The spatial and dynamic diffusion of Large-Scale Solar (LSS) projects: Why do socioeconomic factors matter or not matter?

Haoying Wang
New Mexico Tech
haoying.wang@nmt.edu

Michael H. Young
University of Texas – Austin
michael.young@beg.utexas.edu

Selected Poster prepared for presentation at the 2024 Agricultural & Applied Economics Association Annual Meeting, New Orleans, LA: July 28-30, 2024

The spatial and dynamic diffusion of Large-Scale Solar (LSS) projects: Why do socioeconomic factors matter or not matter?

Haoying Wang* Michael H. Young**

** New Mexico Tech; ** University of Texas - Austin*

Abstract

The study develops a dynamic diffusion model of LSS projects to account for potential spatial spillover effects, and how those effects may be mediated by socioeconomic factors. For instance, existing studies show that solar photovoltaic projects demonstrate significant soft-cost reductions associated with knowledge spillover. The empirical forms of the diffusion model will be estimated at different spatial levels (e.g., county vs. site) to calibrate the relevance of socioeconomic and site-specific factors. We have realized the potential missing variables issue related to unobservable information of local LSS permitting processes. We address this issue by developing proxy variables. For instance, wind energy development was ahead of LSS development in many parts of the US. Information from existing wind turbines can provide hints on the permitting process of LSS if controlling other factors like the availability of renewable energy resources. Our preliminary analysis shows that site-specific factors such as the surrounding land-use history are important for LSS sitting. The relevance of local socioeconomic factors varies by region, which likely reflects their interactions with site and community-specific factors that are not easily observed. Unpacking such interaction effects warrants further research on this topic.

Background

- Addressing the climate crisis requires a systematic decarbonization of economic sectors globally.
- Many national and local governments have already set their timelines towards a mid-century net-zero carbon emission goal for the electricity sector.
- In the US, more than a dozen states have established a net-zero carbon emission goal through either legislative statutes or executive orders.
- To incentivize private investments in energy transition to reach the net-zero carbon emission goal, the US federal and state agencies have initiated and supported many renewable energy programs through grants, subsidies, and tax credits.
- While it is still debatable in the literature how effective those policies and programs are, it has been stressed that key challenges exist between the current energy landscape and the net-zero carbon emission goal.
- Community-level acceptance of Large-Scale Solar (LSS) projects remains a critical issue to address, especially in the Southwest, where the solar resource is the most abundant, but the LSS penetration is low.

Materials and Methods

We empirically estimate the following diffusion model that explains the number or the capacity of new LSS projects in location (i) and year (t):

$$s_{it} = p(L - S_{it}) + q\frac{S_{it}}{L}(L - S_{it})$$

where p is the coefficient of technology innovation and q is the coefficient of imitation or spillover. S_{it} is the cumulative LSS project capacity up to period t in location i. L is the total LSS project capacity of the country. If cross-sectional variation is considered, then $L = L_i$ *or* $L = L_j$, which becomes regional capacity, and $i \neq j$ (a different spatial scale).

The data used in this study come from the US Large-Scale Solar Photovoltaic Database (v 1.0), the US Census of Agriculture, and surveys conducts by the USDA and the US Census. Fig 1 and Fig 2 below illustrates some of the data.

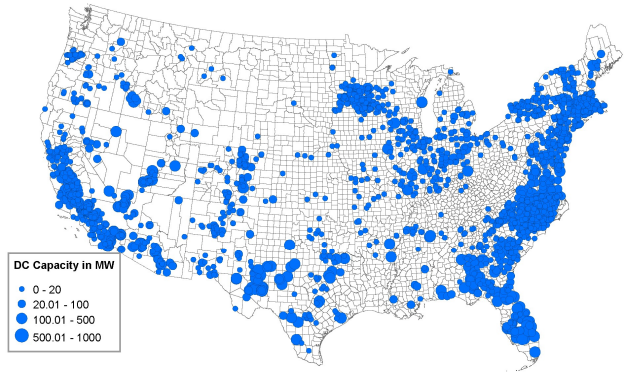

Fig 1. LSS project capacity in the US

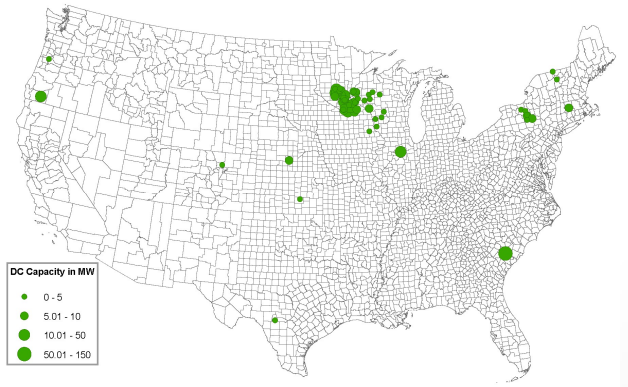

Fig 2. Agrivoltaics LSS project capacity in the US

Preliminary Results

- Our preliminary analysis shows that site-specific factors such as the surrounding land-use history are important for LSS sitting.
- The variation in land-use history reflects local land ownerships, land use regulations, and land management strategies.
- The relevance of local socioeconomic factors varies by region, which likely reflects their interactions with site and community-specific factors that are not easily observed.
- Unpacking such interaction effects warrants further research on this topic.

Conclusion

- Both observed and unobserved socioeconomic factors are important in interpreting community acceptance of LSS projects.
- LSS sitting process and associated transaction costs are an indication of local land ownerships, land use regulations, and land management strategies.

Future Direction

- Develop an empirical strategy to control for unobserved socioeconomic factors and alleviate associated measurement errors.
- Understand community acceptance and the sitting process of special purpose LSS projects, such as agrivoltaics.

Acknowledgments

The authors would like to acknowledge the financial support for this research provided by the **Bureau of Economic Geology** at the **University of Texas – Austin** and the **USDA National Institute of Food and Agriculture** through award #2022-67020-36265 (Project Title: Addressing agricultural drought in the New Mexico High Plains through soil and groundwater management and climate adaptation). All errors are the authors' responsibility.