An Empirical Analysis of the US Generator Interconnection Policy

Sarah Johnston and Chenyu Yang

Existing institutions are often slow to adapt, and this can hinder the transition to new energy technologies. For utility-scale renewable energy and battery projects, access to the transmission grid (interconnection) is a major hurdle to deployment. While a wind project might take 6 months to construct, interconnection takes an average of 3 to 4 years. Interconnection is also costly: in several regions, average interconnection costs currently exceed 20 percent of project capital costs (Caspary et al., 2021). These costs are difficult for developers to predict ex ante, and most projects that apply for interconnection are never completed. Renewable energy advocates argue the traditional queuing system and interconnection cost allocation rules are to blame. In this paper, we estimate a dynamic model of the queuing process and evaluate the welfare effects of counterfactual mechanisms.

Renewable energy generators face two major difficulties in the interconnection process. The first is the high cost to physically connect to the power grid. In the US, most renewable energy projects interconnect to a grid managed by regional transmission operators (RTOs). The RTO performs studies that identify the cost of building interconnection facilities and expanding the capacity of the transmission grid. The project developer must pay nearly all these costs even though other generators - both existing and those constructed later - also benefit; a system known as "participant funding." This system dates from a 2003 FERC order designed to encourage efficient siting. Yet, relative to the fossil fuel generators the system was designed for, renewable generators are significantly more location-constrained (Caspary et al., 2021).

The second difficulty is the cost uncertainty caused by the design of the queuing process. A project developer first applies to an RTO to enter a queue. On a first-come-first-served basis, the RTO typically conducts three studies: a preliminary study, a system impact study, and a facility study. Subsequent studies are more costly and provide a more accurate cost estimate. After each study, a developer may choose to drop out of the queue or pay a portion of the cost estimates to keep its position in the queue. Withdrawals are common: in one RTO, PJM, 85 percent of projects in the queue are eventually withdrawn. When a higher-queued project drops out, other projects may have to share the costs of foregone upgrades, and the increased costs cause further dropouts (Lieberman, 2021).

A simplified example illustrates this cascading effect. Assume that projects 1, 2, and 3 enter the queue sequentially. The RTO then conducts preliminary studies in the order of their queue positions, and the cost estimate f_n is calculated given the assumption that requests $1, \ldots, n-1$ will follow through and complete their respective network upgrades. Assume

further that that all three projects rely on a power line to connect to the grid, where the power line costs 9 million dollars. Each project is then allocated a cost of 3 million dollars. Assume that, in a new round of studies, further costs are identified for project 1 (such as a higher estimate for building a transformation substation), and project 1 drops out. Then, the cost of the transmission line falls on the remaining two projects, which now must each pay 4.5 million dollars. The higher cost may then cause projects 2 and 3 to drop out.

RTOs and renewable energy advocates have examined and attempted several possible reforms. At the planning level, advocates call for RTOs to make larger-scale ex ante transmission investments in areas suitable for renewables (Moore, 2020). Other proposals suggest more cost-sharing for upgrades. MISO (a Midwestern RTO), for example, now shares 10 percent of the upgrade costs. Finally, requiring non-refundable deposits to maintain queue position can discourage speculative projects (Lieberman, 2021).

We focus on solutions based on alternative mechanism designs. Our first goal is to provide an empirical estimate of a "planner solution": when the costs of the network upgrades can be freely shifted across affected projects, what is the maximum number of projects (or total capacity) that can be built subject to the current "participant funding" model and the developers' individual rationality constraints? Secondly, we consider alternative mechanisms that condition priorities not only on the time of entry but also on other characteristics (available before formal studies). Our goal is to find a mechanism closest to the planner solution.

Our empirical approach is based on developer and project characteristics in each study published by the RTOs from 1999 to the present and the cost estimates therein. We hand collect these data from two major RTOs: SPP, which oversees states in the central US, and PJM, which serves several eastern states. As in Jarvis (2021), these data include planned projects that were never completed. We then develop a dynamic model for developers in the queue. Variation in wind and solar resource quality, distance to interconnection points, and cost estimates help to identify the incentive to continue to wait. We also note that increases in the entry of wind and solar projects before potential federal subsidy expirations (in 2012 for wind and 2016 for solar) generate variation in queue lengths. Using the estimated model, we simulate counterfactual scenarios under alternative queue designs.

The project builds on a burgeoning literature on dynamic market design. The bulk of the literature has focused on efficient allocation of objects over time and the design of waitlisting policies (Agarwal et al., 2021; Waldinger, forthcoming; Verdier and Reeling, forthcoming). There has been recent interest in education market design problems where a student's preference depends on the composition of her peers (Dennis Epple, 2018; Allende, 2019), which is similar to the externality in our setting. We contribute to this literature by considering an intertemporal externality in the queuing process in an important market.

References

Agarwal, Nikhil, Itai Ashlagi, Michael A. Rees, Paulo Somaini, and Daniel Waldinger. 2021. "Equilibrium Allocations Under Alternative Waitlist Designs: Evidence from Deceased Donor Kidneys." *Econometrica*, 89(1): 37–76.

Allende, Claudia. 2019. "Competition Under Social Interactions and the Design of Education Policies." Working Paper.

Caspary, Jay, Michael Goggin, Rob Gramlich, and Jesse Schneider. 2021. "Disconnected: The Need for a New Generator Interconnection Policy." Americans for a Clean Energy Grid Report.

Dennis Epple, Akshaya Jha, Holger Sieg. 2018. "The superintendent's dilemma: Managing school district capacity as parents vote with their feet." *Quantitative Economics*, 9: 483–520.

Jarvis, Stephen. 2021. "The Economic Costs of NIMBYism." Working Paper.

Lieberman, Julie. 2021. "How Transmission Planning and Cost Allocation Processes are Inhibiting Wind and Solar Development in SPP, MISO, and PJM." American Council on Renewable Energy (ACORE) Report.

Moore, John. 2020. "The clean energy benefits slipping through states' fingers." *Utility Dive*.

Verdier, Valentin, and Carson Reeling. forthcoming. "Welfare effects of dynamic matching: An empirical analysis." *Review of Economic Studies*.

Waldinger, Daniel. forthcoming. "Targeting In-Kind Transfers Through Market Design: A Revealed Preference Analysis of Public Housing Allocation." *American Economic Review*.

The authors have no conflicts of interests or financial interests in this research.