RENEWABLES AND PORTFOLIO SELECTION OF ELECTRICITY GENERATORS

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Overview

Over the last years the energy market has shown major diversification in terms of generation sources, trading and contracting mechanisms. Market agents are exposed to regulatory, physical and financial risks due to certain aspects of this change, with impacts in the decision-making process and business, especially those related to investments in the sector. On the other hand, a common feature of electricity markets is the existence of a central authority managing the system, or at least monitoring it. On that basis, the diversification process reveals the need for major decentralization of energy markets.

The accelerated decrease in costs of renewables is one of the most relevant characteristics of this diversification scenario. Renewable sources of electricity generation exhibit three particular characteristics: (1) low levels of greenhouse gases (GHG) emissions and pollution; (2) complementarity as a result of the combination of different sources; (3) intermittency in general. The first two characteristics are positive, but not explicitly paid for. The last one is negative, but renewables tend to be paid by the electricity generated, exactly as the dispatchable sources. That is, this third characteristic is also not explicitly priced in a decentralized market.

In most countries, governments are setting targets for renewables and/or guaranteeing the entry of renewables through some sort of subsidies. They are also establishing some kind of mandatory minimum level of other sources to cope with its intermittency to preserve reliability and security of supply of the electric system remains. Therefore, most decisions are centralized.

The increasing inflow of alternative sources of power generation with heterogeneous features presents a challenge for the planner. Under greater decentralization, a cost-based market design may yield lower social welfare due to perverse investment incentives, as well as it leads to distorted dispatch schedules and prices (Munoz et al., 2017). From an economic point of view, all those three aspects should be accounted for and transmitted as tax or subsidies, so that a decentralized and competitive market could provide the optimal level of renewables from the societal point of view.

Present efforts to reduce GHG emissions lead to new challenges in achieving proper electricity market designs. It is necessary to incorporate the proper set of incentives in order to increase efficiency and to induce the investments decisions that would give rise to a cleaner way of producing electricity, such as renewables .

Predominantly, renewables have remarkably low marginal costs though. With their increasing penetration, it is more likely that these sources would eventually determine the spot prices in decentralized markets. In this case, it would be harder for other technologies to recover investment costs. In light of all things considered, it is crucial to design electricity markets that could: (1) encompass the right incentives resulting in efficient levels of investment in portfolios with diverse technologies; (2) set plausible prices that would allow appropriate return for the investments.

Methods

The research approach in this paper combine theoretical results and data analysis. We make use of standard (mathematical and theoretical) tools of mechanism design to analyse the structure of electricity markets, especially with regard to the incentives and dynamics of renewables penetration.

In this paper, we develop a model of optimal portfolio selection of electricity generators, taking into account their characteristics. Our model is based on the framework presented by Joskow and Tirole (2007). The zero-profit equation which implies free entry is central to our developments.

Then, we use data from different countries, but mainly from Brazil, to verify how well balanced their “portfolio” of sources are. From this, we sketch a set of conditions for a decentralized market design that could give the correct incentives to implement the optimal solution. We comment how some countries' rules approximate our prescription.

Results

This paper proposes a mechanism design approach to electricity markets that contrasts with the standard framework of competitive markets used to analyse electricity markets. The standard framework presents electricity as a homogenous good, which is negotiated in a spot market. Although contracts could be written for future delivery, this is only a consequence of the risk aversion of the players, since variation in prices can be significant.

We propose a distinct manner for examining electricity markets: one given by mechanism design. We show that the optimal mechanism is given by an auction of contracts. This is superior to the standard approach in terms of information revelation and efficiency. A crucial implication of our approach is that prices should be different for different plants, in opposition to the standard framework that contends uniform prices among all dispatched technologies.

Conclusions

Perhaps one of the biggest and more important problems of our era is the threat of global warming. To face this challenge, smart solutions are required to reorganize markets so that the results lead to reduced GHG emissions (the main cause of global warming). Electricity markets perhaps are the most important of these markets. On the other hand, they require certain standards of reliability and quality that society is not ready or not willing to give up. Therefore, the effort of reducing emissions must be well balanced and it would be desirable to achieve this through decentralized markets.

This paper studies and proposes a way to organize markets that is based on sound theoretical ideas, although it is still practical. In this way, the paper contributes to this ongoing debate related to the restructuring of these markets by analysing what countries are currently doing and proposing better methods to achieve the desirable outcomes.

References

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