in and put their data in and work out the best tariff for them. You also have to be able to provide access to dynamic prices that reflect location, time of day, season and the costs of generating the electricity they are going to consume. It has retailers who offer text messages and the ability to go into apps to actually see what the price is and change their demand in response. The price responsiveness seems to be greater than has traditionally been thought would be the case. New Zealand also wants to allow access to wider consumption data. It is conscious of the privacy issues that the Netherlands raised but it has the view that consumption data is for the consumer, but it needs to be available to firms so that they can make them proper offers.

Recent reviews of the rules relating to price-quality regulation of monopoly networks have looked at the possibility that the natural monopoly of the grid might disappear if more and more consumers could opt out. They also looked at structural separation. They considered that there were risks in allowing grid operators to participate in markets in terms of discrimination and cross subsidies from the monopolies to the competitive markets, but that there were likely to be economies of scope and transition cost savings. The New Zealand delegation suggested that it was unclear which of these were more important but that in any case legislation requires that electricity networks should not be unduly deterred from entering these markets.

Finally, the regulator was encouraging distributors to reflect the costs of providing services in their prices in order to avoid uneconomic bypass of the grid system. However, it noted that it was not interested in operators avoiding bypass where it was economic.

Brian Motherway from the International Energy Agency (IEA) then made a presentation on energy efficiency services. He explained that energy efficiency measures introduced since 2000 have saved as much energy on an annual basis as the entire usage of the EU, and suggested that in most OECD countries energy demand will not rise again. The energy efficiency industry is worth approximately $24billion, the biggest part of which is China where there is a very healthy Electricity Service Company (ESCO) sector in the industrial sector. The ESCO model involves outsourcing thinking and acting in relation to the supply and/or use of energy. A classic model is an industry that is using a lot of energy may not actually own its own energy generation and distribution on an industrial site. So someone else might own the boilers, own the generators, literally own the hot water that's being piped around the system and is selling that to the energy user, and of course the incentive is on that 3rd party ESCO to do so efficiently.

He gave an example from Korea where one of the main utilities, as well as selling you your electricity, will now sell you services to help you become efficient. They will install their technologies that monitor and manage your energy system and therefore seek out opportunities to make its use more efficient and that can be done in the form of ongoing remote monitoring and management or advisory services or a mix of both. Another example is energy performance contracting where you have a building that someone might offer to upgrade by putting in a new insulation and heating system, new windows and new lighting systems. But instead of charging for that upgrade, it might for example agree a performance contract where the technology provider provides the technology and pays for it off their own balance sheet but then charges you over a period of time based on its performance in reducing energy use.

A final example is in relation to energy access in places where there are no grids and in the classic model in countries in Africa one would think of rolling out a grid and providing power stations and providing certain volumes of energy. However, companies like Bbox and others think about it differently. They do not provide X Gigawatts or gigawatt hours to a community, they provide on a household level, a package of energy services which is a television, lighting, radio, phone chargers or whatever it may be. First of all they developed technology that is ultra-efficient so this entire package, a TV, 2 or 3 lights, a radio, 2 or 3 chargers all comes in under about 80 watts, which is less than what a lightbulb used to use a few years ago. And then they package this really efficient energy with a solar panel and a battery system, they sell it as a service, so the users don't pay for a unit of energy, they do not own the technology, they pay a monthly fee for being able to use all of those things. This is paid for by digital technology over mobile phone, and it is all monitored and managed separately. The firm in London checks whether the battery is

deteriorating, whether the lights are still working and whether the householder is paying the monthly fee. They can switch off the technology remotely so householders just pay on a monthly basis for the package of services.

He suggested that digitalisation is opening new ways of thinking about how energy efficiency can be done and removing some of the classic barriers that have prevented energy efficient actions happening in the past.

Jean-Michel Trochet from EDF then suggested that while investment in generation may be more decentralized, guaranteed capacity running at a national or regional level remains key to ensure supply/demand balance. From this he concluded there was a need to invest in reinforcing transmission grids. On storage he suggested that while this would play a key role, it would for now be complementary and not 100% substitutive of tradition system and centralized generating plants. He argued that consumers would continue to need to rely on centralized systems for security of supply. He said while he favoured marginal pricing and it had been possible for 30 years, it was complex. He said it was not calculated by the invisible hand of the market because there will be local market power, and that was difficult to explain and justify to the consumer.

On peer-to-peer local trading, he considered there would be interesting trading opportunities but this would require rules to govern that trading, and there should not be artificial subsidies to this kind of trading

Lawrence Orsini from LO3 energy then spoke about on the innovation that his company is engaged in. He showed the Californian "duck curve" which shows electricity demand across the day, net of variable renewable generation and identified the financial challenge this was creating. Research from Accenture found that 70% of consumers wanted to participate in the energy market today and half of those wanted to be able to buy renewable energy from local sources. He said that an important regulatory barrier was that utilities were paid a return on capital invested in grid infrastructure. He argued that this needed to change and that utilities should be paid to increase the efficiency and resilience of the grid.

His platform is block chain based. It is a distributed ledger system that is very secure, largely frictionless and gives a level of transparency in markets that has yet been unavailable, so in energy markets it solves a lot of the problems that we have. His firm installs smart meters that host the block chain. They net the energy that goes back on the grid but they also communicate with devices. If it is a commercial building, it can talk to the building management system; if it is residential it can talk to control devices and smart devices inside the home.

He explained that the ultimate vision of LO3's work with Siemens is to move towards location-based dynamic pricing. This would identify a price for the grid infrastructure using predictive algorithms that look to identify the cost of grid infrastructure, as well as the cost of congestion where it exists. This price would reflect the full value stack for energy, not just the commodity itself but the cost of transport, ancillary services priced into a transitive market.

He explained that LO3 had set out their pilot project in Brooklyn where people wanted to create a circular economy effect where they can actually buy energy from members of the community, understanding that when they do that those dollars stay in the community and have local economic effect. The app that they developed lets consumers decide where their energy comes from and what sort of fuel sources they are willing to buy. They can simply set how much they are willing to pay for local energy that produces local

environmental benefits and forget about it. That shows how much they are willing to pay for that locally generated energy; how much of their battery are they going to want to keep in reserve and how much do they want to open to a market to achieve full value. The pilot involves a physical micro-grid that will be able to run disconnected from the main grid (island mode)

Pallas Agterberg from the Dutch distribution system operator Alliander then made a presentation. She described the way in which energy was becoming less of a public service and more of a sharing economy service, something that you can do yourself and exchange with your neighbours. In a sharing economy model you need a platform, and Alliander is a grid operator that wants to be that platform. This platform needs to involve peer-to-peer trading, so you can choose a windmill or solar plants where you catch your energy. It has to be flexible, so you need an open flexibility market that creates new opportunities for storage or for new services that come up to the market. Finally, the platform will involve charging and storage in electric vehicles.

The UK then made a presentation that focused on the impact of regulation on technologies in the Competition and Markets Authority's recent investigation into the energy market. This found a number of problems in wholesale and retail markets including in the regulatory framework and identified significant customer detriment in the form of higher prices and more limited innovation. It explained that while the focus of the investigation was on the current dynamics in the market and the regulatory framework, it had been very mindful during the investigation of the potential impact of new technologies on the industries and a lot of its interventions reflected the concern to ensure that consumers benefit fully and rapidly from innovations.

It found that a number of recent and prospective technological innovations offer significant potential for customer benefits both in terms of reducing the costs of energy and also in facilitating consumer engagement; Some examples are smart meters that facilitate load shifting of demands, the development of the internet of things and digital comparison tools like price comparison websites that reduce the transaction costs faced by customers when they seek to engage.

In order to introduce many of these innovations or realise the full benefits of them, changes are often required to existing regulations codes. It found however, that regulations were not necessarily keeping pace with technological change and this situation was particularly exacerbated by industry control of the system of codes that governs the industry. Given the complexity of the codes this effectively put power in the hands of the large incumbents who often lacked incentives to push through changes, particularly ones which open the industry up to disruption. For example, it found several examples of beneficial code reforms being delayed or blocked because the energy firms had conflicting interests or limited incentive to deliver the particular change. In the case of locational pricing of transmission losses, this had intended to be introduced shortly after privatisation and had been delayed for around 20 years due to the conflicting incentives and interests of the big 6 energy firms; because of the different location of generational plants, these policies would effectively create winners and losers. Another example was half-hourly settlements of electricity. Half-hourly settlement is required to realize the full potential of smart meters in terms of load shifting, the internet of things. However there was no industry plan to move to half-hourly settlements based on actual consumption and that was even after the roll out of smart meters.

In addition to implementing specific remedies to address location pricing of the transmission losses and half-hourly settlements, it also made a number of

recommendations regarding the reform of the code governance process. It required the regulator Ofgem to take a more active role in code governance. Firstly, setting out a strategic framework for code development. Secondly, initiating or prioritizing modification proposals necessary to meet key strategic objectives. Thirdly, intervening to take control of the important modification proposals in exceptional circumstances. It also recommended legislation to give Ofgem more power to modify industry codes where necessary to ensure the achievement of important policy objectives.

The second area that was addressed through remedies was improving customer access to their own data, since this is required for many of the technological innovations to work effectively. It noted that energy markets are typically very confusing for consumers as a result of a number of factors, such as the role played by traditional meters, which were infrequently read and so customers were often being billed based on estimates rather than actual consumption. Confusion was also created by: the complexity of bills and the structure of tariffs; the lack of confidence in, and sometimes a lack of access to, price comparison websites; and by poor experiences in switching, for example as a result of transfers.

It therefore concluded that better products and services could be developed if customers had better access to data on their own energy usage. So, it designed a number of remedies to improve access with the hope that this would facilitate the introduction of a greater range of innovative technologies. The first aspect is Midata, which is a government program to ensure that customers of certain key industries are able to access the data that firms had concerning their patterns of usage. This is relevant where making informed customer choices often requires customers to understand not only the price attributes of the products they are selecting, but also how much of the product they tend to use. For example, by enhancing Midata, customers could choose to share their data on an ongoing basis with a digital comparison tool. The digital comparison tool could then offer an ongoing energy monitoring service, alerting customers when their patterns of usage change such that a different tariff would be of greater benefit and would eventually enable customers with smart meters or smart home networks to use a service that would enable them to optimise energy usage and acquisition in real time to minimise costs with no need for customer involvement.

The Netherlands asked how many States we were actually talking about in terms of the real present progress on dynamic pricing.

Professor Wolak replied that Australia, New Zealand and the US were all more advanced on this. It is also required under the most recent European Commission energy package. He said that there was not more of it because there were regulatory barriers put in place by regulators that did not want to give up their price-setting role. He said it was happening slowly but surely and in large part that was because of the growing penetration of solar, because it addresses the issue of the variable amount of distributed solar that is on the system at a given time.

The Chair asked whether intermittent generators should be asked to pay the full cost they impose on the network.

Professor Wolak replied that it often was not possible to say who caused the need for an incremental amount of ancillary services (e.g. congestion management). He suggested charging prosumers based on their location, which can indicate the average level of ancillary cost that they will create.

Australia replied that the intermittent generator, just like the non-variable generator gets paid low or negative prices if it is producing when there is already a surplus on the grid. It said that intermittent generation might cause additional costs from having to very quickly ramp up alternative sources of generation. It suggested that the reward for fast-ramping generation might be inadequate if the dynamic pricing window is too broad. For example if it is an hour as opposed to the 5-minute interval that Australia is moving to.

Italy commented that there were clearly differences in speed: technology is changing very quickly, regulation is changing not so quickly and consumers are not very quick at all. In Italy, 30 million households have moved to smart meters. It said that the transmission system, the distribution systems and the information system are the three main pillars of an open and liberalized sector. These infrastructures must be open to everyone but must be also neutral. It said it was not confident that a distribution system that is also an actor in the market would be good for the market. Instead they should be neutral and not subject to any partial interest in providing ancillary services such as storage.

New Zealand said it had taken steps to make the ancillary services market more competitive. This included changing the operating objective of the system operator, so that they also have to take into account the promotion of competition and efficiency as well as reliability.

The Chair then asked what the competitive purpose of making data available was.

Italy replied that the data, which was previously the property of the distributors, was now the property of the consumer and that it could help them react to price changes and also to improve their energy efficiency, for instance by using a third party application on their phone.

Professor Wolak said that the big competition issue with respect to this data is that if I own my data, I can go to the many electricity retailers out there and I can say, “Here’s my data, make me an offer.” So, they can see what my load shape looks like and essentially make an offer based upon that data. Otherwise, I am just choosing who is going to supply me in such a way that they do not know who I could be; they have no information about who I am. Instead, if I can show them my data I can maybe get a more competitive offer from them because they can see down to the hourly level or 15 min level what I consume and therefore what the liability is for them in providing energy to me. This means they can make me a better offer as a result and that is the big competitive benefit of having customers owning their data. Without that information the retailer will think I am a generic customer, but with it they can know exactly what I consume and it can tailor a price specifically for me.

The Chair finished by noting that solar capability within crowded cities will be different from more rural locations. He suggested that the model of Bbox might be an interesting one and that this would become increasingly important as electric vehicles began to impose an additional burden on the grid.