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New Business Models in Electricity: the Heavy, the Light, and the Ghost

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Highlights[1]

- New ways to create and capture value are emerging in the electricity sector, with important implications. An understanding of their key drivers is fundamental.
- Wind and solar, the two fastest-growing renewables, require investments in long-lived physical assets with negligible variable costs. Green generators must identify revenue streams that cover the upfront costs. While public support policies have mostly guaranteed generators' income in the past, market-based solutions are now appearing.
- Digitalisation is a second big change, currently addressing retail-size units, expanding the availability and usability of information and the controllability of all the interconnected devices. Building on that, new players can develop innovative services targeting specific groups of customers without the need for a significant investment in physical capital.
- Greening of generation and digitalisation of retail-size units deeply affect the activities of electricity grids, both transmission and distribution. The existing regulatory compact no longer looks suitable for adapting the current business model of grid companies.

1. This policy brief is based on Glachant J.-M., *New Business Models in the Electricity Sector*, EUI Working Paper RSCAS 2019/44. The paper is available at: http://hdl.handle.net/1814/63445.

Introduction

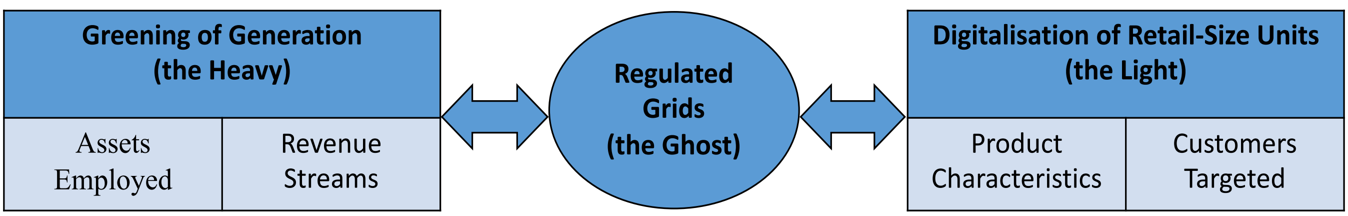
Decarbonisation and digitalisation are changing the way value is created, delivered and captured in the electricity sector. On the one hand, new physical assets are being deployed to generate electricity without emitting CO_2 and other greenhouse gasses (*greening of generation*); on the other hand, digital technologies are being adopted to develop innovative services and offer them to targeted customers (*digitalisation of retail-size units*). In the 1980s and 1990s, the development of combined cycle gas turbines (CCGT) and the political decision to introduce competition and dismantle the vertically integrated electric utilities shook the industry and led to the emergence of independent power producers and retailers, unbundled transmission system operators, merchant interconnectors, and the like. Today, the increasing decarbonisation of the generation mix and the progressive digitalisation of the entire electricity system are leading, again, to the appearance of new business models with important implications for the companies implementing them and for the electricity sector as a whole.

A business model is an expression frequently used by scholars and non-expert alike, sometimes with different meanings and for different purposes. Several definitions of it do exist. Osterwalder and Pigneur provide one of them in a book published in 2010.[1] According to them, a business model represents "the rationale of how an organisation creates, delivers, and captures value". Nine components fully characterise it.[2] Together, they form the so-called "business model canvas", a flexible tool particularly useful for entrepreneurs and managers tasked with the elaboration of new models, but also valuable for researchers interested in understanding what firms do or try to do to make a profit.

The observation of everyday business news and a review of the existing scientific literature suggest that four basic business model components, gathered in two pairs, are sufficient to identify the chief drivers of the new business models in electricity and understand what they mean for public policies and regulation. The new assets employed to generate electricity and the special revenue streams that must be secured to recover the related costs are key for the greening of generation, while the specific characteristics of the product delivered and the identity of the particular customers targeted are fundamental ingredients to the digitalisation of retail-size units (see Fig. 1).

Electric grids – both transmission and distribution – lie in between these two main novelties. They stand in the middle, not just in a physical sense, but also because their business is directly affected by what is happening upstream and downstream. Used to a world of mostly captive network users, investments in long-lived physical assets, and capital remuneration

Figure 1: The new business models in the electricity sector and their basic components.



1. Osterwalder, A. and Y. Pigneur (2010), *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, John Wiley and Sons, New York.

2. They are the following: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure.

ensured by regulated network tariffs, grid companies face the challenges, but also the opportunities, posed by the greening of generation and the digitalisation of retail-size units. A shift in focus towards products' characteristics and targeted customers could be a necessary step, but the final decision does not rest only with them due to the regulated nature of their business.

In this policy brief, we first look at the new businesses sprung from the greening of generation and the digitalisation of the retail-size units. We show how the pairs assets-revenues and characteristics-customers can explain the specificities of those new business models and the way they work. Then, we turn our attention to electricity grids, whose business is heavily impacted, and we investigate the constraints and the options they face in adapting to the new landscape.

Greening of Generation: Special Revenue Streams for New Assets

The production of electricity from the wind or sunlight requires the employment of specific assets, namely wind turbines and PV panels, with a cost structure that is different from that of CCGT widely adopted in Europe and the US after the liberalisation of the electricity sector. While for CCGT capital expenditure represents between 30 and 50% of the levelised cost of energy (LCOE), for wind and PV the share is typically between 80 and 95%.[3] This cost structure has profound implications for the business model of any new green generator. The magnitude of the upfront investment for every kW installed and the fact that the assets engaged are expected to last for about 20 or 30 years imply that finding an adequate and stable revenue stream is a necessary condition before taking any final investment decision. If this condition is unmet and market risks are not reduced, then the cost of finance tends to go up and overall capital expenditure escalates, seriously undermining the economics of the whole project.

In the past two decades, supportive public policies have usually ensured those indispensable revenue streams, either by granting green generators feed-in tariffs (FiT) for 15 or 20 years or by establishing an artificial demand for green electricity via tradable green certificate schemes or renewable portfolio standards. The shield against any price risk provided by FiTs has been particularly effective, leading to a huge investment wave in wind and PV. Indeed, in the absence of those support measures, investments in new capacity have been limited. Despite an ongoing cost reduction, electricity spot markets and their volatile energy prices do not seem fit to induce, by themselves, investors to pour money into additional wind farms or PV power plants. The impossibility to dispatch generation at will and the cannibalisation effect make the inadequacy of spot markets only bigger.[4]

A solution to the insufficiency of spot markets to secure a satisfactory revenue stream to green generators is offered by the signature of a long-term power purchase agreement (PPA) backed not by a public entity, as in the case of FiTs, but rather by a corporate buyer (off-taker). In the past few years,

3. See Lazard (2018), *Lazard's Levelized Cost of Energy Analysis – version 12.0*; IRENA (2018), *Renewable Power Generation Costs in 2017*, International Renewable Energy Agency, Abu Dhabi; and IEA (2018), *World Energy Outlook*, International Energy Agency, Paris.

4. When the primary energy source is available, all the wind turbines or PV panels located in a certain market area tend to produce. Unless a convenient storage solution is available, all the energy generated is then injected into the grid or used to reduce net demand, thereby depressing prices. Hence, the more turbines and panels are deployed in a certain market area, the lower the price at which wind and solar PV can sell their electricity. See on the topic: Hirth L. (2013), The market value of variable renewables. The effect of solar and wind power variability on their relative price, *Energy Economics*, vol. 38, July, pp. 218-236. For a more recent analysis, see: Joskow P. (2019), Challenges for wholesale electricity markets with intermittent renewable generation at scale: the US experience, *Oxford Review of Economic Policy*, vol. 35, no. 2, pp. 291-331.

large companies with a significant energy load – as for instance technology firms, data centres or aluminium smelters – or companies keen on greening their brand have shown interest and signed several deals with renewable developers. Appeared first in the US, this market practice is becoming common also in Europe and supported in 2018 alone around 13.4 GW of investments in renewables.[5] Although this is still a small number relative to the overall capacity additions of wind and PV at the world level – BNEF estimates them at about 150 GW last year[6] –, in the most mature market, the US, procurement by commercial and industrial buyers represented about 22% of all signed wind and solar PPAs.[7] Innovation in the structure of the contracts and the possibility to tailor them to fit the needs of the off-takers better are expanding the potential "audience". Made more comfortable also by the growing maturity of the market, even smaller corporate buyers are approaching the world of PPAs, frequently together with other peers or under the lead of a bigger and more experienced partner, the so-called anchor tenant.

The relevance of the link between the new assets employed and the revenue streams to be secured is apparent if we zoom in on the individual technologies that are enabling the greening of electricity.[8] Four types of green generators are then identifiable (see Fig. 2).

First, onshore wind. In this case, the basic asset is a wind turbine with a nominal capacity of one to a few MW and an upfront investment cost of around 1,000-1,500 $/kW. Several entities can afford to pay an amount in this order of magnitude: not only classical electric utilities but also independent power producers, local communities and cooperatives of consumers can get, possibly by resorting to project financing, an onshore wind farm with a few or a few tens of turbines.[9] However, as more recent support mechanisms replace FiTs with feed-in premiums awarded through competitive auctions, more experienced, professional and better-funded players tend to dominate the scene.

Figure 2: Four types of green generators.

Greening of Generation			
Onshore Wind	Offshore Wind	Utility-Scale PV	Rooftop PV

5. According to BloomberNEF, 121 corporate PPAs were signed in 2018 in 21 countries around the world. The US still represents the largest market (around 60% of the deals in terms of capacity). See: BNEF (2019), *Corporate Clean Energy buying Surged to New Record in 2018*, BloombergNEF, January 28. For a comprehensive view on corporate PPAs, see: IRENA (2018), *Corporate Sourcing of Renewables: Market and Industry Trends – Remade Index 2018*, International Renewable Energy Agency, Abu Dhabi.

6. BNEF (2019), *Clean Energy Investment Exceeded $300 Billion Once Again*, BloombergNEF, January 16.

7. Foehringer Merchant E. (2019), *Corporate Renewables Procurement Accounted for Nearly a Quarter of All Deals in 2018*, Greentech Media, February 5.

8. Although their role in the generation mix is still rather small, wind and solar are growing fast and getting the centre-stage in several countries. At the world level, their share in electricity generation grew from 0.2% in 2000 to almost 6% in 2017. See: IEA (2018), *World Energy Outlook*, International Energy Agency, Paris, p. 528.

9. In recent years, project financing has been widely used by smaller entities like independent renewable developers and local communities lacking a sufficiently robust balance sheet or collateral. See: Steffen B. (2019), The importance of project finance for renewable energy projects, *Energy Economics*, vol. 69, January, pp. 280-294.

Second, offshore wind. The fundamental infrastructure is again the wind turbine, but the need to install, operate and maintain it offshore requires additional and rather specific skills. Economies of scale are more important, not only for the turbine but also for the connection to the grid. The consequence is the use of turbines with an average nominal capacity of six to 10 MW or more and offshore wind farms with several tens or even hundreds of turbines, essentially as big as the traditional fossil fuel power plants. Only very large players have the financial firepower and the competences to play in this game, eventually in cooperation with a small bunch of large technology vendors. A few European companies, some of them coming from the oil & gas sector, currently dominate the global market.[10]

Third, utility-scale PV. It is the plain vanilla of renewable generation: thousands of PV panels put on the ground to total up to several tens or even a few hundred MW. Developing such projects does not require advanced engineering skills, but rather the ability to get administrative processes done and access to low-cost financing. As a result, barriers to entry are not particularly high and several players, some of them entirely new to the electricity business, are competing hard both in mature and emerging markets. Prices in auctions are going down at breakneck speed and some investors will likely lose their money.

Fourth and final, rooftop PV. Again the PV panel, this time installed on the rooftop of houses and commercial or industrial buildings. In this case, a typical plant ranges from one to a few hundred kW, i.e. more or less the same size as a single consumption unit. Once installed, generating electricity requires almost no effort; nonetheless, the average cost of the kWh produced is definitely higher than the average wholesale price. Competition is possible only with the final retail price of electricity, loaded with network charges, green levies and taxes (socket parity).[11] The regulation of such charges and levies plus the possibility to self-consume most of the energy produced is then essential to the economic viability of solar prosumers around the world.

Digitalisation of Retail-Size Units: Innovative Services for Targeted Customers

Digitalisation is driving the emergence of new business models in the electricity sector. Unlike the case of green generators, these new models tend to be ‘asset light’, and the offering of innovative services that target particular groups of customers represents their essence.

The power sector ‘delivery loop’ was traditionally rather static. Retail-size customers, like households and small and medium enterprises, were used to withdraw electricity from the grid according to their own will and pay a fixed tariff for each kWh to their supplier. The product delivered was a commodity and interactions with the rest of the electricity system were extremely basic.

The digitalisation of the electricity sector alters this situation profoundly.[12] Digital technologies improve the availability, usability, storability and transmissibility of information, thereby allowing a reduction of transaction costs and more efficient use of resources. The application of digital technologies to networks of physical infrastructures enable their smarter operation and gives the possibility to define and deliver customised products to attract particular groups of

10. Ørsted, a former oil and gas company, RWE, Vattenfall and Equinor, another oil and gas major, had the largest installed offshore wind capacity at the world level in 2018. Source: Ørsted (2018), *Capital Markets Day 2018*, Presentation, p. 15.

11. IRENA (2017), *IRENA Cost and Competitiveness Indicators: Rooftop Solar PV*, International Renewable Energy Agency, Abu Dhabi.

12. Glachant J.-M. and N. Rossetto (2018), The Digital World Knocks at Electricity’s Door: Six Building Blocks to Understand Why, *EUI RSCAS Policy Brief*, issue 2018/16, September.

users. By allowing an easier tracking of transactions, a finer forecasting of production and consumption patterns and a better coordination of the activities by multiple devices and actors, digital technologies make possible the offering of new products without the need for a significant investment in physical capital, thereby opening the door to new players next to the traditional electric utilities. Of course, it takes time for consumers to validate the value proposition behind these new business models and the kind of companies that will be able to prevail in this digitalised landscape remains to be seen.

It is currently possible to recognise at least three new types of actors, offering three new types of services to retail-size customers, located both on the supply and the demand side of the electricity system (see Fig. 3).

First, aggregators target electricity consumers and distributed generation units that used to be excluded from direct participation in wholesale markets because of the technical or economic impossibility to monitor their behaviour closely and to provide them with dynamic price signals. Thanks to digital technologies, aggregators are able to pool the resources of their customers and offer capacity and energy on the wholesale markets or in the balancing mechanisms managed by system operators. Customers give away (part of the) control on their distributed energy assets and receive pecuniary compensation or other benefits in return.[13] The current landscape of aggregators includes several start-ups and a few more established players. Electric utilities or larger companies willing to enter the electricity business have acquired some of them, while others remain independent from any generator or electricity retailer.[14]

Second, platforms for direct trade target consumers, prosumers and prosumagers (i.e., prosumers owning a storage unit as well), by offering them the membership to a decentralised community of buyers and sellers, not necessarily spatially close to each other. Differently from the case of aggregators, these platforms for direct trade leave bilateral exchanges to the initiative of their customers and enable truly peer-to-peer (P2P) interactions. Thanks to the data coming from smart meters, to automated algorithms and distributed ledger technologies like the blockchain, platforms for direct trade make all of this possible. And they can do more: next to P2P transactions, they may enable retail-size units to sell ancillary services to system operators in the emerging local flexibility markets.[15] Some of these platforms and the related communities are established by start-ups

Figure 3: Three new business models enabled by the digitalisation of retail-size units.

Digitalisation of Retail-Size Units		
Aggregator of Distributed Energy Resources	Platform for Direct Trade	Smart Manager of Autonomous Territories Behind the Meter

13. Among others, see: IRENA (2019), *Aggregators – Innovation Landscape Brief*, International Renewable Energy Agency, Abu Dhabi; and Burger S., J. Chaves-Ávila, C. Battle, and I. Pérez-Arriaga (2017), A review of the value of aggregators in electricity systems, *Renewable and Sustainable Energy Review*, vol. 77, September, pp. 395-405.

14. The market for aggregators is more mature in the US, but Europe is quickly catching up. At the moment, the majority of aggregators are independent from utilities or other market parties, although in recent years there have been several cases of acquisitions (e.g., Enel bought EnerNOC and Shell acquired Limejump). Some market data can be found in: IEA (2018), *World Energy Outlook 2018*, International Energy Agency, Paris, pp. 58, 304-05, 314; and ENTSO-E (2019), *Power Facts Europe 2019*, European Network of Transmission System Operators for Electricity, Brussels, pp. 60-61.

15. An example of platform where distributed energy resources can sell services to DSOs is Pilco Flex in the UK.

and technology companies independently from traditional utilities, while others are initiated by utilities themselves or are created in close cooperation with them.[16]

Third and final, "smart managers of autonomous territories" located behind the meter (BTM) do not target the consumers, prosumers or prosumagers themselves, but rather the devices inside their homes, offices and everyday life. They offer to provide a full-time professional and centralised management of vast networks of interconnected smart devices that operate beyond the electricity delivery loop controlled by the DSO and the energy regulator. In this space located at the grid's edge, the internet of things and artificial intelligence pledge to gather huge amounts of data and exploit them to benefit the consumer. A consumer that, although not always active, will be able to assess the service through interactive and user-friendly digital interfaces. Three candidate applications are easily visible. Smart fleets of electric vehicles (EV) can autonomously operate themselves and decide where and how to recharge or discharge their batteries. They would offer mobility as a service and at the same time act as a large virtual pool of distributed batteries, able to provide ancillary services to the local grid or arbitrage the price of electricity on wholesale markets through smart charging.[17] Next, smart homes represent an integrated environment where artificial intelligence manages the whole network of appliances through sensors and control devices. Its ultimate aim is the provision of comfort to the dwellers while keeping energy consumption and costs in check.[18] Digital applications and vocal assistants, already provided by several technology firms, constitute the natural interface between the smart home and its inhabitants. Going one step further, there are micro-grids, smart neighbourhoods and even smart cities. Again, the purpose is to manage hundreds of devices and provide a plurality of services to the people living there (e.g., road traffic management, re-use of natural resources, etc.), while optimising the use of the distributed energy resources within the boundaries of such autonomous territories that lie all around the public grid.

Caught in Between: the Case of Regulated Grids

Electricity grids – both transmission and distribution – are caught in between the greening of electricity and the digitalisation of retail-size units. On the one hand, the rapid expansion of renewables in the generation mix, in particular wind and solar PV, calls for a quick adaptation of the electricity network and its operation. This is necessary to integrate the massive amount of new generating units, sometimes located far from the load centres and sometimes so small and dispersed that they must be connected directly to the distribution grid. On the other hand, the activation of smaller network users enabled by digitalisation still rely on the use of a physical delivery loop, again the distribution grid. However, this activation creates a more complex environment where the use of the grid can be less predictable, some actors can free ride the system, and digital firms may enter the

16. SonnenCommunity in Germany is an example of platform to share energy P2P developed without the direct involvement of utilities. On the contrary, Elblox is a case of a platform built by established companies, the Swiss Axpo and the German Wuppertaler Stadtwerke.

17. IRENA (2019), *Innovation outlook: Smart charging for electric vehicles*, Internationa Renewable Energy Agency, Abu Dhabi.

18. Digital solutions managing local energy production and consumption will be indispensible to satisfy the requirements for net-zero energy buildings mandated in several jurisdictions across the world from the next decade onwards.

scene, get the centre stage and disrupt the traditional organisation of the industry.[19]

The development, maintenance and operation of electricity grids typically constitute a set of regulated activities. Grid companies must connect network users and ensure that they have access to electricity continuously and securely. To do that, they invest in long-lived physical assets, whose cost-recovery is then ensured, up to a certain extent, by the regulatory framework and the tariffs defined by the regulator.[20] In other words, the traditional business model of grid companies is by and large captured by the assets employed and the revenue streams secured.

The greening of generation and the digitalisation of retail-size units challenge the traditional regulatory compact as well as its ability to provide an efficient service and fair treatment of customers.

Let us consider the case of renewables. Their deployment and integration into the electricity system requires new investments in grid capacity that may be particularly expensive when developers do not take into account the existing topology of the grid, the best renewable sources are located far from the load centres and when the output of renewables is highly variable and not in line with the system load patterns. Due to these facts, grid companies may see an explosion in the costs associated with the performance of their service obligations. An explosion that may not be well received by the energy regulator. At the same time, the greening of generation, together with the new possibilities allowed by digitalisation, may jeopardise the traditional revenue sources of grid companies. The reduction in solar PV and battery costs, for instance, allows consumers to produce their electricity at a cost close to the retail price of electricity. This is particularly the case in jurisdictions where network costs and levies are charged according to the volume of electricity withdrawn from the public grid. In those cases, active consumers can invest in PV and batteries, turn into prosumers or prosumagers, and push the cost of the grid and public policies to passive consumers. The implications in terms of efficiency and equity are clear, as well as the risks for the grid company.[21]

The example above highlight the importance of the regulatory framework to enable grids' adaptation to the new reality. In particular, regulation should protect grid companies and their investors from excessive risks, while at the same time induce them to experiment with innovative technologies and non-wire alternatives, possibly less capital intensive than the traditional solutions. The development of local markets for flexibility, potentially in cooperation with other parties like power exchanges and software companies, is an example of such a move beyond the usual "fit & forget" approach and the classical tendency to solve problems by using more iron and copper.[22]

Unfortunately, regulatory changes currently look like slow and tentative. This is not surprising, given the political sensitivity of certain choices and their distributive implications, not to mention the concerns over unbundling and the preservation of a level playing field for all market players. Moreover, although there are some concrete experiences, like

19. For an overview, see: Sioshansi F. (ed. by, 2019), *Consumer, Prosumer, Prosumager. How service innovation will disrupt the utility business model*, Elsevier – Academic Press, London and San Diego.

20. Incentive regulation does not ensure the automatic recovery of the costs incurred by a grid company under all circumstance. Indeed, the incentive lies in the possibility for the firm to lose money, if it is not able to deliver the service required or to contain its costs vis-à-vis the expectations set by the regulator.

21. Schittekatte T., I. Momber and L. Meeus (2018), Future-proof tariff design: Recovering sunk grid costs in a world where consumers are pushing back, *Energy Economics*, vol. 70, February, pp. 484-498.

22. Schittekatte T. and L. Meeus (2019), Flexibility markets: Q&A with project pioneers, *EUI RSCAS working paper*, 2019/39.

the RIIO model in Great Britain,[23] and some theoretical blueprints, like the MIT Utility of the Future,[24] practical implementation of new regulatory principles is not that simple and straightforward.[25]

Grid companies seem aware of the challenges and, at least in the most advanced cases, are willing to embrace the opportunities that decarbonisation and digitalisation of the sector are providing. The idea is to turn from "dumb" pipes into platforms that put the customer at the centre, control the flow of data on the electric system status, and enable new services to be developed (also) by third parties.[26] This transition to a business model driven by the pair "characteristics-customers" may allow grid companies to resist the entrance of digital companies in the electricity sector and manage its growing decentralisation.

Nonetheless, grid companies do not enjoy the same freedom that innovative companies in other economic sectors like clothing or consumer electronics have. Grids are vested with a public interest and a series of public service obligations. They are mandated to provide access to all network users based on predictable, transparent and non-discriminatory tariffs, exactly the opposite of what other well-known platforms do. In addition to that, grid companies may be blocked by legacy investment, a less innovative company culture or the lack of specific skills and expertise among their employees.

Conclusion

Radical changes are sweeping the electricity sector and two groups of business models are clearly visible on the landscape.

The appearance of new green generators embodies the first group. Both professional investors and individual prosumers have to secure an adequate and stable income flow before deciding to invest in the new types of assets able to generate CO_2-free electricity, i.e. wind turbines and solar PV panels. In the past decade, governments have largely ensured stable revenues through the provision of feed-in tariffs and the like. This contributed to the renewables take off, but made green generators dependent on the choices, not always consistent over time, of policy-makers and regulators. It is now to be seen if the business models of wind and solar PV utility-scale generators and prosumers can survive the phase-out of those support policies and stand on their own feet. Also thanks to an enduring technology cost-reduction, long-term corporate PPAs are a possible market-based solution. Time will tell if they are sufficient to finance the massive amount of investments required in the coming years to replace ageing power plants and enable the decarbonisation of the power sector.

The second group of business models aims to offer tailored products to specially targeted customers.

23. Rious V. and N. Rossetto (2018), The British reference model, in Meeus L. and J.-M. Glachant (ed. by), *Electricity Network Regulation in the EU. The Challenges Ahead for Transmission and Distribution*, Edward Elgar, Cheltenham, pp. 3-27.

24. Pérez-Arriaga I., C. Knittel, R. Miller et al. (2016), *Utility of the Future: An MIT Energy Initiative response to an industry in transition*, MIT, Cambridge, MA.

25. Some of the authors of the MIT Report have recently underlined the trade-offs and the difficulties in implementing their vision. See Burger S., J. Jenkins, C. Battle, and I. Pérez-Arriaga (2019), Restructuring Revised Part 2: Coordination in Electricity Distribution Systems, *The Energy Journal*, vol. 40, no. 3, pp. 55-76. The difficulties are visible also in the slow implementation of the Reforming the Energy Vision adopted by the New York State in 2014. See for instance: Sioshansi F. (2016), N.Y. Regulators Take Next Step On Path To Sweeping Reform, *The Electricity Journal*, vol. 29, no. 6, pp. 74-75; and Makholm J. (2016), The REVolution yields to a more familiar path: New York's Reforming the Energy Vision, *The Electricity Journal*, vol. 29, n. 9, pp. 48-55.

26. Among the recent positions expressed by the industry, see: Elia Group (2018), *Towards a consumer-centric system. An Elia Group point of view*, Elia Group, Brussels; and EY-Eurelectric (2019), *Where does change start if the future is already decided?*, Eurelectric, Brussels.

Building on the wealth of data and increasingly interoperable devices provided by digitalisation, innovators coming from within or outside the sector are pushing novelties with the hope that customers will appreciate them and be willing to pay for them. Thanks to aggregators, new centralising intermediaries are disrupting the trade arrangements in the existing wholesale markets. A combination of decentralised digital platforms and new algorithms disintermediating trading are creating previously non-existing communities. Finally, artificial intelligence and the internet of things are extending the possibility of trading up to the devices realm and unleashing new sources of value. However, a proof of the sustainability of these new business models related to the digitalisation of retail-size units is currently missing. In particular, it is yet unclear whether these models will be able to sustain a pricing of the delivery loop that more closely reflects actual costs and does not allow anymore for an inefficient bypassing of network charge, taxes and levies.

This leads us to the regulated activities performed by electricity grids. Regulators provide the framework within which grids develop their business model and take their investment and operative decisions. The greening of generation and the digitalisation of retail-size units are affecting the environment around the grids and challenging the regulatory compact that emerged during the liberalisation era. A different incentive framework and a different set of coordination tools must be identified and implemented to respond to the decarbonisation and digitalisation of electricity. The choices of the regulatory authorities will then be as relevant as those of the companies' top management in determining whether grids will lead the change or follow it. Whether they will turn from dumb pipes into platforms or, on the contrary, be disrupted by digital companies and innovative actors playing at the grid's edge.

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