



Data Analytics for Residential PV From Permit to Interconnect: Final Technical Report

Jeffrey Cook,¹ Kristen Ardani,¹ Jesse Cruce,¹ Shiyuan Dong,¹ Emily Dalecki,¹ Jesse Geiger,¹ Jenna Harmon,¹ Robert Margolis,¹ and Eric O'Shaughnessy²

*1 National Renewable Energy Laboratory
2 Clean Kilowatts*

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Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-6A20-84536
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Suggested Citation

Cook, Jeffrey, Kristen Ardani, Jesse Cruce, Shiyuan Dong, Emily Dalecki, Jesse Geiger, Jenna Harmon, Robert Margolis, and Eric O’Shaughnessy. 2023. *Data Analytics for Residential PV From Permit to Interconnect: Final Technical Report*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-84536.
<https://www.nrel.gov/docs/fy23osti/84536.pdf>.

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This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. This material is based on work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Just in Time Laboratory Call 2019, Agreement 35658. The views expressed herein do not necessarily represent the views of the DOE or the U.S. Government.

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FINAL TECHNICAL REPORT (FTR)

Federal Agency: U.S. Department of Energy
Award Number: 35658
Project Title: Data Analytics for Residential PV From Permit to Interconnect
Recipient Organization: National Renewable Energy Laboratory
Project Period: 07/01/2019–09/30/22
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Signature of Certifying Official

11/15/22

Date

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1 Project Summary

The main objective of this research is to provide novel insights into the effects of permitting, inspection, and interconnection (PII) processes on PV system installations—and in particular, into the relationship between PII processes and adoption timelines. This research can then be used to clarify the potential effect of various process changes on reducing PII timelines, customer cancellation rates, and related costs nationwide. NREL completed this research by assembling a data set of distributed, largely residential rooftop solar systems less than 50 kilowatts in size from participating solar installers. NREL produced five publications describing the effects that PII processes can have on adoption timelines nationwide, in addition to publishing an interactive data viewer with five years of PII cycle time data. This tool can be used by stakeholders to identify potential adoption timelines by local government.

2 Project Objectives and Outcomes

This project is the first analysis of PII that leverages a nationwide set of installer data. The analysis identified the individual and cumulative effects of PII on process cycle times. Although there is some initial literature focused on interconnection, this effort is the first to couch interconnection requirements within the linked permitting and inspection process. In addition, this project is the first to evaluate how cancellations are associated with PII-related delays and the types of costs that may need to be passed on to successful installs. Moreover, this work is the first to provide insights into how installer size can influence PII timelines, related cancellation rates, and potential cancellation costs. NREL collected PII-related data on 364,176 projects across 34 states, 7238 jurisdictions, and 560 utilities from 2017–2021. NREL found that permitting cycle times ranged from 0–35 business days, interconnection review timelines for preinstallation review ranged from 0–24 business days, and post-installation reviews ranged from 0–72 business days. NREL published this data in an interactive web tool that also provides detailed PII-related requirements that contractors must follow within each local government and utility, thereby increasing transparency into potential adoption timelines and PII-related requirements nationwide. Over the course of the project, NREL modified the project plan to expand the scope and collect more PII-related data. The key barriers that NREL faced in completing this project were related to identifying willing data partners to improve the coverage of the data set and conducting data analysis with only contractor-provided data, as opposed to comparing that data with other sources, such as utility and local government data.

Table 1. Project Milestones

Milestone	Delivery Date
Collect permitting and inspection process data and conduct preliminary analysis of requirements and relationship with customer cancellation rates by local government	9/30/2019
Develop, distribute, and collect responses to a questionnaire for small- and medium-sized installers to evaluate PII timelines and cancellation rates	9/30/2019
Collect interconnection process data by electric service provider	12/31/2019
Interim Check Point 1: Preliminary PII Results	12/31/2019
Interim Check Point 2: Preliminary PII Results	3/31/2020
Interim Check Point 3: Preliminary PII Results	6/30/2020
Complete technical report describing permitting and inspection variation across AHJs	1/31/2021
Develop interactive online data visualizations for PII – Permitting and Inspection	1/31/2021
Develop interactive online data visualizations for PII – Interconnection	1/31/2021
Complete technical report describing interconnection variation across electric service providers	1/31/2021
Complete workshop discussing novel research opportunities to streamline PII processes	1/31/2021
Collect 2020 cycle time data from partner installers	6/30/2021
Complete survey of AHJs on COVID-19 impacts on permitting and inspection	9/30/2021
Complete beta data viewer	12/31/2021
Collect feedback from stakeholders on data viewer	3/31/2022
Update final data viewer tool	6/30/2022
Finalize technical report on COVID-19 impacts	9/30/2022

3 Path Forward

Given the wide variation in PII-related cycle times, there is immense value in continuing to collect information related to adoption timelines within all solar market segments. Data should continue to be collected from industry, as was done here, while also expanding data sources to local governments and utilities to more effectively analyze review timelines and areas for improvement for local governments, utilities, and industry. Additional research is also needed to evaluate the true impact of PII-related delays and requirements on final installation costs. Finally, populating and maintaining these types of data sets can be time-intensive; thus, it would be valuable to investigate pathways to automate data collection. If PII-related data is not regularly updated in the SolarTRACE tool, it will become less informative to the solar stakeholder community. These automation pathways could also help expand into other project types, such as storage, solar at time of new construction, building-integrated PV, and commercial systems, among many others.

4 Inventions, Patents, Publications, and Other Results

NREL has published two journal articles, three technical reports, a data set, and an interactive data viewer. All of these publications are summarized by category below.

Journal Articles

O’Shaughnessy, E., Shiyuan Dong, Jeffrey J. Cook, Jesse Cruce, Kristen Ardani, Emily Fekete, and Robert Margolis. 2022. “Effects of local permitting and interconnection requirements on solar PV installation durations.” *Energy Policy*. (161).

<https://doi.org/10.1016/j.enpol.2021.112734>.

Cook, Jeffrey J., Jesse Cruce, Eric O’Shaughnessy, and Kristen Ardani. 2021. “Exploring the link between project delays and cancellation rates in the U.S. rooftop solar industry.” *Energy Policy*. (156). <https://doi.org/10.1016/j.enpol.2021.112421>.

Technical Reports

Cruce, Jesse R., Eric O’Shaughnessy, Jenna Harmon, Jesse Geiger, and Jeffrey J. Cook. 2022. *Residential Solar Adoption Timelines and Impacts from the COVID-19 Pandemic*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-83529.

<https://www.nrel.gov/docs/fy22osti/83529.pdf>.

Cruce, Jesse R., Eric O’Shaughnessy, and Jeffrey J. Cook. 2022. *Evaluating the Impact of Residential Contract Cancellations in the United States*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-80626. <https://www.nrel.gov/docs/fy22osti/80626.pdf>.

Fekete, Emily S., Jesse R. Cruce, Shiyuan Dong, Eric O’Shaughnessy, and Jeffrey J. Cook. 2022. *A Retrospective Analysis of Distributed Solar Interconnection Timelines and Related State Mandates*. Golden, CO: National Renewable Energy Laboratory. NREL/TP6A20-81459.

<https://www.nrel.gov/docs/fy22osti/81459.pdf>.

Interactive Data Viewer (SolarTRACE)

NREL. n.d. “SolarTRACE.” <https://solarapp.nrel.gov/solarTRACE>.

Data Set

NREL. n.d. “Solar permitting, inspection, and interconnection cycletimes and requirements.”

<https://data.nrel.gov/submissions/160>.

5 Project Team

The project team is summarized in Table 2.

Table 2. Project Team and Roles

Name	Role	Organization
Jeffrey Cook, Ph.D.	Principal Investigator	NREL
Kristen Ardani	Data Analyst	NREL
Jesse Cruce	Data Analyst	NREL
Shiyuan Dong	Data Analyst	NREL
Emily Dalecki	Data Analyst	NREL
Jesse Geiger	Data Analyst	NREL
Jenna Harmon	Data Analyst	NREL
Robert Margolis	Data Analyst	NREL
Eric O'Shaughnessy	Data Analyst	Clean KWs