EQ Research

Comparing Utility Interconnection Timelines for Small-Scale Solar PV

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July 2015

Acknowledgments

The author would like to thank the following individuals and organizations for their contributions to this work: Richard Johnson (National Grid), Bob Woerner (PG&E), Ken Parks (SDG&E), Sean Gallagher (SEIA), Justin Baca (SEIA), Colin Silver (SEIA), Justin Barnes (EQ Research), Rusty Haynes (EQ Research), Kim Kooles (EQ Research), Amanda Vanega (EQ Research), Jason Keyes (Keyes, Fox & Wiedman), and the PV installers that contributed data and insight.

About EQ Research

EQ Research provides policy research, analysis, and incentive data services to businesses, non-profit organizations, and others engaged in the clean energy sector. The EQ staff's areas of policy expertise include legislation and regulatory policy, general rate cases, integrated resource plans, utility proposals, financial incentives, net energy metering, interconnection, energy storage, distributed generation (DG), renewable portfolio standard policies, renewable-energy credit (REC) issues, and energy efficiency.

Acronyms and Abbreviations

ACE	Atlantic City Electric Company
APS	Arizona Public Service Company
BGE	Baltimore Gas & Electric
CL&P	Connecticut Light & Power
Con Ed	Consolidated Edison Company
DG	Distributed Generation
EIA	Energy Information Administration
HECO	Hawaiian Electric Company
HELCO	Hawaii Electric Light Company
IREC	Interstate Renewable Energy Council
JCP&L	Jersey Central Power & Light
kW	Kilowatt
kWh	Kilowatt-hour
LADWP	Los Angeles Department of Water & Power
LIPA	Long Island Power Authority
MECO	Maui Electric Company
MID	Modesto Irrigation District
NREL	National Renewable Energy Lab
NSTAR	NSTAR Electric Company
NYSEG	New York State Electric & Gas Company
ORU	Orange & Rockland Utilities
Pepco	Potomac Electric Power Company
PG&E	Pacific Gas & Electric
PGE	Portland General Electric
PSE&G	Public Service Electric & Gas
PTO	Permission to Operate
PV	Photovoltaic
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
SMUD	Sacramento Municipal Utility District
SRP	Salt River Project
TEP	Tucson Electric Power Company
WMECO	Western Massachusetts Electric Company

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Executive Summary

Interconnection standards and procedures are designed to allow electric customers to safely connect distributed generation (DG) systems to the grid. Even as distributed solar photovoltaic (PV) systems become more common, the interconnection process can be lengthy and problematic for solar customers and installers, increasing overall system installation costs and delaying the benefits of PV generation. As DG penetration levels increase, utilities are more likely to deny DG system interconnection by raising safety and grid reliability concerns, further complicating and delaying the interconnection process. However, many utilities – even some with high levels of DG penetration – process and approve customer interconnection through quick, streamlined processes, illustrating that solutions to existing challenges are within reach.

In order to identify the root causes and potential solutions to these challenges, we surveyed PV installers that operate in utility service territories with the highest numbers of net-metered residential PV systems. With a focus on systems 10 kW or less, we asked installers to report the average number of days individual utilities took to grant permission to operate (PTO) after a system installation in 2013 and in 2014, and the number of applications denied by the utility due to grid reliability concerns for both years. We received data for 34 utilities in 13 U.S. states and Washington, D.C. Overall, utilities took longer to grant PTO in 2014 than in 2013, with average approval times increasing by 68%. For the 24 utilities operating under state interconnection procedures that prescribe PTO deadlines, the average PTO waiting period reported exceeded the regulated limit for 14 of those utilities. Rejections related to grid reliability concerns increased significantly in 2014, with installers reporting denials in 14 utility service territories. As DG penetration levels rise, PTO waiting periods are expected to increase unless efforts are made to streamline the process.

Through interviews with PV installers and utility interconnection staff, we identified a number of key issues that cause delays and best practices for expediting the interconnection process without sacrificing safety and reliability. Most state interconnection standards set timeline requirements for application review, but many have overlooked PTO timelines. Regulators can set the stage by mandating enforceable PTO timelines for utilities. The application process itself can be improved significantly by using an online application system and syncing the interconnection customer database with grid penetration and customer account databases. Utilities may consider consolidating pre- and post-construction paperwork in order to simplify the overall process. In general, process transparency and effective communication between utilities, installers, and customers can help resolve problems faster and improve the experience for customers. Transparency and communication can also help resolve problems related to grid capacity concerns. Allowing installers to access grid penetration maps and/or data can help avoid unexpected delays, rejected applications, and application backlogs. As grid penetration levels increase, broader transmission and distribution planning processes should include a plan for managing a growing number of interconnection applications. Streamlining the interconnection process not only helps utilities meet deadlines and improve customer satisfaction, it can also yield internal time and cost savings. Improvements to the interconnection experience will lower PV installation costs while helping states meet policy goals and objectives related to renewable energy and DG.

I. Introduction

The process of interconnecting a PV system to the grid can be long and complicated. Delays can cost installers and customers significant amounts of time and money. The Department of Energy estimates that if interconnection for every PV system projected to be installed in 2015 was delayed one day, it would cost the U.S. $4 million in lost electricity generation.[1] On an individual level, a hypothetical customer that installs a 5 kW system in Maryland would be deprived of approximately $73.48 in electricity generation for every month that interconnection is delayed.[2] Considering that every year thousands of customers across the country experience even longer delays, the aggregate financial impact of such delays is staggering. A system sitting unused, waiting for permission to operate, is not only a cost to the system owner, but to ratepayers as well.

Interconnection delays also contribute to the excessive soft costs that haunt PV installers and, by extension, PV customers. These soft costs can be substantial: a study by the National Renewable Energy Lab (NREL) found that soft costs can account for 64% of the cost of a residential PV installation.[3] The sources of and reasons for interconnection delays are frequently the subject of disagreement and finger-pointing among utilities, customers, and installers. For example, utilities may argue that many of the applications they receive are incomplete or inaccurate, while installers and customers may argue that utilities' review processes are opaque, confusing, and ultimately at least partially responsible for application errors and subsequent delays.

Problems with the interconnection process, especially regarding permission to operate (PTO) waiting periods, can leave customers dissatisfied. Customers understandably want to begin using and benefiting from a PV system as soon as it is installed, rather than endure a waiting period of unknown length. A negative experience with a PV installation has impacts beyond the individual customer – studies have concluded that the most significant driver of PV adoption is peer pressure, which often takes the form of learning from friends or family about the benefits of PV.[4,5] If a customer is unsatisfied with the installation process, a poor review can erode an installer's reputation – even if the delays are not the installer's fault – and repress the word-of-mouth advertising that is a significant driver of PV adoption. Unfortunately, regulations regarding PTO timelines are absent from many states' interconnection rules, leaving installers and customers without a clear path for resolving disputes with utilities.

Problems within the interconnection approval process will only become more apparent as customer-owned solar becomes more common. Residential solar is increasing at a faster rate than

[1] U.S. Department of Energy. SunShot Prize: Race to 7-Day Solar Official Rules. April 30, 2015. http://energy.gov/sites/prod/files/2015/05/f22/SunShot%20Prize%20Official%20Rules%2004302015-live.pdf

[2] Assuming a retail electricity price of 13.16 cents per kWh and a system that produces 6,700 kWh per year. Energy Information Administration. Maryland State Energy Profile. http://www.eia.gov/state/print.cfm?sid=MD

[3] National Renewable Energy Laboratory. Benchmarking Non-Hardware Balance-of-System (Soft) Costs for U.S. Photovoltaic Systems, Using a Bottom-Up Approach and Installer Survey – Second Edition. October 2013. http://www.nrel.gov/docs/fy14osti/60412.pdf

[4] The Washington Post. Why do people put solar on their roofs? Because other people put solar on their roofs. October 23, 2014. http://www.washingtonpost.com/blogs/wonkblog/wp/2014/10/23/study-solar-energy-isnt-just-for-rich-liberals-any-more/

[5] PV Solar Report. Drivers of Residential Solar Adoption: Environmental Preference or Peer Pressure? January 27, 2014. http://pvsolarreport.com/drivers-of-residential-solar-adoption-environmental-or-peer/

any other sector: 2014 was the third year in a row that the residential market experienced an annual growth rate of more than 50%.[6] Both the non-residential and residential solar markets are expected to continue to grow over time, which means more interconnection applications for utilities to process (Figure 1).

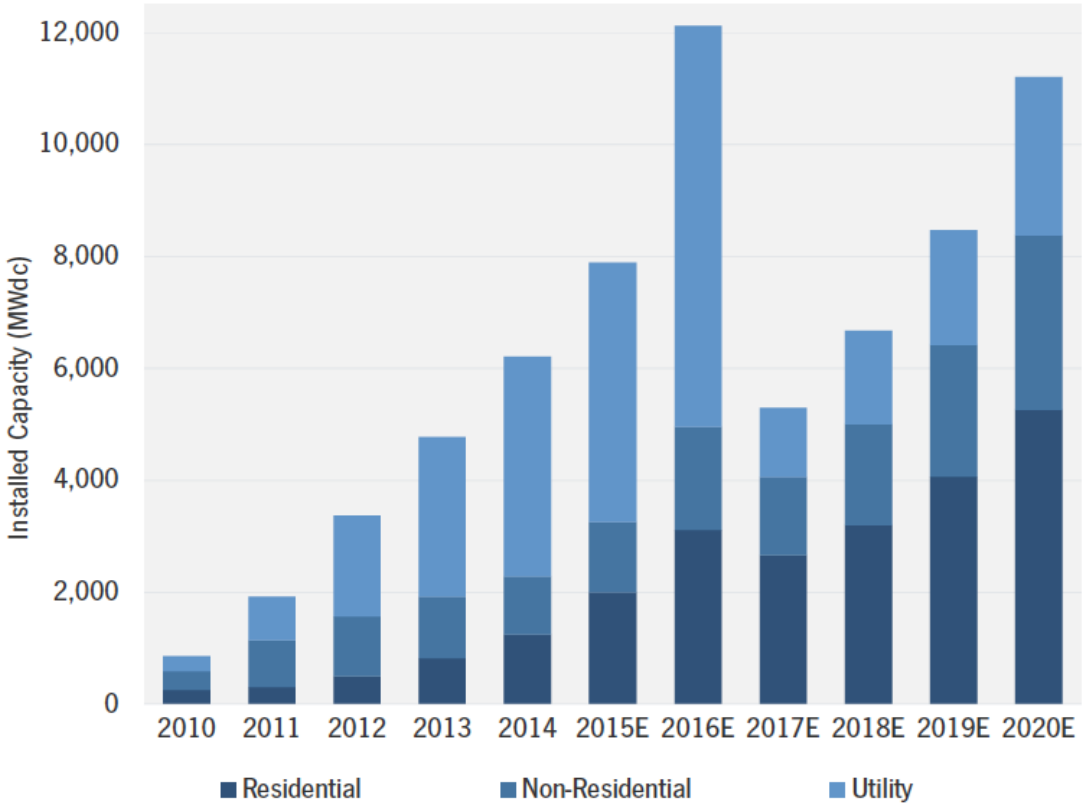

Figure 1. U.S. PV Installation Forecast, 2010-2020.[7]

As a result of this growth, in some locations, grid reliability is increasingly concerning to utilities. As PV penetration expands, utilities may exercise more caution when considering new interconnection applications. Not surprisingly, some PV proponents believe that utilities are overly cautious in some cases. These types of fundamental disagreements, bolstered by reports of increasing delays in the interconnection process (particularly with respect to PTO waiting periods) and increasing numbers of application rejections due to grid reliability concerns, led us to conduct a survey of installers to quantify the problem.

Although improvements can be made to multiple aspects of the interconnection process, our analysis focuses on PTO timelines, meaning the period of time that it takes a utility to grant permission to energize the PV system after it is installed and all final paperwork is submitted. Making the PTO process more efficient is especially important to third-party owners of systems

[6] Solar Energy Industries Association. U.S. Installs 6.2 GW of Solar PV in 2014, Up 30% Over 2013. March 10, 2015. http://www.seia.org/news/us-installs-62-gw-solar-pv-2014-30-over-2013

[7] GTM Research and Solar Energy Industries Association. U.S. Solar Market Insight Report. Q1 2015. Executive Summary. http://www.seia.org/research-resources/solar-market-insight-report-2015-q1

because contracts are typically structured such that they do not receive payment from the customer until the system is energized. Unfortunately, this last step in the interconnection process is often overlooked even when regulators and stakeholders undergo efforts to improve utility interconnection reporting and process transparency. Improvements to interconnection guidelines and reporting requirements typically focus on pre-construction interconnection steps, rather than PTO waiting periods.[8] Additionally, our analysis focuses on PV systems up to 10 kilowatts (kW), which pose lower risks in terms of grid reliability and are typically installed with relatively standardized configurations, meaning they can be shepherded through the interconnection process on an expedited timeline in most circumstances.

II. Data Collection

The research for this report is based on surveys emailed to PV installers that operate in the 50 utility service territories with the most net-metered residential PV customers based on 2013 EIA data.[9] For 2013 and 2014, installers were asked to provide the following data for each individual utility:

- The number of interconnection applications submitted
- The average PTO waiting period (i.e., the amount of time post-installation before the utility approved operation)
- The number of applications denied due to utilities' grid reliability concerns

In addition to the above data, we asked installers to describe their general impressions of utility interconnection procedures and applications. Lastly, we interviewed utility staff regarding interconnection software, methods, improvements, and best practices.

III. Survey Results

We received responses from 20 PV installers, covering 34 utility territories in 13 U.S. states and Washington, D.C. (Figure 2, Appendix A).[10] Surveyed PV installers reported a total of 30,088 applications submitted in 2013 (in 33 utility territories) and 57,482 applications submitted in 2014 (in 34 utility territories).

Data Considerations and Variability

While analyzing the responses from installers, we noted that some installers track PTO waiting periods very precisely, while others provided more general ranges or estimates. In addition, PTO

[8] National Renewable Energy Laboratory. Distributed Generation Interconnection Collaborative. "Improving Data Transparency for the Distributed PV Interconnection Process: Emergent Utility Practices and State Requirements." June 3, 2015. http://www.nrel.gov/tech_deployment/pdfs/2015-06-03_improving-data-transparency-for-distributed-pv.pdf

[9] Energy Information Administration. Electricity Data – Net metering customers and capacity by technology type, by end use sector. http://www.eia.gov/electricity/data.cfm#sales

[10] Additional responses were received, but data was excluded for a utility if fewer than 30 applications were reported through the survey.

waiting periods sometimes varied drastically within individual utility territories, even for individual installers. These issues can arise for a number of different reasons, such as changes in procedures, high DG penetration leading to grid reliability concerns, variations in permitting across local jurisdictions, or communication and transparency issues in the interconnection process. Ultimately, we included extreme outliers in reported PTO waiting periods when calculating the averages because such extremes are important for illustrating where problems may exist.

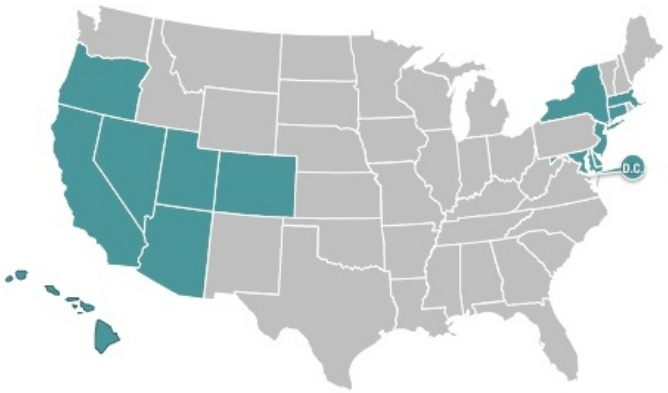

Figure 2. Geographic location of survey responses

Permission to Operate

In 2013, the average PTO waiting period ranged from two days for JCP&L (NJ) to 35 days for Delmarva (DE).[11] Individual installers reported PTO waiting periods ranging anywhere from one day for JCP&L (NJ) to 120 days for HELCO (HI). The median number of days reported was 18 days. See Figure 3 and Appendix A for the average number of days for PTO reported per utility in 2013.

In 2014, the average PTO waiting period ranged from five days for CL&P (CT) to 76 days for Pepco (MD).[12] Individual installers reported PTO waiting periods ranging from three days (BG&E - MD and PSE&G - NJ) to 129 days for MID (CA). The median number of days reported increased to 25 days, compared to 18 days in 2013. See Figure 3 and Appendix A for the average number of days reported per utility in 2014.

Installers reported that in most utility service territories, PTO waiting periods increased in 2014 compared to 2013. The average PTO waiting period per utility rose 68% in 2014 compared to 2013. Of the 33 utilities surveyed for both years, 25 utilities took more time to process PTO approval in 2014 than in 2013. Only six utilities reduced their average PTO waiting period: CL&P (CT), National Grid (MA), PG&E (CA), MECO (HI), Delmarva (DE), and HECO (HI). Two utilities' average reported PTO waiting period remained the same in both years (Figure 4).

[11] All average times described within the report are weighted based on the number of applications. All days and durations are reported in calendar days (as opposed to business days) unless otherwise specified.

[12] Connecticut Light & Power, Western Massachusetts Electric Company, and NSTAR have been rebranded as Eversource, but we refer to these utilities using their former names to avoid confusion.

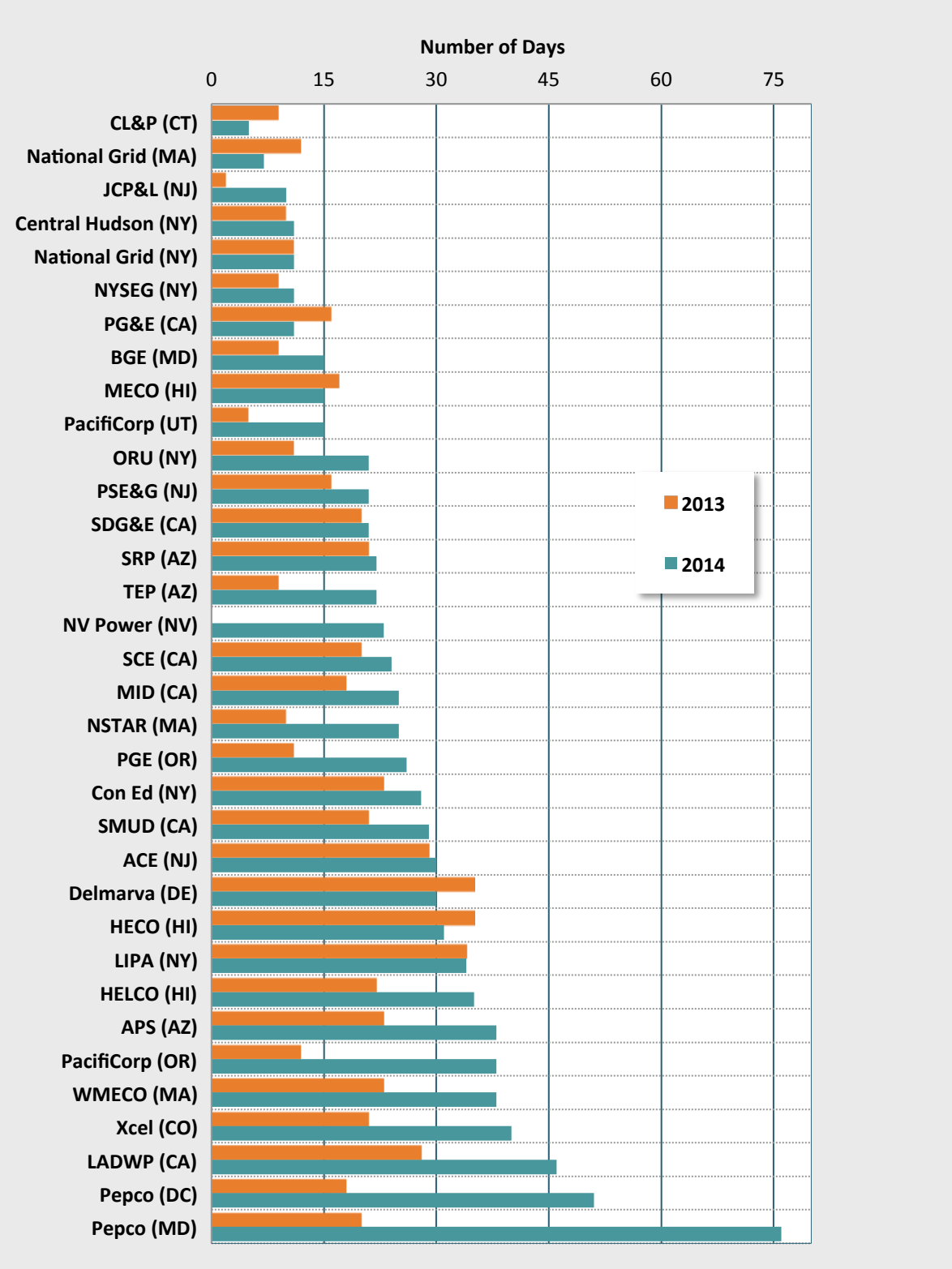

Figure 3: Average PTO waiting periods by utility, 2013 and 2014

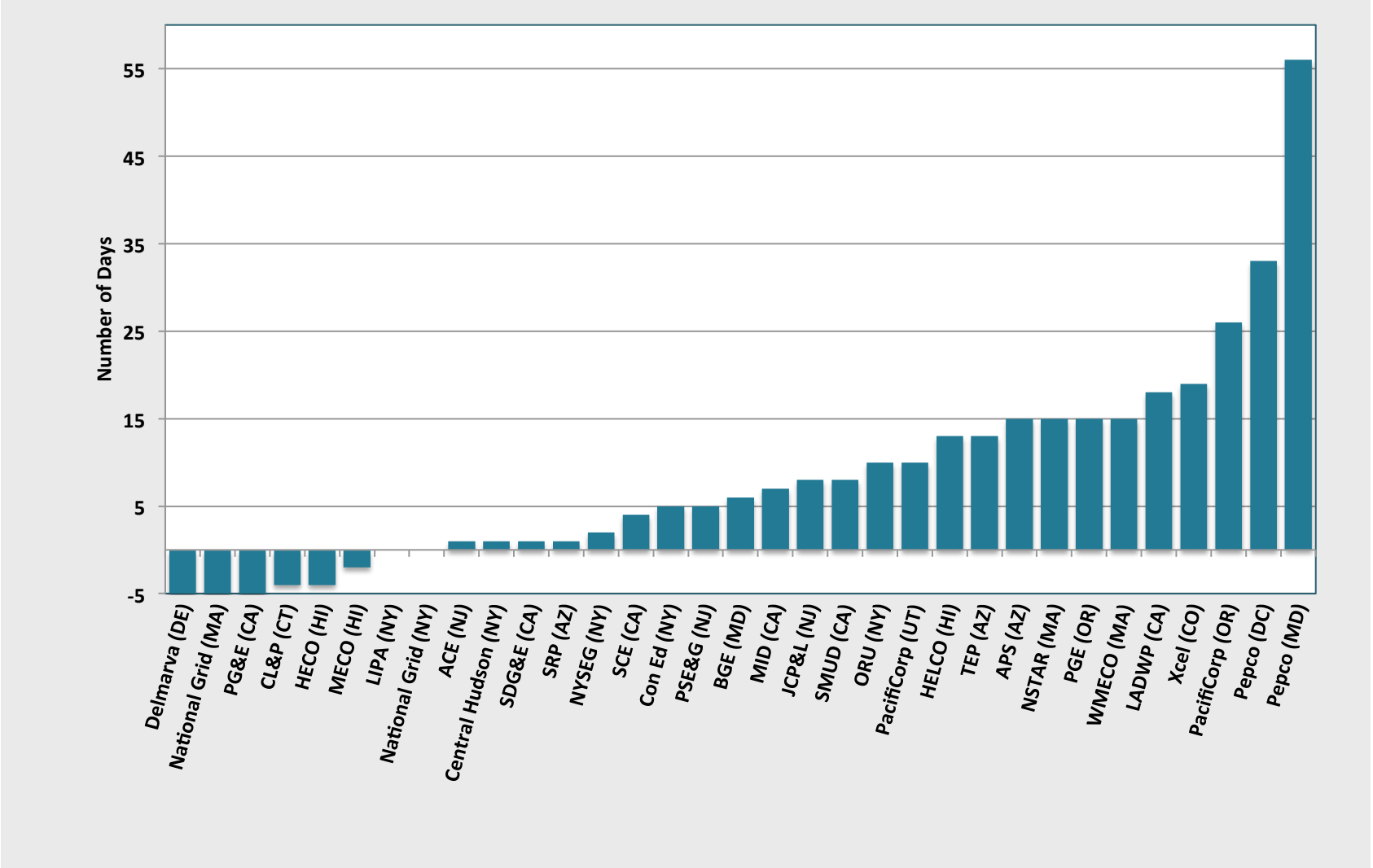

Figure 4. Difference in average PTO waiting periods from 2013 to 2014, in days

Grid Reliability Denials

In 2013, only three utilities in two states denied interconnection applications based on grid reliability concerns – Delmarva (DE), HECO (HI), and MECO (HI). That number rose to 14 utilities in seven states in 2014. Installers reported that 35.71% of applications submitted in HELCO (HI) territory in 2014 were denied due to grid reliability concerns – the most of any utility reported in 2014 (Table 1).

State	Utility	% of 2013 Applications Denied Citing Grid Reliability	% of 2014 Applications Denied Citing Grid Reliability
HI	HELCO	0.00%	35.71%
NY	Central Hudson	0.00%	5.28%
HI	HECO	1.69%	4.40%
NY	NYSEG	0.00%	2.56%
HI	MECO	5.41%	2.38%
NJ	ACE	0.00%	0.81%
DE	Delmarva	1.12%	0.72%
NJ	PSE&G	0.00%	0.66%
NY	ORU	0.00%	0.46%
NY	National Grid	0.00%	0.35%
MA	National Grid	0.00%	0.31%
MD	Pepco	0.00%	0.15%
MD	BGE	0.00%	0.09%
CO	Xcel	0.00%	0.07%

Table 1. Applications denied due to grid reliability concerns.

IV. Discussion

The survey data and interviews revealed several consistent issues and areas for improvements in the interconnection process. Customers, installers, and utilities all experience problems with interconnection applications, and some installers would prefer to have pre- and post-construction paperwork consolidated. Several state regulations do not set PTO deadlines, and those that do may not be enforced consistently or may allow the utility too much leeway. As utilities gain additional experience with DG interconnection and technology advancement continues, regulators may need to reevaluate existing deadlines. General communication and transparency issues also lead to delays, as can a lack of coordination or communication with local jurisdictions. Lastly, increased grid penetration is causing delays and disputes in a growing number of utility service territories. Several utilities including National Grid (MA), SDG&E (CA), and PG&E (CA) have developed systems that address many of these problems and can serve as models for improving other utilities' interconnection processes.

Applications

While the survey focused on PTO waiting periods, conversations with installers and utility staff revealed a number of issues with the application process that can cause problems further along in the interconnection process. Most utilities' interconnection applications and agreements must be filled out manually by the customer and/or installer and mailed, emailed, or faxed to the utility. This method of collecting information can cause delays and errors in a number of different ways. Forms can be lost; handwriting may be illegible; and errors may occur when utility staff enter information into the utility's data system. In addition, installers report that forms can often be confusing or unnecessarily long. PV installers in PSE&G (NJ) territory reported that some applications were rejected because the installer had used an old, out-of-date application form. HECO has reportedly required wet signatures on various forms, which complicates and delays the submission of applications and agreements.[13]

Efficient, user-friendly online application systems could eliminate these and other problems that can arise with conventional interconnection paperwork. SDG&E and PG&E in California both utilize software that allows customers or installers to fill out and submit online applications that interface with utilities' internal data systems. This change saves time since utility employees are no longer entering information from a paper form into their database, and reduces the risk of human error. PG&E estimates that its error rate with applications will plummet to 5% by July 2015 – down from rates of 30% to 40% prior to the implementation of the online application system. Furthermore, both utilities' applications have been simplified. SDG&E reports that an application can now be completed in less than three minutes. PG&E has systematically eliminated redundancies in its required forms, making sure it does not ask for the same information twice. All of these improvements greatly increase the success rate of application processing. SDG&E reportedly processes approximately 100 applications daily, while PG&E is processing approximately 5,000 monthly.[14]

Of course, an online system is not a guaranteed solution to all of a utility's interconnection troubles. Installers in SCE (CA) service territory have reported that there seem to be "bugs" with the new online application system resulting in drastically variable PTO waiting periods and lost data.[15] Ironing out these bugs requires both time and commitment: SDG&E is using the 14th version of its application system since the original launch in February 2013. Furthermore, several utilities manage their manual application systems without noticeable issues. National Grid (MA) and JCP&L (NJ) rank second and third in terms of fastest PTO waiting periods in 2014, and both use manual application processes. National Grid (MA) uses a dedicated software program to manage and track the progression of individual interconnection projects, and it has streamlined the internal review process by making changes to staff workflow. National Grid (MA) staff also indicated that its system for processing interconnection applications has yielded cost savings and ensures that it will not be fined for missing established deadlines. Even so, National Grid (MA) is still working to improve its

[13] From communication with surveyed installers.
[14] From personal communication with utility staff.
[15] From communication with surveyed installers.

process, which could include the creation of an online application system in order to reduce the time spent on manual data entry.[16]

An online application software program may be cost prohibitive for some utilities, but where DG penetration is high or growing quickly, such a tool could help utilities cut costs significantly over a relatively short amount of time. For example, SDG&E staff report that its online application system paid for itself in one year.[17] Recognizing the factors in play, and how they may vary among individual utilities, the issue is not so much what type of system is employed (i.e., manual or automated), but what level of effort is devoted to improving aspects of the system that is in place. Streamlining this process will likely yield both cost savings and a better customer experience.

Consolidating Pre- and Post-Construction Approval

Most interconnection procedures require installers to submit a pre-construction application before beginning construction. However, California's investor-owned utilities allow customers with certain types of systems to submit all paperwork at once (after system construction) and can process interconnection applications without a pre-construction approval requirement.[18,19] This option has allowed installers to begin construction without waiting for utility pre-approval, significantly expediting the installation process. The utilities (SCE, PG&E, and SDG&E) provide interactive maps that allow installers to determine available generation capacity for different substations and feeders. Using these maps, installers can begin basic construction armed with the knowledge that the system will not be denied due to safety or reliability concerns. Installers still have the option of requesting a pre-application report, which the utilities generally advise taking advantage of.

Several states are moving in the opposite direction, despite having lower PV penetration than California. For example, in May 2015, Maryland enacted legislation that requires solar contractors to wait for approval of an interconnection request before beginning installation.[20] If the application is denied, the installer must refund any payments made by the customer. Maryland's law is the result of customer complaints that systems were denied interconnection post construction due to "line or wire capacity issues." The Maryland Public Service Commission testified at bill hearings that many customers had complained to the Commission about similar denials or unexpected costs due to upgrades required by the utility.[21] Virginia also enacted legislation in March 2015 requiring all net metering customers to notify their electricity supplier and receive approval from the supplier prior to installing a new facility.[22,23] A more proactive approach would be to anticipate DG growth and

[16] From personal communication with utility staff.

[17] From personal communication with utility staff.

[18] From personal communication with utility staff.

[19] Pacific Gas & Electric. Electric Generation Interconnection. Rule 21 Form 79-974 Online Application Checklist. http://www.pge.com/includes/docs/pdfs/mybusiness/customerservice/nonpgeutility/generateownpower/Rule21NonExportApplicationChecklist.pdf

[20] Maryland Chapter 161 (S.B. 353), 2015. http://mgaleg.maryland.gov/2015RS/Chapters_noln/CH_161_sb0353t.pdf

[21] Maryland Chapter 161 (S.B. 353), 2015. Senate Finance Committee Hearing. February 17, 2015. http://mgaleg.maryland.gov/webmga/frmMain.aspx?pid=billpage&tab=subject3&id=SB0353&stab=01&ys=2015rs

[22] Virginia Chapter 431 (S 1395) and Chapter 432 (H 1950), 2015. http://lis.virginia.gov/cgi-bin/legp604.exe?151+ful+CHAP0431, http://lis.virginia.gov/cgi-bin/legp604.exe?151+ful+CHAP0432

[23] Customers with systems greater than 25 kW are already required by the State Corporation Commission to notify their supplier prior to installation.

integrate it into transmission and distribution planning more holistically, so that preferred locations can be communicated to the public in advance of construction.

Ultimately, pre-approval may be necessary even for small systems in areas with high DG penetration, and installers should be cognizant of the risk they place on themselves and their customers by assuming their projects will be allowed to interconnect without first verifying that assumption with the utility. The installer has a responsibility to its customers to abide by the rules in place and not introduce unreasonable expectations regarding if and when the system will be allowed to operate. For their part, utilities can allow for a pro forma approval process for standard configurations in order to expedite the application for small systems in lower penetration areas. Providing installers with access to grid penetration information and otherwise enabling streamlined interconnection procedures allows customers to connect their systems quickly and efficiently, reducing costs and improving customer satisfaction.

Regulated Deadlines

Most state-level interconnection rules and regulations set deadlines and limits on how long utilities or applicants have to respond for various steps in the interconnection process. However, among states that have established such timelines, several have yet to set a PTO time limit. Notably, of the states included in the survey, Arizona, Delaware, D.C., and Maryland utilities are not required to meet specific PTO approval timeline. Of those states that have set PTO timelines, for "fast track" or Level 1 systems, the time limit ranges from five to 30 business days, assuming no additional distribution system improvements are needed.[24] PTO timelines vary for individual utilities depending on whether the utility requests that one of its employees be present for any facility testing or inspection.

Model interconnection guidelines produced by the Interstate Renewable Energy Council, Inc. (IREC) recommend the following PTO time limits for Level 1 facilities:

> "If the proposed interconnection requires no construction of facilities by the Utility on its own system, the interconnection agreement shall be provided within three (3) Business Days, the Utility shall send the Applicant a copy of the Application form, signed by the Utility, forming the Level 1 Interconnection Agreement. If a Utility does not notify an Applicant in writing or by email within twenty (20) Business Days whether an Application is approved or denied, the Interconnection Agreement signed by the Application as part of the Level 1 Application shall be deemed effective."
> …
> "Unless extended by mutual agreement of the Parties, within six (6) months of formation of an Interconnection Agreement or six (6) months from the completion of any upgrades, whichever is later, the Applicant shall provide the Utility with at

[24] IREC defines a Level 1 system as an inverter-based generating facility that has a generating capacity of 25 kW or less. Utilities do not necessarily categorize their applications following this definition, but systems considered in this survey would eligible under each utility's Level 1 interconnection track, or most simplified track.

least ten (10) Business Days notice of the anticipated start date of the Generating Facility.

"A Utility may conduct an inspection within ten (10) Business Days of receiving the notice of the anticipated start date at a time mutually agreeable to the Parties."[25]

State regulators should consider implementing these guidelines for PTO, although many utilities can approve interconnection on a shorter timeline than what IREC's model rules embrace. Utilities, regulators, and other stakeholders should work together to consider how the process could be improved to accelerate interconnection timelines and determine a PTO timeline that a utility can reasonably meet.

However, more work may be needed to enforce such regulations. Of the assessed utilities, 24 are subject to regulated PTO timelines. The average PTO waiting period reported for 2014 exceeded regulated time limits for 14 utilities.[26] These include Xcel (CO), HECO (HI), HELCO (HI), NSTAR (MA), WMECO (MA), PSE&G (NJ), ACE (NJ), Con Ed (NY), LIPA (NY), ORU (NY), NV Power (NV), PGE (OR), PacificCorp (OR), and PacifiCorp (UT). Utilities should make the improvements necessary in order to meet applicable deadlines, and regulators should work to better enforce those deadlines.

Communication and Transparency

In general, installers report greater satisfaction and faster interconnection in utility service territories where utility staff is courteous and responsive. In certain utility service territories, installers reported that utility staff was unresponsive when questions or problems arose, even if the utility had assigned a specific staff member to a project. For example, installers operating in Con Ed (NY) territory and PSE&G (NJ) reported that projects have been delayed for extended period of times due to application errors that were not communicated to the installer or customer.[27] These installers reported that it would have taken only a few minutes to fix these errors, had they been made aware of them. Installers also reported a lack of communication from Delmarva (DE) and ACE (NJ). One installer reported that a project approved for interconnection in ACE's territory had been operating for over a year but had not received any net metering bill credits, or any assistance or explanation from ACE despite continuous calls to the utility's customer support line.[28]

A contributing factor to this problem is utility staffing. Under-staffed interconnection teams can exacerbate all other issues involved with the interconnection process. For example, installers report that PacifiCorp (UT) is severely understaffed, causing worsening delays in application and PTO waiting periods. One installer reported waiting an average of 20 days for pre-construction approval in 2013, 30 days in 2014, and 45 days so far in 2015.[29] Conversely, National Grid (MA) has optimized its available staff by modifying workflow so that individuals are focused on processing a dedicated

[25] Interstate Renewable Energy Council. Model Interconnection Procedures. 2013 Edition. http://www.irecusa.org/regulatory-reform/interconnection/

[26] Assuming basic fast track or Level 1 interconnection not requiring additional distribution equipment installations or modifications.

[27] From personal communication with utility staff.

[28] From communication from surveyed installers.

[29] From communication from surveyed installers.

step of the application process for a portion of the day, rather than having one individual process an application from start to finish. Segmenting the process into an "assembly line" has allowed National Grid (MA) to process high volumes of interconnection applications daily – approximately 75 – even though it has not deployed an online application portal.[30] These changes to procedures, as well as improvements to internal tracking mechanisms, have greatly improved customer satisfaction, according to staff. Although some of the utilities with the lowest PTO waiting periods have removed employees from certain aspects of the interconnection process, fully-staffed interconnection teams with a focus on customer satisfaction are key to a smooth interconnection process. Some utilities may have concerns with and objections to the growing popularity of customer-owned DG systems, but DG customers are customers nonetheless, and utilities have an obligation to serve all customers in a satisfactory manner.

In addition to reducing application errors and complexity, online application systems can also address common communication and transparency issues that can cause costly delays. Both PG&E's and SDG&E's interconnection software systems are designed to send an email alert directly to the customer and installer if there are issues with the application, as well as every time the application status changes. Customers and installers can check the application system to find out the current status of a planned PV project. These systems reduce the amount of utility staff time needed to communicate directly with installers and customers, reducing operational cost to the utilities.[31]

Coordination with Local Jurisdictions

Typically, a utility must wait for approval from a local jurisdiction to approve necessary permits and/or an electrical configuration before providing PTO. These timelines and requirements vary by jurisdiction – even within a single utility territory – and delays at the local jurisdiction can contribute to delayed PTO. For example, currently in PG&E's territory, an engineer from the local jurisdiction must visit the project site and sign the relevant permits or approvals. The installer then takes the forms, loads them onto a computer, and submits the form electronically to the utility. PG&E staff then must check the forms to ensure they are signed and that all forms reference the correct system and site. By fall 2015, PG&E reports that it will be able to avoid most of these steps by coordinating with local jurisdictions to allow the utility's software to be accessed directly by the local jurisdiction's software. Using this arrangement, the local engineer can sign off on the permit online, and the utility's database is notified immediately. By implementing this process, PG&E will be able to grant PTO the same day that the permit is approved by the local jurisdiction.[32] In addition to improvements made by the utility, cities and counties can work to improve their own policies and procedures to expedite DG permitting and inspections to further encourage DG development in their jurisdictions.

Preparing for Increased DG Penetration

Especially where PV penetration is relatively high, interconnection rejections based on grid reliability and safety concerns will continue to rise. Installers should, when possible, track the

[30] From personal communication with utility staff.
[31] From personal communication with utility staff.
[32] From personal communication with utility staff.

specific locations within a utility's territory where interconnection is becoming problematic, and utilities should communicate areas of concerns directly to installers.

Hawaii's utilities (specifically HELCO, HECO, and MECO) are on the front line of this issue, as they now have some of the highest DG penetration rates in the United States. This has resulted in major delays in application review and PTO waiting periods, with installers in Hawaii reporting the following extremes:

- HELCO PTO waiting periods of up to 120 days in 2013 and up to 90 days in 2014;
- HECO PTO waiting periods of up to 35 days in 2013 and up to 31 days in 2014;
- MECO PTO waiting periods of up to 21 days in 2013 and up to 79 days in 2014.

The three utilities' processes are reportedly improving, but the Hawaii Public Utilities Commission is currently considering proposals for solutions to existing interconnection issues, addressing the backlog of pending interconnection requests, and future improvements to the interconnection process.[33]

PG&E and SDG&E have addressed this issue by integrating into their application systems a process to check for potential grid reliability and safety issues, saving both time and money by avoiding the cost of engineer labor to review potential concerns.[34] National Grid (MA) checks for potential problems when applications are submitted, using its software to generate reports to compare proposed systems to where all existing and approved systems are located on the distribution grid, and providing applicants an early warning of any potential safety and reliability concerns.[35]

Installers should be aware of the increasing risk of interconnection rejections based on grid reliability, and they should take advantage of pre-construction reports (where available) to ensure projects are not rejected after significant financial commitments have been made. Regulators and/or utilities in high DG penetration areas should consider offering pre-application or pre-construction reports to avoid issues that could arise further along in the interconnection process. In addition, utilities or regulators should consider providing installers with access to maps or information on DG penetration levels so that installers are aware of potential problem areas in advance.

V. Recommendations

Policymakers, regulators, utilities, installers, and customers can work together to make improvements to the interconnection process that will reduce PTO waiting periods, lower costs, and improve customer experiences. Based on the findings of this study, we present the following recommendations:

[33] Hawaii Public Utilities Commission. Order No. 32737, Granting Motions to Intervene, Consolidating and Incorporation Related Dockets, and Establishing Statement of Issues and Procedural Schedule. Docket 2014-0192. March 31, 2015. http://dms.puc.hawaii.gov/dms/DocumentViewer?pid=A1001001A15D01A84805H58433

[34] From personal communication with utility staff.

[35] From personal communication with utility staff.

- Regulators should set firm deadlines for utilities to grant PTO after all paperwork and inspections are completed, and should consider decreasing those timelines when possible.
- Regulators should incorporate a strategy for accommodating increasing interconnection applications as part of larger transmission and grid optimization planning processes.
- Utilities should make grid penetration maps or data available to installers so that installers are aware of potential problem areas in advance.
- Utilities and regulators should work to streamline interconnection applications and PTO where possible, keeping in mind the potential for cost-savings and improved customer satisfaction.
- Installers should systematically track utility response times in order to provide solar industry stakeholders, utilities, and regulators with clear examples of problems in the interconnection process, ultimately to inform policymaking.
- Policymakers and local jurisdictions should implement policies and procedures to expedite permitting and inspections for PV systems, while utilities and local jurisdictions should coordinate to streamline permitting and interconnection.
- Utilities should consider online, automated application systems to simplify application and approval processes.
- Automatic screening for grid reliability and penetration issues should be built into utilities' online application systems, and pre-application studies should be made available to customers, especially in high-penetration areas.
- Utilities that do not implement online systems should improve their systems to facilitate better communication between customers, installers, and utility staff.
- Utilities should work to improve communication and transparency in the interconnection process, prioritizing customer satisfaction.

VI. Conclusions

As PV and DG system growth accelerates in the United States, problems with interconnection procedures have become more apparent. Delays in receiving PTO can be costly to installers and customers, reduce marketplace efficiency, and prevent states from achieving policy goals. Yet there are many opportunities to improve the interconnection process. Streamlining and improving interconnection procedures will require policymakers, regulators, utilities, installers, and customers to coordinate to identify problems and solutions. Utilities such as National Grid (MA), PG&E, and SDG&E have demonstrated that striving to continually improve the process can be beneficial to all parties. Such improvements can result in cost savings for utilities, customers, and installers, and will be key in achieving the nation's full clean energy potential.

Appendix A

2013 and 2014 Average PTO Times, Number of Applications, and Time Limits on PTO Approval Required by State Rules, Sorted by Fasted PTO Time in 2014. PTO Maximum per state rules assumes basic fast track or Level 1 interconnection not requiring additional distribution equipment installations or modifications.

State	Utility	2013 Total Applications Submitted	2014 Total Applications Submitted	2013 Average # of Days PTO	2014 Average # of Days PTO	% Change in 2013 and 2014 Average PTO	PTO Max per State Rules (in Business Days)
CT	CL&P	162	1022	9	5	-44%	10 BDs
MA	National Grid	295	1605	12	7	-42%	5-15 BDs
NJ	JCP&L	208	294	2	10	400%	5-20 BDs
NY	NYSEG	38	78	9	11	22%	5-20 BDs
NY	Central Hudson	131	436	10	11	10%	5-20 BDs
NY	National Grid	185	852	11	11	0%	5-20 BDs
CA	PG&E	8193	16150	16	11	-31%	30 BDs
UT	PacifiCorp	50	70	5	15	200%	10 BDs
MD	BGE	418	1089	9	15	67%	N/A
HI	MECO	111	126	17	15	-12%	15 BDs
NY	ORU	70	219	11	21	91%	5-20 BDs
NJ	PSE&G	383	602	16	21	31%	5-20 BDs
CA	SDG&E	2254	4774	20	21	5%	30 BDs
AZ	TEP	490	1446	9	22	144%	N/A
AZ	SRP	1308	3312	21	22	5%	N/A
NV	NV Power	0	754	N/A	23	N/A	10 BDs
CA	SCE	4968	7978	20	24	20%	30 BDs
MA	NSTAR	236	402	10	25	150%	5-15 BDs
CA	MID	97	384	18	25	39%	N/A
OR	PGE	553	717	11	26	136%	25 BDs
NY	Con Ed	120	291	23	28	22%	5-20 BDs
CA	SMUD	891	993	21	29	38%	N/A

State	Utility	2013 Total Applications Submitted	2014 Total Applications Submitted	2013 Average # of Days PTO	2014 Average # of Days PTO	% Change in 2013 and 2014 Average PTO	PTO Max per State Rules (in Business Days)
NJ	ACE	323	615	29	30	3%	5-20 BDs
DE	Delmarva	89	279	35	30	-14%	N/A
HI	HECO	591	954	35	31	-11%	15 BDs
NY	LIPA	237	1195	34	34	0%	5-20 BDs
HI	HELCO	32	196	22	35	59%	15 BDs
OR	PacifiCorp	160	97	12	38	217%	25 BDs, or N/A
AZ	APS	3058	4080	23	38	65%	N/A
MA	WMECO	33	68	23	38	65%	5-15 BDs
CO	Xcel	2215	4082	21	40	90%	5-15 BDs
CA	LADWP	1817	1636	28	46	64%	N/A
DC	Pepco	110	40	18	51	183%	N/A
MD	Pepco	262	646	20	76	280%	N/A