

MARKET AND REGULATION DESIGN OF FUTURE ELECTRICITY MARKETS: BETWEEN EVOLUTIVE AND DISRUPTIVE ARCHITECTURES

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Overview

The issue of renewable energy integration and power system flexibility has received increasing attention during the last years because of the important deployment of variable renewable energy (VRE) sources on the grid introducing higher variability and uncertainty on the system along with the phase-out of traditional providers of flexibility. These issues introduce new challenges for system operation regarding the continuous balance between supply and demand, as well as the transparent and credible price signals driving the right incentives for energy commitment and dispatch in the short-term, and to secure capacity and flexibility investments in the long-term. Additionally, novel grid management issues appear due to the scattered location of these sources on the distributed network or even at the user level (e.g., behind-the-meter generation and storage capabilities such as micro-generation, batteries, EVs, etc.), and the increasingly active role of the consumer (e.g. prosumer, demand response). Moreover, new information and communications technologies (ICT) and digitalization enablers (e.g. distributed ledger technologies, artificial intelligence, etc.) are expected to create a substantial disruption on the main ontology of power grids. The power industry is experiencing an entire revolution. The pace of this transformation seems to be accelerating but its consequences remain anyhow endemically uncertain. Technical progress, cost improvements, energy policies and technology adoption experience multiple and complex interactions. Market designs and regulatory frameworks define possible business models so determining the relative profitability of technologies, so shaping the industry landscape, but are also affected by them in return in a co-evolutionary manner. Therefore, any discussion on market and regulation design should be based on innovation-oriented and future-proof principles.

Current market designs and regulatory frameworks face difficulties on handling with adequate architectures defining the roles, responsibilities and interactions between market facilitators, system operators and market players. Even if recent developments on this field are well aware of these issues, and ground-breaking initiatives are being discussed and implemented across different markets, there is still a lack of principles, categories and terminology allowing a definite comparison of different market architectures.

In this study we propose a review of existing and innovative market and regulatory designs of electricity markets to come up with a taxonomy of alternatives, allowing to identify the key dimensions considered. The market architectures reviewed are classed according to three categories regarding their intrinsic characteristics, so far: moderate, evolutive and disruptive designs. From this point, we are able to propose a consistent interpretation grid constituted by the key harmonization challenges identified, such as pricing issues for temporal and spatial coordination in a future with near-zero energy marginal cost, dealing with real-time markets (i.e. energy balancing and ancillary services) short-term ones (i.e. day ahead and intraday) and capacity remuneration mechanism in the long-term, their scope (i.e., local versus global products) and their implications on a continuum towards decentralization of decision making (from configuration markets based on competitive tenders or PPAs, to transactive or peer-to-peer markets).

Methods

Qualitative analysis. Survey of game-changers, and review and comparison of existing alternatives. Taxonomy of market design alternatives.

Results

The main drivers of transformation are addressed and a taxonomy of market designs is proposed. Thus, key principles and good practices for designing future electricity market architectures are introduced.

Conclusions

The main drivers of the revolution taking place on the power industry are identified and their implications explained. Market and regulation design have a relevant role on incentivizing innovation but are also prone to become obsolete in cases of disruptive industrial change. Thus, they need to integrate these aspects to be in line with economic

efficiency and to allow a feasible and efficient green energy transition. The reading grid proposed in this study not only allows to class current evolving and disruptive design alternatives, but also allows to propose new more advanced ones.

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