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Exploring the impact of permitting and local regulatory processes on residential solar prices in the United States

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HIGHLIGHTS

- We show local regulatory processes meaningfully affect U.S. residential PV prices.
- We use regression analysis and two mechanisms for "scoring" regulatory efficiency.
- Local permitting procedure variations can produce PV price differences of $0.18/W.
- Broader regulatory variations can produce PV price differences of $0.64–$0.93/W.
- The results suggest the cost-reduction potential of streamlining local regulations.

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ABSTRACT

This article statistically isolates the impacts of city-level permitting and other local regulatory processes on residential PV prices in the United States. We combine data from two "scoring" mechanisms that independently capture local regulatory process efficiency with the largest dataset of installed PV prices in the United States. We find that variations in local permitting procedures can lead to differences in average residential PV prices of approximately $0.18/W between the jurisdictions with the least-favorable and most-favorable permitting procedures. Between jurisdictions with scores across the middle 90% of the range (i.e., 5th percentile to 95th percentile), the difference is $0.14/W, equivalent to a $700 (2.2%) difference in system costs for a typical 5-kW residential PV installation. When considering variations not only in permitting practices, but also in other local regulatory procedures, price differences grow to $0.64–$0.93/W between the least-favorable and most-favorable jurisdictions. Between jurisdictions with scores across the middle 90% of the range, the difference is equivalent to a price impact of at least $2500 (8%) for a typical 5-kW residential PV installation. These results highlight the magnitude of cost reduction that might be expected from streamlining local regulatory regimes.

1. Introduction

Though still constituting a minor share of total electricity supply, solar photovoltaics (PV) have been deployed at a rapid pace in recent years. In 2013, 38 GW of PV were installed globally, up from just 1.1 GW installed 10 years earlier in 2004 (EPIA, 2014). The United States, as the world's third-largest market in 2013, installed 4.8 GW, with significant new capacity in smaller household and larger commercial systems as well as in utility-scale applications (SEIA/GTM, 2014). This growth has been spurred by both government policy and system cost reductions (Shrimali and Jenner, 2013), with continued growth expected over the near and longer terms, especially within the context of combating global climate change (Baker et al., 2013; Edenhofer et al., 2011; IPCC, 2014).

For this growth to continue, given recent changes in the cost structure of PV systems, heightened emphasis is now being placed on reducing non-hardware "soft" costs. In particular, overall

Abbreviations: BIPV, building-integrated PV; DOE, U.S. Department of Energy; HHI, Herfindahl–Hirschman Index; LBNL, Lawrence Berkeley National Laboratory; PII, permitting, inspection, and interconnection; PV, photovoltaic; RSC, Rooftop Solar Challenge; TPO, third-party owned; TTS, Tracking the Sun

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system-level PV cost reductions have been substantial in recent years (Barbose et al., 2014; Bazilian et al., 2013; Bolinger and Weaver, 2013; Branker et al., 2011; Candelise et al., 2013; Hernández-Moro and Martínez-Duart, 2013). However, in the United States at least, these system-cost reductions have been driven largely by hardware-cost reductions—specifically, a steep decline in the price of PV modules. Though learning-based reductions in soft costs are apparent on a longer-term basis (Schaeffer et al., 2004), soft costs have been somewhat stagnant in the United States, at least through 2012 (Barbose et al., 2014). As a result, for typical residential systems, soft costs represented 64% of total system costs in the United States in 2012 (Friedman et al., 2013). Moreover, these high soft costs are at least somewhat unique, as average residential PV prices in the United States remain well above those witnessed in many other major global PV markets (Barbose et al., 2013). Significant additional reductions in total installed costs, likely a precondition for continued rapid market growth, will therefore necessitate substantial progress in reducing soft costs.

This article focuses on one soft-cost element that has received a considerable amount of recent attention in the United States as potentially being partly responsible for the persistently high PV prices: local regulatory processes, including permitting, inspection, and interconnection (PII). A typical local regulatory process for PV may involve multiple local government departmental reviews (e.g., building, electrical, mechanical, plumbing, fire, structural, zoning, and aesthetic), a permitting fee and a site inspection, as well as interconnection-based reviews by the local utility. These processes are partially directed by state policies, but local governments and utilities are typically given wide latitude in how they are administered. Though the resulting procedures can help protect against unscrupulous or unskilled PV installers, the diversity of documentation requirements, application procedures, inspection processes, and fees complicates the PV market: approximately 18,000 different local “authorities having jurisdiction” exist in the United States, many of which have unique requirements.[1]

A variety of efforts is underway to not only document the procedures required in various jurisdictions, but also to streamline those procedures in order to reduce PV costs, especially in jurisdictions where procedures are particularly taxing. The U.S. Department of Energy's (DOE's) Rooftop Solar Challenge (RSC), for example, has funded teams of local and state governments along with utilities, installers, nongovernmental organizations, and others to reduce local administrative barriers to PV.[2] As part of this effort, DOE has developed a scoring protocol for cities and applied it on two occasions. The nonprofit Vote Solar Initiative, meanwhile, created “Project Permit,” which includes an online summary of city-level permitting requirements and scores cities based on those processes.[3] The Solar America Board for Codes and Standards has developed an expedited permit process for PV (Brooks, 2012). Clean Power Finance has created an online database that compiles permitting requirements from around the nation; it is the data source for Vote Solar's Project Permit.[4] Partly in response to these myriad efforts, a number of states have sought to streamline their local procedures (Stanfield et al., 2012).

In this article we statistically analyze the impact of these local, often city-level processes on the reported prices of residential PV systems. We use the unique city-level scores of these processes created by DOE through its RSC program and by Vote Solar through its Project Permit initiative. Our work leverages the sizable dataset of system-level PV prices managed by Lawrence Berkeley National Laboratory (LBNL) and is part of a larger body of research conducted by LBNL, Yale University, University of Wisconsin, and University of Texas at Austin that is exploring, more broadly, the drivers of PV price variability in the United States.

Our analysis helps to answer two key questions. First, to what degree are local regulatory processes in the United States impacting residential PV prices? Second, do the two different scoring mechanisms capture the idiosyncrasies of these local processes? Answers to these questions can highlight the magnitude of cost reduction that might be expected from streamlining local regulatory regimes and, secondarily, may help refine city-level scoring methods.

We build on existing literature that has assessed these costs, and we seek to inform efforts that have sought to reduce them. Friedman et al. (2013) find that the national average cost of PII in the United States for residential systems in 2012 was $0.19/W ($0.10/W for labor and $0.09/W for the permit fee). Seel et al. (2014) compare average PII costs in Germany and the United States for 2011, finding that German costs (at just $0.03/W) were substantially lower than U.S. costs, on average. Ardani et al. (2013) identify a roadmap by which U.S. PII costs might approach German levels by 2020. SunRun (2011) finds that local permitting and inspection could cost $0.50/W in total for a typical residential installation. Tong (2012) estimates that the labor costs associated with permitting averaged $0.11/W, with 36% of installers limiting or avoiding certain jurisdictions due to cumbersome processes. Dong and Wiser (2013) evaluate the heterogeneity in city-level permitting practices, finding that cities in California with the most-favorable permitting practices had PV prices that were $0.27–$0.77/W lower than cities with the least-favorable practices.

This previous work suggests that local regulatory processes can impact PV prices both directly, through administrative labor and fees imposed on PV installers, and indirectly, as economic rents accruing to installers because of barriers to market entry created by these processes. The impact of local regulatory procedures on the PV market exceeds the impact on PV prices alone, because these procedures may delay the completion of PV projects (Dong and Wiser, 2013) and can also limit participation in the market by both installers and potential PV customers (Tong, 2012). At the same time, there remains some uncertainty about the size of the *average* price impact and, more significantly, about the *heterogeneity* of those price effects across jurisdictions.

Our work addresses the uncertainty in heterogeneity. In so doing, it builds on Dong and Wiser (2013), who conducted an econometric analysis of residential PV systems in California to explore the relationship between DOE RSC residential permitting scores and PV prices. We extend that work in several respects. First, we evaluate the impact of local processes using two third-party jurisdiction-level scoring systems, from the RSC and Vote Solar. Second, we extend the work both geographically and temporally. Whereas Dong and Wiser (2013) focus on RSC scores and PV installations in California in 2011 (44 cities, 3,000 PV installations), the present analysis uses RSC scores and PV installations for both 2011 and 2012, and we evaluate the impact of those scores across 13,904 PV systems within 73 cities and 6 states. The Vote Solar scores allow us to assess a much larger number of PV systems (43,551), cities (603), and states (11), adding to the richness of our dataset. Though the present work clearly does not cover all states and jurisdictions in the United States, it does significantly expand on previous work and does cover a sizable fraction of the

[1] These 18,000 authorities oversee roughly 42,000 unincorporated communities, some of which have their own requirements. Though we colloquially refer to “city-level” processes throughout much of this article, in fact, local procedures impacting PV are sometimes set by the county or by unincorporated jurisdictions. For the sake of consistency and ease of reading, however, and because most of the local procedures are in fact established by cities, throughout this paper we will use the terms “city” and “cities” to refer to loosely to “authorities having jurisdiction.”

[2] See: http://www.energy.gov/eere/sunshot/rooftop-solar-challenge.

[3] See: http://projectpermit.org/.

[4] See: http://solarpermit.org/.