Business Model for Storage Sharing

Background: The sharing economy has disrupted housing and transportation sectors. Homeowners can rent out their property when they are on vacation, car owners can rent their automobiles when not in use. These sharing economy businesses are based on monetizing under-utilized infrastructure. They are enabled by peer-to-peer platforms that match eager sellers with willing buyers. Are there compelling sharing economy opportunities in the electricity sector? What products can be shared in tomorrow's Smart Grid? Could consumers trade electricity via online matching markets?

Our Idea: In [1], we discuss regulatory and technical challenges to the sharing opportunities in the electricity sector. We then study the specific problem of a collection of firms sharing their electricity storage in two-tier ToU prices. We show that the investment decision of the firms form a Nash equilibrium which supports the social welfare.

We further this line by investigating more practical and more complicated pricing schemes, multiple tier ToU. Sharing may happen in many periods in this case, and the temporal coupling between decisions across these periods make it difficult to design the optimal sharing mechanism supports social welfare. We first propose an (M,C) control policy for the optimal storage control in general single peaked ToU schemes. Using two coupled games (capacity decision game and aggregator-firm interaction game), we characterize the energy sharing spot market and the storage investment decision making (as shown in Fig. 1). We offer explicit expression for optimal storage investments and equilibrium prices for shared storage in spot markets of different periods [2].
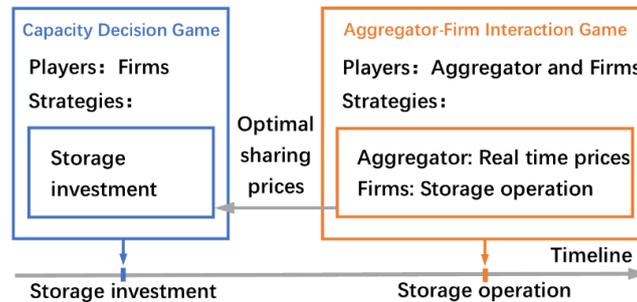

Fig. 1 The coupling between two games: CDG and AFIG.

Future Work: We intend to provide a generic framework for storage control and storage sharing. It is also interesting to exploit other sharing opportunities in the electricity sector, e.g., to share the energy generated by rooftop photovoltaic in the distribution grid, to share the flexibilities in the demand side using the concept of virtual battery, etc.

References

[1] Dileep Kalathi, **Chenye Wu**, Kameshwar Poolla*, Pravin Varaiya, The sharing economy for electricity storage, IEEE Transactions on Smart Grid, Vol. 10, No. 1, pp. 556-567, 2019

[2] Kui Wang, Yang Yu, **Chenye Wu***, "Optimal Electricity Storage Sharing Mechanism for Single Peaked Time-of-Use Pricing Scheme," in submission to IEEE Transactions on Smart Grid, initial submission: Aug. 2019.