WHAT MAKES GRIDS REALLY SMART?

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Overview

In recent decades and in several countries, the electric industry has been deeply changed by liberalization and competition in some segments (e.g., power generation, energy trading and retail supply).
In this new regulatory framework, electric firms face substantial demand price shocks driven by demand-supply unbalances on the grid. This instability determines the need for infrastructural improvements on transmission and distribution networks that were suffering of underinvestment in many countries. Grid modernization must face these new system challenges, and the infrastructure shall become "smarter" than before to manage new agents and assets (Joskow, 2012; Luthraa et al., 2014).

Methods

In this paper, we introduce a new definition of (investments in) smart grids (SG) that are identified by the capacity to curb market risks faced by electric firms. Then, we theoretically analyse the main determinants and implications of smart grids, focusing on the role of the Distribution System Operator (DSO) in determining the investment level.
We model an environment where risk averse producers decide whether to enter the market or not, depending on the level of market risk (i.e. either in the presence or not of the SG). The Distribution System Operator (DSO), that is managing the local grid, is the agent in charge of investing in SG technologies. The DSO plays as a local monopolist on the local distribution grid, but, in most cases, it is subject to a detailed regulation, making it difficult to frame its behaviour in economic theory (de Joode et al., 2009).
In particular, considering that the SG investment may reduce market risk by making demand shocks more easily manageable, we study what makes an investment in smart grid particularly attractive, focusing on market aspects such as the level of demand elasticity, the maximum willingness to pay of consumers and the type of producers' technologies. Then, we study how a SG investment may affect new entering of firms in the market and what are implications in terms of social welfare.
Relying on Italian data about local producers, DSOs and zonal prices, in the second part of the paper we provide a preliminary discussion to empirically test our theoretical predictions. In this work, we want to provide a preliminary empirical investigation on local markets and differences existing between areas with respect the need for SG investments.

Results

We find that the introduction of smart grids by a DSO depends on the number and type of producers, the demand elasticity and the demand size. In particular, we find that investments in SG enhance the overall energy production and increases the number of producers that decide to enter the market. These findings are particularly interesting since they contribute to fill the literature gap regarding the effects on the market of the SG introduction; moreover, they pave the way to the definition of a coordinated regulation strategy for SG investments.

Conclusions

Smart Grid technologies are the future of the electric system. Regardless of which kind of technology will realize the SG (demand side, batteries, smart meters, smart inverters, a combination of all available technologies, etc.), what is relevant is the effect that the system smartness will have on the market: in our paper, we consider the SG as a system that can reduce market risk. The consequence of this effect is that the total energy production increases, and the number of producers too: this happens in an environment where the DSOs are the agents that are more likely to take decisions on SG investments, on the basis of market agents predicted reactions (Stakelberg game). The analysis paves the way to the definition of correct incentive policies for DSOs in developing SG investments.

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