Peter Bogetoft, Luis Boscán and Peter Møllgaard

MODELLING THE FLEX-OFFER AS A COMMODITY[*]

Peter Bogetoft, Department of Economics, Copenhagen Business School.
Porcelænshaven 16A, 2.68, Frederiksberg DK-2000, Denmark.
Phone: +45 38152506, e-mail: pb.eco@cbs.dk

Luis Boscán, Department of Economics, Copenhagen Business School.
Porcelænshaven 16A, 3.36, Frederiksberg DK-2000, Denmark.
Phone: +45 38152340, e-mail: lbo.eco@cbs.dk

Peter Møllgaard, Department of Economics, Copenhagen Business School.
Porcelænshaven 16A, 1.79, Frederiksberg DK-2000, Denmark.
Phone: + 45 38152584, e-mail: hpm.eco@cbs.dk

Overview

From a technical perspective, Flex-Offers (flexible offers) are an Information and Communications Technology (ICT) concept that enables all agents participating in electricity markets to express, communicate and trade the *energy* and *time* dimensions of flexibility with which they offer to operate. According to this view, consumers, owners of storage devices and power plants operating in the Smart Grid will be able to promptly mobilize resources which will facilitate the adoption of intermittent, renewable energy sources of electricity generation.

Based on economic first principles, we interpret flexibility as a tradable commodity and propose a mechanism that leads to an optimal contractual relationship between parties offering and buying it.

Methods

As an initial step, we conduct a critical review of the financial and economic literature and of business models pertaining to flexibility in power systems.

However, the main building block of our approach is a tractable partial equilibrium model with two agents who bargain over the value of flexibility. A household, which typically pays a fixed, retail price of electricity, offers flexibility (i.e.: surrenders control of the delivery of the load it consumes) to an aggregator in exchange for a price reduction. The aggregator, which faces a stochastic, wholesale cost determined by the market, profits from acquiring flexibility from households and then reselling it to Distribution System Operators (DSOs) or Transmission System Operators (TSOs) which, in turn, strive to minimize the cost of balancing the system.

Specific features of our modelling approach include specification of household preferences over electricity consumption, the profit function of the aggregator as well as the risk tolerance of both agents. Furthermore, our model specification allows for a clear-cut assessment of the agents' welfare under different circumstances, which is an essential input for the bargaining approach which, ultimately, determines the price of the contract.

In summary, our methodological approach is general, yet sufficiently simple to modify assumptions and, consequently, assess ensuing implications.

Results

Preliminary results indicate that under the assumption of risk-neutrality for both agents, the absence of informational asymmetries and an independently and identically distributed uniform distribution governing the wholesale cost of electricity, flexibility is welfare enhancing for both parties. Furthermore, with equal bargaining power, the Nash equilibrium equally splits the gains from trade. This is our first-best, benchmark solution.

When we modify each assumption in turn, results change. For example, allowing for serial correlation in the wholesale cost of electricity and introducing risk aversion reduces the value of flexibility. Nonetheless, relative to each agent's outside option (i.e.: not signing the contract to trade flexibility), it still increases welfare for both parties.

Finally, we propose a mechanism that induces both agents to reach an agreement which leads to a second-best solution.

Conclusions

1. Our analysis is theoretical in nature and provides, to the best of our knowledge, the first systematic analysis of incentive issues arising in the harnessing of flexibility in a Smart Grid environment.

2. The assumptions of our model are realistic enough to guide the actual implementation of contracts for flexibility in the real world.

3. This work paves the way for subsequent work which involves the design of a far-reaching, market based mechanism to trade with Flex-Offers.

References

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