Energy Transition: Interdisciplinary Approaches Against Uncertainty

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Introduction

Radical innovations in the way in which energy is produced, distributed, and traded are expected all over the world (EU, 2017; IEA, 2019). In the eye of legislators, these innovations are both technological and organizational: technology, however, seems to be quite ready – at least at the theoretical level - but what really is lacking is the environment, where to apply it.

One of the main targets of the expected energy revolution is the inclusion in the markets all existing players (end-users, producers, distribution system operators, transmission system operators, etc.) with old and new tasks, and "new" players – with *prosumers* and *aggregators* on the front line.

Since political announcements are frequent, and a willingness to open the markets can be now taken as given, the fact that so far only a mild attempt to move in this direction has been made, implies that the realization of the strategy is not that easy.

Reasons for this could be many, but one of the big issues of this revolution is surely the uncertainty we meet at different levels and in all fields. Technically, because we care about system stability, letting more agents in the market or even moving system control from central to a peripheral level, sounds like a menace. Economically, playing on natural monopolies is always tricky, and uncertainty and risk deriving from the opening of the markets impact every decision of rational agents.

Literature so far: some examples

In recent years, the participation of renewable energy sources in specific markets, e.g., ancillary markets have been studied, but despite the accurate design for both energy and ancillary service markets, there are still difficulties in supporting high renewable penetration (Banshwara A. et al., 2017).

With the so called *Smart Grid*, local agents can effectively contribute to real-time balancing of the electric system and, in this way, be paid for reducing network imbalance costs (Belli et al., 2017; Burgio et al., 2017; Puglisi et al., 2017; McPherson M., Tahseen S., 2018). Given this, it is necessary to study the reactions of market agents to the new scenarios. The presence of a *smart* electricity grid empowers small producers to enter the market, having an impact on decisions in investment time and size (Bertolini M., D'Alpaos C., Moretto M., 2018).

Integrating distributed renewable energy sources (RES) into the system means that distributed energy power plants will be allowed to participate to energy markets, at least at the local level: renewable energy sources (RES), for instance, could be involved in zonal energy markets, or in the balancing market or in the ancillary service market (Ruester et al., 2014). At the same time, grid operators, i.e , Distribution System Operators (DSOs) and Transmission System Operators (TSOs) need to adapt their grid management in order to take into consideration these new agents in the market.

Literature moving on and further research

Despite all the valuable contributions to worldwide debate, there is always something missing for the concrete application of new local market models. This might derive from a lack of understanding on the part of the various disciplines on how physical markets really function. In a highly innovative and uncertain world, binding disciplines could be a valuable way to overcome critical points. Market equilibria, indeed, derive from economic theories and agents' behaviour: working for systems stability. Avoiding the correct economic approach leads to unexpected results. Similarly, part of the variance in economic parameters (i.e., costs and prices) could be explained by means of technical functioning. Uncertainty rate can be reduced with a common approach; Interdisciplinary can be seen as a risk mitigation strategy in designing new markets. Dealing with the topic with an interdisciplinary approach, however, is still quite complicated.

In a recent working paper, we tried to provide a definition of *smart* investment that disregards the usual understanding of investment and considers the impact that the investment has on the local (and total) grid. After a wide overview of definitions provided by both grey and scientific literature, we concluded that *smart* investments are those impacting on "the reduction of market risks faced by market players, such as production firms, consumers, and distribution system operators (DSOs) who manage local grids" (Bertolini et al., 2018). *Smartness*, then, is connected to volatility of prices and flows, which are the direct expression of uncertainty.

Moving from this definition, we provide a simple industrial organization model that "confirmed the intuition that investments in SGs have a pro-competitive, risk-reduction effect" attributable to the reduction of market risk. This effect seems to prevail on the competition effect when the demand uncertainty and firms heterogeneity is high, allowing small and risk-averse firms to enter the market

Even though the intuition on the link between smartness and volatility was corroborated by long discussion in an interdisciplinary research group, the next step is to include in market models and simulations features, tools and effects actually present in the network. There is a lack of a consideration of this in current literature. From the economic theory perspective, the market functioning seems equivalent to the actual in absence of grid boundaries, and technical optimization models usually lack a definition of price equilibria.

The absence of a coordinated research approach prevents the creation of a reliable environment for market agents: only "enriched" models (technical and economic) could lead to an effective regulatory framework.

Regulation is truly relevant in this sector, where natural monopolies make incumbents particularly strong. Market power in natural monopolies has always been an issue, but it will become even more relevant if we consider the introduction of new market forms, especially at the local level. An explicative example can be found in the SmartNet project (http://smartnetproject. eu/), where the role of the DSOs emerges to be fundamental. If DSOs are in charge of investing on the grid, they could keep structures and potential congestions that may prevent market access. Aggregators, on the other side, are encouraged to enter the market to manage small resources and reduce volatility of flows (Burger et al., 2017; Iria and Soares, 2019). They are endowed with the power to set market prices at the balancing level, but without proper regulation they could play strategically both in the day ahead and balancing market. Economically, there is a lot of risk connected to price level; technically, this is the result of strong players with targets that are not necessarily consistent with system stability.

Conclusion

To really foster the Energy Transition in electricity markets and reach all the results we expect from it (opening the market, greening the production, reducing wastes), we must deal with the uncertainty generated by the process. To translate a new solution in a proper environment to a successful regulatory framework, an interdisciplinary approach is needed. To do this, we all must relax our boundaries. Economists must abandon the "purity" and universal applicability that they usually want to obtain by models, and apply them to real networks; engineers have to deal with the idea that, in opening markets, the system must be re-adapted, considering the dynamic interaction with market operators, and this means to consider agent's economic choices. Both the disciplines must interact with other research fields that, in one way or another, are touched by the energy market revolution (Information Technologies, of course, but also social and environmental sciences). Strengthening the collaboration between disciplines is costly, especially in terms of time, and asks for an increase in *perceived* uncertainty, since assumptions must rely on reciprocal trust. Keeping the current approaches, again, gives only the impression of providing solutions for the effective realization of energy markets – otherwise they will already have been put in place.

A key aspect for the design of local markets, their functioning and investments is to deal with *uncertainty* on both prices and flows: from the economic perspective, this could limit competition and reduce overall welfare; from the technical perspective, systems stability is in danger. Separate solutions to the problems are not sufficient: The next – urgent – step in research regards the joint modelling of local markets.

References

Banshwara A., Sharma N. K., Sood Y.R., Shrivastavad R., 2017. "Renewable energy sources as a new participant in ancillary service markets" in Energy Strategy Reviews, Volume 18, December 2017, Pages 106-120;

Belli G., Brusco G., Burgio A., Menniti D., Pinnarelli A., Sorrentino N., 2017."Imbalances costs of small scale renewable not dispatchable power plants in the italian electricity market" in: 14th International Conference on5 the European Energy Market, EEM 2017, Article number 7981895. DOI: 10.1109/EEM.2017.7981895, Dresden, Germany, 2017.

Bertolini M., Buso M., Greco L., 2018. "Competition and regulation with the Smart Grid", Marco Fanno Working Paper No.226-2018;

Bertolini M., D'Alpaos C., Moretto M., 2018. "Do Smart Grids Boost Investments in Domestic PV Plants? Evidence from the Italian Electricity Market" in Energy, Volume 149, 15 April 2018, Pages 890-902.

Burger S., Chaves-Avila J.P., Batllea C., Perez-Arriaga I.J., 2017. "A review of the value of aggregators in electricity systems". Renewable and Sustainable Energy Reviews 77, 395-405

Burgio A., Brusco G., Menniti D., Pinnarelli A., Sorrentino N., Vizza P., 2017. " Economic evaluation in using storage to reduce imbalance costs of renewable sources power plants, in: 14th International Conference on the European Energy Market, EEM 2017, Article number 7981982. DOI:10.1109/EEM.2017.7981982, Dresden, Germany, 2017.

Iria J., Soares F., 2019. "Real-time provision of multiple electricity market products by an aggregator of prosumers". Applied Energy, 255

McPherson M., Tahseen S., 2018. "Deploying storage assets to facilitate variable renewable energy integration: The impacts of grid flexibility, renewable penetration, and market structure" in Energy, Volume 145, 15 February 2018, Pages 856-870

Puglisi C., Stabile M., Cabano M., 2017. "Cost saving due to imbalances reduction in the italian ancillary services market, in: Proccedings of the 6th International Conference on Clean Electrical Power: Renewable Energy Resources Impact ICCEP 2017, DOI: 10.1109/ICCEP.2017.8004844, Santa Margherita Ligure, Italy, 2017, pp. 384–391.

Ruester S., Schwenen S., Batlle C. and I. Perez-Arriaga, 2014. "From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs." Utilities Policy, 31: 229- 237

http://smartnet-project.eu/

https://ec.europa.eu/energy/en/topics/energy-strategy/clean-energy-all-europeans

https://www.iea.org/reports/world-energy-outlook-2019