ADJUSTING THE ELECTRICITY CONSUMPTION: CONSUMER'S OPTION TO CHOOSE

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Overview

The energy transition is driven by two major dimensions: the reduction of energy use and the development of renewable energy. Both dimensions are to be considered in the context of active public policies but in a random future, with poorly known reserves and uncertain effectiveness of renewable energy. Whether to reduce the energy use or to choose the energy mix, major decisions are to be taken. In this context, attention is increasingly given to smart grids technologies, which link two research fields: the technological sphere and the economic and societal one. Hence, regarding to the multidimensional context of smart grids implementation, three main types of uncertainties may be identified: technologic, economic and socio-political.
First, the evolution of technology is important. Arrival of new information can generate more uncertainty on certain technologies that existed before. In addition, the length of obsolescence cycle for the new technologies is unknown. Second, the uncertain demand for energy, the evolution of energy prices and the uncertain cost recovery for investments may affect firm's decisions in an environment of accelerated innovation. Third but not least, there is no guarantee that economic agents will react spontaneously to specific choices of technologies. The objectives of consumers caring for a safe and easy access to the least costly energy are not necessarily in line with those of a society sensitive to environmental concerns or more possible depletion of fossil resources.
In this paper our focus is mainly on this last type of uncertainty. It is clear that one of the main drivers for the development of electrical smart grids is the consumer participation in the electricity market. Nowadays the electricity supply industry faces more and more challenges regarding the evolution of consumer consumption patterns and of the technology. In this context there is a need of a better integration of the potential of the demand side into the supply investment decision. If in the past the consumers have been passive participants in the electricity market, nowadays there is an increased interest to be actively involved by controlling the electricity use and its subsequent costs. Thus, a consumer may decide to manage its electricity use and be actively engaged in the electricity market, or to continue on the same consumption pattern. Because the consumers are likely to be more interested in optimizing their electricity consumption at specific times, the time of changing the behavior determines their level of awareness and information concerning the evolution of the market. Consequently, the main objective of this paper is to obtain a timing rule for adjusting the electricity consumption and thus answer the following question: How long should a consumer wait before reducing his consumption or modify it?

Methods

To answer the question we apply the real option theory, which offers a new perspective of analyzing the decision under uncertainty and flexibility of choice. Because the future is uncertain, we model the consumer's future earnings as a continuous stochastic process. These future earnings may be related to the cost savings on consumers' electricity bills from using less energy when prices are high, from shifting usage to lower-priced periods, or simply using different appliances at different times of day. They may also concern the financial rewards that the consumer receives for agreeing to curtail the usage in a demand response program or the payment perceived from the reduced likelihood of being involuntarily curtailed. We use the dynamic programming technique to compute this earnings threshold for which a representative consumer should adjust the electricity consumption in order to maximize its welfare.

Results

We are able to provide an analytical framework of various determinants which affect the timing of the decision to adjust the behavior of electricity consumption: the load period (peak and off-peak), the cost of electricity consumption, the availability of an appropriate enabling metering technology, etc. For example, we find that a higher uncertainty of earnings increases the period of waiting before taking the decision to participate to a demand response program. With a rapid growth of expected consumer's earning, this period will decrease leading to more participation on the market. Raising the marginal rewards for a period of electricity curtail will encourage, for instance, more acceptance to use the equipment enabling the measure of electricity consumption. Increasing curtailment costs may also increase the decision to participate at the program as long as the marginal reward for a period of curtailment is sufficiently high.

Conclusions

Our research may offer recommendations for policy makers regarding the consumer-specific behaviour which is vital for the conversion of the energy systems. Different costumers may react differently with different strategies under modified framework conditions, may influence each other and may modify their strategies continuously. So our goal of economic modeling is to tackle these aspects with the optional approach and to show that such approach may be particularly valuable for uncovering flaws in theory.

References

De Castro, L., Dutra, J., 2013, *Paying for the smart grid*, Energy Economics, 74–84

Gangale,F., Mengolini, A., Onyeji, I., 2013, *Consumer engagement: An insight from smart grid projects in Europe*, Energy Policy, Volume 60, p 621-628

Hadjsaid, N., Sabonnadière, J.C., 2012, *Smartgrids* , Editions ISTE Ltd and John Wiley & Sons Inc-UK, ISBN: 978-1848212619

Park, C.K., Kim, H.J., Kim, Y.S.,2014, *A study of factors enhancing smart grid consumer engagement* Energy Policy, In Press, Corrected Proof

Siano, P., 2014,*Renewable and Sustainable Energy Reviews*, Volume 30,p 461-478