Transitioning the California Energy Commission Eligible Equipment List to a National Platform

Options and Potential Funding Models

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Technical Report
NREL/TP-7A40-68115
October 2013

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Prepared under Task No. ST6B.1621

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1.0 Introduction

The California Energy Commission (Energy Commission), as mandated in California Senate Bill 1 (SB1), maintains a list of photovoltaic (PV) equipment (i.e., modules, inverters, and meters) that are eligible for California's solar electric incentive programs.[1] The purpose of the Energy Commission's eligible equipment list (list) is to ensure reasonable performance and safety of equipment that is subsidized by utility ratepayer funds. The list is the most robust source of this information for PV equipment in the United States. Over the years, the list has become the *de facto* national eligible equipment list, now used by 16 states representing 70% of the U.S. solar market.[2] The maintenance of the list has been historically funded through the Renewable Resource Trust Fund (RRTF). In 2011, the California legislature did not reauthorize the electric Public Goods Charge, which stopped new monetary inflows to the RRTF and threatened to eliminate the largest PV module and inverter dataset currently available in the market. The lack of transparent information on such a large scale could create a barrier to a growing solar energy market.

The Energy Commission called on the National Renewable Energy Laboratory's (NREL)'s Solar Technical Assistance Team to explore various pathways for supporting continued evolution of the list. NREL staff utilized the Database of State Incentives for Renewables and Efficiency (DSIRE), California Solar Initiative (CSI) data, and information from in-depth interviews to better understand the impact of a lack of an updated list and suggest potential solutions. A total of 18 people from state energy offices, rebate program administrators, utilities, national testing laboratories, private companies, nonprofit organizations, and the federal government were interviewed between July and September 2013. CSI data were analyzed to illustrate the monetary benefits of the algorithm behind calculating performance of PV modules included on the list.

The primary objectives of this study are to:

1. Determine the impact of not maintaining the list
2. Explore alternatives to the State of California's maintenance of the list.

The list has provided value to the solar marketplace for well over a decade. Transitioning to a national list in a database format will promote consistency across states and provide a more equitable solution for meeting the needs of many diverse stakeholders. This paper serves as a starting point for a national discussion about the next evolution of the list. The intent is not to make a specific recommendation, but rather to quantify the pending problem and outline potential pathways forward. Further research may be needed to determine the optimal path forward. The U.S. Department of Energy (DOE) SunShot Initiative may provide additional funding in 2014 to determine the optimal path forward, socialize the potential solutions, identify funding partners, and promote the availability and benefits of a national database.

[1] http://www.energy.ca.gov/2012publications/CEC-300-2012-008/CEC-300-2012-008-ED5-CMF.pdf (pg. 11)
[2] Calculations performed in-house at NREL based upon the Interstate Renewable Energy Council (IREC) report: http://www.irecusa.org/wp-content/uploads/2013/07/Solar-Report-Final-July-2013-1.pdf

2.0 Background

The list is used to verify which equipment is eligible for ratepayer-funded incentives. Manufacturers who are interested in having their equipment be eligible for use in a State of California solar electric incentive program must obtain specific safety certifications to Underwriters Laboratories, Inc. (UL) standards from a nationally recognized testing laboratory (NRTL). In addition, the equipment must undergo electrical characterization testing from an accredited test lab (for partial IEC standards for modules and conversion efficiency for inverters). As of July 2013, the list included information on approximately 15,000 models of modules and 2,000 models of inverters.

Between 2006 and 2013, the Energy Commission used ratepayer funds to support administration of the list, but it no longer has the funding to do so. In May of 2013, the Energy Commission brought administration of the list in-house while it sought additional funding. In July 2013, the Energy Commission issued a solicitation for an administrator for a period of three years, subject to annual funding. The Energy Commission has secured funding for the first year of the project, but future funding is uncertain.

The list comprises the most comprehensive collection of information on PV equipment that meets U.S. safety standards (Underwriters Laboratory 1703 and 1741) and has undergone a one-time performance test to parts of the International Electrotechnical Commission (IEC) 61215 (crystalline silicon) and 61646 (thin film) tests. The many ways that the list is used by multiple stakeholders is discussed in Section 3 of this study. The loss of this data will create a void in the marketplace for the solar industry, for states, and for consumers.

2.1 PV Eligible Equipment Requirements

The National Electrical Code (NEC) is the benchmark for safe electrical design, installation, and inspection to protect people and property from electrical hazards. The NEC, which has been adopted by all 50 states, applies to almost all PV installations on public and private premises throughout the country (federal government and utility owned and operated systems are exempted). The NEC states that PV modules and inverters must be certified by an NRTL to UL 1703 (for PV modules) and 1741 (for inverters). These safety standards require the materials used and the construction of the product to meet U.S. standards under normal and abnormal conditions.

In addition to UL 1703 and UL 1741, the Energy Commission has required that PV equipment be tested to parts of IEC 61215 (crystalline silicon) and 61646 (thin film) and that meters meet certain performance requirements.[3] These IEC certifications require a one-time performance test on a small sample of PV equipment (1 module, 5 inverters). IEC standards set minimum design criteria; those criteria do not indicate module reliability, nor do they account for climate variation across geographic regions or quality assurance within the manufacturing process.

[3] http://www.energy.ca.gov/2012publications/CEC-300-2012-008/CEC-300-2012-008-ED5-CMF.pdf (pg. 11-13)

2.2 Potential Evolution of PV Eligible Equipment Requirements

Because the standards writing, publishing, and adoption process is long, it could take many years to establish manufacturing quality assurance standards. Quality management systems typically follow International Standards Organization (ISO) standards. The applicable ISO standard, ISO 9001-2008, is a general program for all manufacturers that does not account for the technical nuances of the PV industry. The international community is addressing PV module quality through the PV Module Quality Assurance Task Force (PV QA Task Force). The task force has two stated goals:

1. Develop a quality assurance rating system that is useful for evaluating module durability across a variety of climate conditions
2. Create a guideline for factory inspections of the quality assurance system used during manufacturing.[4]

In 2013, the task force proposed supplemental requirements to the international manufacturing standard (ISO 9001-2008) that would specifically address PV modules.[5] A draft version of the supplemental requirements has been published on NREL's website at http://www.nrel.gov/docs/fy13osti/58940.pdf. The Energy Commission is considering identifying equipment that voluntarily adheres to the draft version of the manufacturing quality assurance standards. This voluntary requirement provides a means of differentiation and recognition for companies and products. However, making the requirements partially mandatory and partially voluntary could cause confusion among manufacturers and create implementation challenges for NRTLs.[6]

Experts in the field consider the current requirements threshold to be low because the Energy Commission does not require ongoing performance testing or quality assurance standards in the manufacturing process. The Energy Commission is revising its requirements and considering including full testing to IEC tests 61215, 61646, or 62108 or to the U.S.-published versions of these IEC standards (UL 21215 and UL 61646).

3.0 Stakeholder Use of the Energy Commission Eligible Equipment List

A diverse set of stakeholders use the list in many different applications. These data are used by:

- States to ensure the judicious use of ratepayer- or taxpayer-supported incentive programs
- Rebate program administrators and public utility commissions to forecast funding requirements for incentive programs

[4] http://www.nrel.gov/ce/ipvmqa_task_force/index.cfm
[5] Full report available at http://www.nrel.gov/docs/fy13osti/58940.pdf
[6] Discussion with Underwriters Laboratories, Inc staff. November 4, 2013.

- The modeling community to accurately forecast PV performance and cash flows
- Project developers, building engineers, facilities managers, and researchers who utilize PV performance models.

3.1 States

Nationwide, 38 states and the District of Columbia have PV incentive programs, according to the Database of State Incentives for Renewables and Efficiency (DSIRE).[7] Of those, 34 have an equipment eligibility requirement for either safety, performance, or both reasons. Of the 34 states with eligibility requirements, 16 states have programs that directly refer to the list for their requirements.[8] Fifteen states have equipment requirements, but do not point to the Energy Commission list, and three are silent on the matter. Figure 1 shows which states have incentive programs that require some type of equipment eligibility testing, and which states rely upon the CEC list. In locations with multiple incentive program administrators (such as Minnesota), a utility may rely upon the Energy Commission list even if the state does not, indicating that there could be more programs utilizing the list than identified through this study.

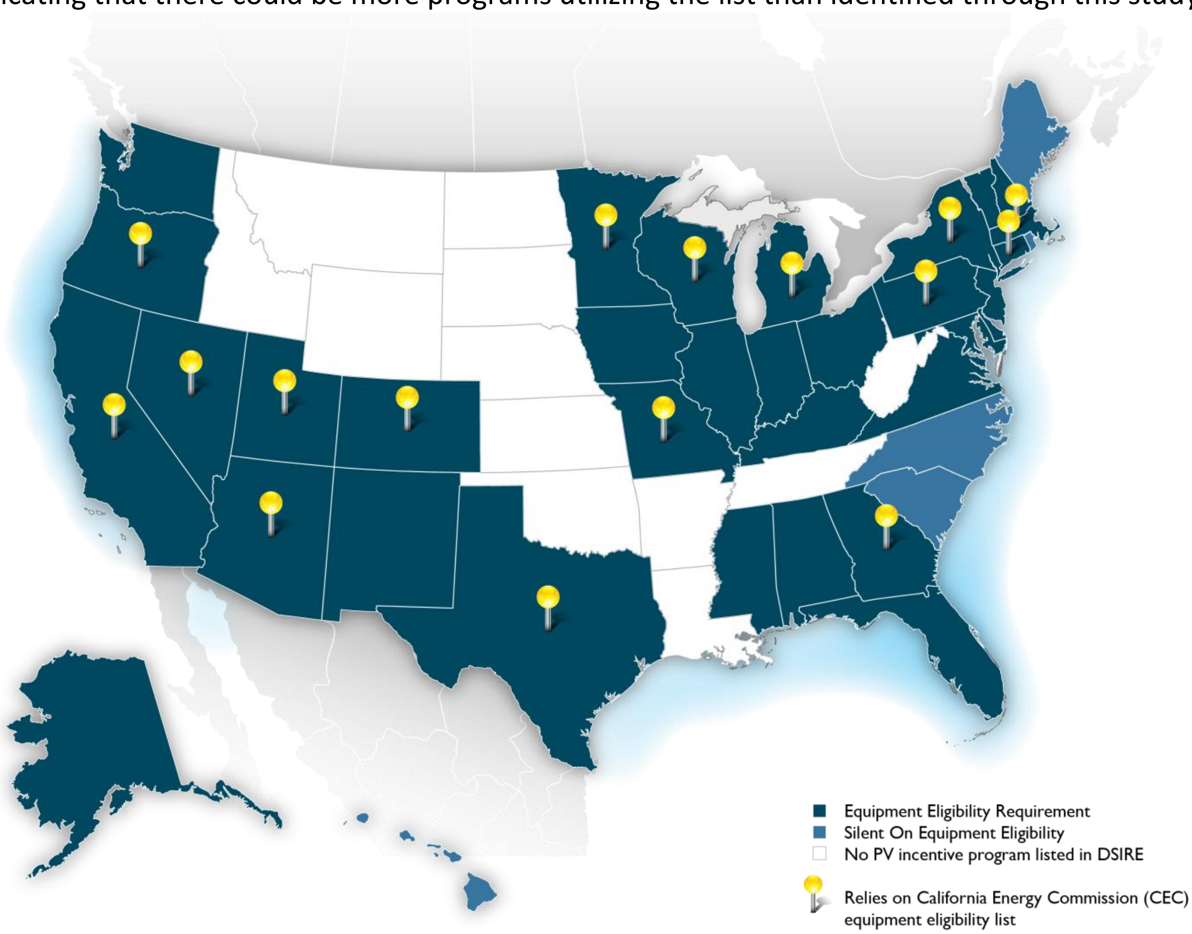

Figure 1: Eligible equipment requirements by state

[7] http://dsireusa.org/
[8] DSIRE web site and Clean Power Research (CPR) interview

States use the Energy Commission list in a variety of ways. Incentive program administrators use the performance data to calculate upfront incentives for PV systems. Programs with performance-based incentives (PBIs) use the performance data to forecast future costs to the incentive program. By employing the eligible equipment performance forecasts, solar incentive programs are able to more accurately forecast the budget for the performance-based incentive and more accurately calculate expected performance for systems receiving upfront incentive payments.

States may also rely upon the Energy Commission list to determine which equipment is eligible for tax credits. Twelve of the twenty states that have a state income tax credit for solar PV projects have some form of equipment requirement. Many of these states have vague requirements like the use of new equipment; however, seven states require equipment listed to UL standards or compliance with federal and state safety requirements. Of those seven, three rely on the Energy Commission list in their PV incentive programs.

Utah is the only state that uses the Energy Commission list to determine which equipment is eligible for the Utah State Renewable Energy System Tax Credit.[9] According to the Utah Administrative Code, "The costs of solar PV modules are eligible for Utah tax credits only if they are listed as eligible modules under the California Solar Initiative Program." [10] Table 1 shows the states with eligible equipment language in their state income tax codes.

Table 1: Equipment Requirements for Solar State Income Tax Credits

State	Program Name	Equipment Requirements
Arizona	Residential Solar and Wind Energy Systems Tax Credit	PV should meet all applicable NEC requirements, UL 1703 requirements, JPL Block V, Energy Commission Specification 503, IEC 904-3, IEC 1215, and meet USHUD approval, RVIA approval.
Hawaii	Solar and Wind Energy Credit (Corporate)	Equipment must be new. Additions to existing systems and new systems for second homes qualify for this credit. However, repairs to existing systems do not qualify.
Hawaii	Solar and Wind Energy Credit (Personal)	Equipment must be new. Additions to existing systems and new systems for second homes qualify for this credit. However, repairs to existing systems do not qualify.
Kentucky	Renewable Energy Tax Credit (Corporate)	PV panels and inverters must meet article 690 of the NEC and be UL-certified.
Kentucky	Renewable Energy Tax Credit (Personal)	PV panels and inverters must meet article 690 of the NEC and be UL-certified.
Louisiana	Tax Credit for Solar Energy Systems on Residential Property (Corporate)	Must be tested and certified by a Federal Occupational Safety and Health Administration (OSHA) nationally recognized testing laboratory.
Louisiana	Tax Credit for Solar Energy Systems on Residential Property (Personal)	Must be tested and certified by a Federal Occupational Safety and Health Administration (OSHA) nationally recognized testing laboratory.

[9] http://www.energy.utah.gov/renewable_energy/renewable_incentives.htm#retaxcred
[10] http://www.rules.utah.gov/publicat/code/r362/r362-002.htm#T7

Massachusetts	Residential Renewable Energy Income Tax Credit	Equipment must be new and must be reasonably expected to remain in operation for at least 5 years.
Montana	Alternative Energy Investment Tax Credit (Corporate)	System must be new and in compliance with all applicable performance and safety standards.
Montana	Alternative Energy Investment Tax Credit (Personal)	System must be new and in compliance with all applicable performance and safety standards.
New Mexico	Solar Market Development Tax Credit	Systems must demonstrate compliance with applicable federal, state, local, and utility laws and regulations. Tax credit may not be applied to commercial or industrial system other than an agricultural system that is not grid-connected.
New York	Residential Solar Tax Credit	Equipment must be new.
North Carolina	Renewable Energy Tax Credit (Corporate)	Equipment must be new. Recommend that grid-connected systems meet IEEE Std. 929-2000.
North Carolina	Renewable Energy Tax Credit (Personal)	Equipment must be new. Recommend that grid-connected systems meet IEEE Std. 929-2000.
North Dakota	Renewable Energy Tax Credit	Equipment must be new.
Oregon	Residential Energy Tax Credit	Systems must be composed of new UL listed equipment.
Utah	Renewable Energy Systems Tax Credit (Corporate)	Equipment must be new and listed on the California Solar Initiative Program's list of eligible equipment or meet equivalent standards.
Utah	Renewable Energy Systems Tax Credit (Personal)	Equipment must be new and listed on the California Solar Initiative Program's list of eligible equipment or meet equivalent standards.

Source: DSIRE USA http://dsireusa.org/solar/comparisontables/

Assessing each state's use of the list as it pertains to permitting or local government use was not possible given the time and budget available for this study.

3.2 Utilities

Many utilities throughout the United States have adopted interconnection standards for distributed generation. These standards control the interconnection of generators to the utility distribution system. Utility customers must get approval for interconnection from the utility prior to tying into the grid.

Pacific Gas and Electric (PG&E) allows for an expedited interconnection process by using the list to qualify inverters that an NRTL has tested for compliance with the UL 1741 standard. According to PG&E, an interconnection review can proceed as a "fast track" project if the inverter specified is included on the list.[11] If the inverter is not on the Energy Commission list, PG&E may require a more in-depth review from an engineer before proceeding with the interconnection process. Such in-depth interconnection studies can increase the cost and uncertainty associated with PV installations and can result in a delay or cancellation of projects.

[11] Interview with Robert Chan from PG&E, October 10th, 2013

3.3 Building Designers, Engineers, and Facilities/Energy Managers

Commercial building engineers and designers are frequently approached with energy efficiency and renewable energy products. In many cases, engineers and designers cannot verify performance claims made by the manufacturer or installer, so they take no action on making efficiency or renewable upgrades. This barrier also exists for electric utilities, which often commit extensive resources to quantify technology performance as part of the process to validate incentive program rebates. The list provides a means for verifying performance (at least performance at one point in time) various technologies.

3.4 Solar Industry

The solar industry depends on accurate PV performance models to forecast the economic and energy output of a PV system. This information is critical for obtaining project funding and selling PV systems to consumers. Many PV developers use federally funded and commercially available PV performance models, such as the System Advisor Model and PowerClerk. These models rely on performance coefficients as the foundation for the list performance data. The Energy Commission makes this underlying data freely available to modelers on a monthly basis in a single location. Modelers can automatically pull this performance data into PV performance algorithms that are embedded in widely used software packages, which allows for consistency and cost savings.

NREL's System Advisor Model (SAM) is a performance and financial model designed to facilitate decision-making for people involved in the renewable energy industry. The model's main users are project developers, technology developers, policy analysts, and researchers. SAM's user interface makes it possible for people with no experience in developing computer models to build a model of a renewable energy project, and to make cost and performance projections based on model results. SAM includes several libraries of performance data and coefficients that describe the characteristics of system components, such as PV modules and inverters, parabolic trough receivers and collectors, wind turbines, and biopower combustion systems. After the user chooses the specified equipment from a dropdown list, SAM applies values from the library to the input variables. SAM incorporates performance coefficients contained in the Energy Commission dataset (underlying the eligible equipment list) into its modeling software to model PV module and inverter performance. Figure 2 shows a screenshot of SAM's electricity generation and cash flow models for a PV system.

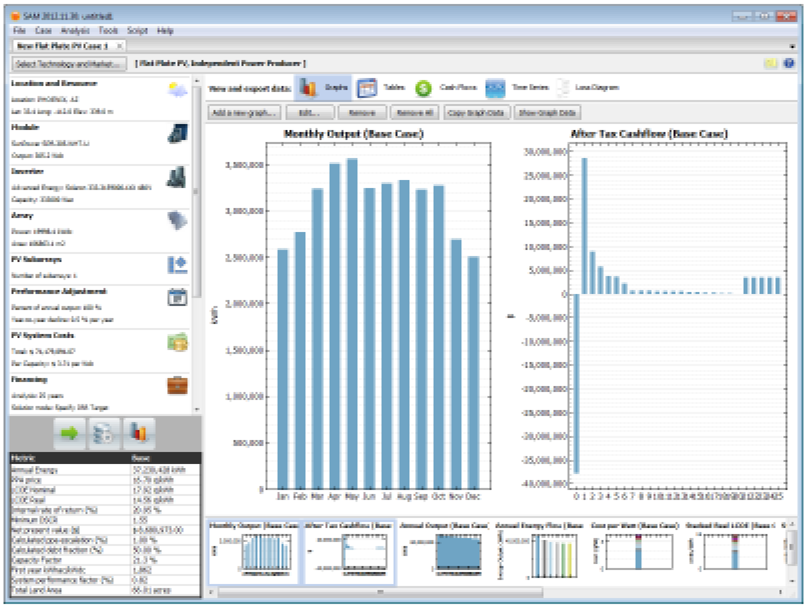

Figure 2: SAM-modeled PV system monthly electricity generation and annual cash flow

Since its introduction to the market in 2004, SAM has been downloaded more than 50,000 times. SAM's default setting includes a drop down menu of equipment choices to model. This is, by far, the easiest and most useful way for SAM users to select particular PV equipment for their analysis. In 2013, NREL began providing the SAM Simulation Core (SSC) software development kit (SDK) to software developers for creating renewable energy system models. With a user-friendly front end for desktop applications, the SDK allows software developers to create their own applications using the SSC library. As of September 2013, 600 copies of the SDK have been downloaded and several major PV installer firms are known to be using it in their workflow, including PV market leaders SunRun and SolarCity. The use of the underlying dataset of the list is essential for the continued success of SAM and the software models that incorporate the SAM engine.

The most widely used incentive program management software tool in the United States is Clean Power Research's (CPR's) PowerClerk. As of September 2013, PowerClerk was being used to manage incentive programs for energy agencies in California, Connecticut, Massachusetts, New York, Oregon, and Pennsylvania, and for utilities in Arizona, California, Georgia, Nevada, New York, and Utah.[12] These states make up approximately 70% of the solar market.[13] Similar to the way the data are used in SAM, PowerClerk includes the Energy Commission list as a dropdown menu from which users can select equipment when searching for an incentive. The software calculates the expected performance of a PV system based on the information from the Energy Commission dataset.

[12] Interview with Clean Power Research, October 2013

[13] Calculations performed in-house at NREL using the IREC report: http://www.irecusa.org/wp-content/uploads/2013/07/Solar-Report-Final-July-2013-1.pdf

According to CPR, the Energy Commission list provides a number of valuable benefits, including the following:

- The SB1 requirements and list of eligible equipment posted online are easy for participants to understand.
- The list's drop-down menu leaves little room for human error, providing a clear guide to what equipment is included in the PowerClerk software.
- The ability of PowerClerk to leverage freely available information limits the costs that are passed on to incentive program administrators for managing their programs through PowerClerk.

Discontinuing the list could create a barrier to providing accurate performance models to the solar industry at a reasonable price, which could slow the growth of the solar market. Therefore, it is important to develop a strategy for maintaining the performance and safety data that are available in the market today.

4.0 Value Analysis

As outlined in Section 3.0, different stakeholders use the information contained in or behind the list in many ways, and therefore derive value from the list in different ways. In this section, we discuss monetary and nonmonetary values identified by various stakeholders, including states, utilities, building engineers, facilities managers, and PV modelers. It is critical to understand the range of values the list provides when determining the optimal path forward for transitioning to a national platform.

4.1 Comprehensiveness

California has led the nation in terms of PV market share for years. With more than 15,000 modules and 2,000 inverters represented, the California Energy Commission's list is the most comprehensive database of PV component information available in the U.S. market today. The current alternative is a database of modules that houses information on about 500 modules and does not include the latest industry standard modules. Without a smooth transition from the Energy Commission list to a national database, the robustness of the data may be compromised.

4.2 Single, Easily-Accessible Location

A single source of information promotes uniformity in the marketplace, which helps enable industry scaling. Stakeholders benefit from having the list information freely and easily available in one online location. NREL interviewed representatives from states and utilities, in addition to modelers. The sources indicated that the online list's ability to consistently define which equipment is eligible for solar incentive payments mitigates human error associated with calculating the payments. An online location to which stakeholders can point PV buyers and suppliers reduces the administrative burden of solar incentive programs by diminishing the volume of inquiries program administrators must field.

The accessibility of the underlying dataset is extremely valuable to PV modelers. Without this option, modelers would need to compile information from thousands of manufactures on an ongoing basis. This would dramatically increase their costs and compromise the quality of the PV modeling products available on the market today. The result would be increased costs to companies and states that use tools like PowerClerk, as well as increased costs to the federal government for maintaining SAM.

4.3 Ability to Update Requirements as the Market Evolves

Current Energy Commission eligible equipment requirements do not include full testing to IEC tests 61215, 61646, or 62108; ongoing performance testing; or manufacturing quality assurance testing. Therefore, the threshold for inclusion on the list is low. If the Energy Commission requirements are updated to include more rigorous provisions, stakeholders may gain more value from the list. Of course, more rigorous testing may increase the cost of doing business for equipment manufacturers, which could impact average selling prices of PV equipment.

Interviewees indicated that adding new equipment categories as the industry evolves and removing obsolete or no-longer-certified equipment are extremely important. Providing a structure that incorporates a technical component for reviewing requirements on a regular basis is an important consideration for transitioning to a national platform.

4.4 Underlying Assumptions in Calculations

The underlying assumptions in the prescribed formula included in the Energy Commission's calculations have had a monetary impact on the State of California's solar incentive payments. The monetary benefits analyzed here include only savings associated with the main CSI program and do not include data from the New Solar Homes Partnership or publicly owned utility programs. A data set of CSI incentive applications was acquired from the Go Solar California website in September 2013.[14] The data contain information on individual incentive applications, including nameplate capacity rating, PV for Utility-Scale Applications Test Conditions (PTC) rating, detailed incentive design, solar contractor, module/inverter models, and various other details.

For this analysis, only those observations that have a current application status of “completed”[15] were considered. This group includes 115,006 individual incentive applications,[16] which account for approximately 751 MW of nameplate capacity and $739 million of incentives.

The incentive structure for the Expected Performance Based Buydown (EPBB)[17] of each application was applied to its nameplate rating and then its PTC rating. The difference between

[14] http://www.californiasolarstatistics.ca.gov/current_data_files/ Current data set was last updated Sept. 19, 2013.
[15] As opposed to canceled, suspended, withdrawn, pending payment, in review, wait list, etc.
[16] Fewer than 200 observations were removed because of missing data.
[17] The EPBB incentive methodology pays an up-front incentive to participants installing systems less than 30 kW in size. The methodology is based on a system’s expected future performance. EPBB incentives combine the performance benefits of PBI with the administrative simplicity of a one-time incentive paid at the time of project installation. The EPBB Incentive will be calculated by multiplying the incentive rate by the system rating by the

these measures is the amount that would have been added to the incentive if the CSI program administrator based them on nameplate capacity, assuming that incentive design would stay the same.

4.4.1. Utility-Scale Applications Test Conditions vs. Standard Test Conditions

The State of California has been paying incentives based on the PTC and single point inverter efficiency since the mid-1990s. The PTC rating is generally recognized as a more realistic measure of PV output because the test conditions better reflect "real-world" solar and climatic conditions, compared to the STC rating.[18] The Energy Commission's use of PTC rather than manufacturer-reported Standard Test Conditions (STC) when calculating module performance resulted in significant monetary savings. Actual PV output could be higher or lower depending on site-specific conditions such as tilt, azimuth, soiling, shading, geographic location, mounting technique, and season.

There are several ways to summarize the results of using PTC ratings instead of STC ratings[19]:

- For every $1 spent on incentives, the program administrator would have spent $1.16, on average, if the nameplate capacity rating was used instead of the PTC rating.
- CSI paid an average of $6,003 per application (using PTC) compared to $6,981, which the initiative would have paid if nameplate capacity was used (an increase of $978 per incentive application, or $0.148 per nameplate Watt) to calculate incentive payments.[20]
- By using PTC ratings, the Energy Commission saved California ratepayers $118 million over the life of the CSI program, or 16%.

4.4.2. Inclusion of the "Design Factor" within the calculation

While the State of California has been paying incentives based on PTC ratings for more than a decade, the passage of SB 1 in 2006 included an "expected performance" calculation that introduced a "design factor" to account for specific site conditions such as tilt, azimuth, shading, and geographic location. Isolating the design factor accounts for incentive payment savings of less than 1%.

Design Factor. More information can be found at http://www.gosolarcalifornia.org/documents/CSI_HANDBOOK.PDF.

[18] PTC are 1,000 Watts per square meter solar irradiance, 20 °C air temperature, and wind speed of 1 meter per second at 10 meters above ground level. PV manufacturers use Standard Test Conditions, or STC, to rate their PV products. STC are 1,000 Watts per square meter solar irradiance, 25 °C cell temperature, air mass equal to 1.5, and ASTM G173-03 standard spectrum. http://investmentgradesolar.com/ptc1.htm, Accessed September 20, 2013.

[19] These calculations assume that individual incentive structures would stay the same if incentives were being awarded based on nameplate capacity.

[20] Note: This differs somewhat from the "official" figure found by taking the average of the incentive amounts from the original data set. This difference happened because incentive structures were applied to nameplate ratings using an algorithm that parsed the text in the "Incentive Design" field of the spreadsheet to appropriately multiply through. Because of some inconsistencies in data format among the observations, this difference led to occasional errors. Incentive structures were also applied to PTC ratings the same way, rather than using the official figure, for the purposes of comparison. These estimates are still believed to reliable.

This analysis illustrates how other states may benefit from utilizing California's experience in calculating PV performance. Providing the opportunity for states to rely on the Energy Commission's eligible equipment list may be having significant monetary impacts and cost savings for other states paying incentives based on California's methodology or directly based on list information.

5.0 Transition to a National Platform

It is critical to maintain the range of values derived from the list when moving to a national platform. To meet this objective, the following features must be maintained:

- A single, easily accessible location for the information (and the underlying dataset)
- Data comprehensiveness
- The ability to update requirements as the market evolves; and
- Sound and transparent underlying assumptions.

All of these features are included in the cost estimates below.

5.1 Estimated Costs

The cost for the Energy Commission to maintain the list is approximately $205,000 per year (including CEC staff and subcontractor time). The primary activities involved in maintaining the list include:

- Compiling data from testing laboratories on a monthly basis
- Checking data quality
- Answering questions from manufacturers, sellers, installers, and incentive program administrators
- Adding new product categories as the industry evolves
- Reviewing requirements on a periodic basis.

Because of the added time and expense, the Energy Commission does not actively monitor whether certifications are maintained or a product is continuously available in the market.

Continuing to provide performance data for PV equipment through an online database is the most effective format for facilitating information exchange between the many stakeholders relying upon this data for various uses. However, providing the data online is only part of the service that the Energy Commission currently provides to the market. The Energy Commission also funds a subcontractor to field questions from stakeholders and provide rigorous data review (approximately $40,000/year). All of these services should be taken into consideration as various funding models and platforms are explored.

The cost for additional testing required by the Energy Commission is borne by equipment manufacturers and paid directly to testing labs, and therefore is not represented in Table 2.

Table 2. Estimated Costs for a National Online Database Built from Scratch

Item	Description	Estimated Cost	Frequency
Database Infrastructure	Building a database that accommodates 20,000+ items	$500,000	One time
Infrastructure Maintenance	Perform security updates and address system glitches if needed	$20,000-$30,000	Annual
New Technology Categories/ Enhancements	Adding new technology category infrastructure to the database	$25,000-$30,000	As needed
Data Collection/Population	The cost to populate the database varies. A structure that allows stakeholders to upload data has minimal population costs.	$0-$80,000*	As needed (anticipate monthly)
Batch Upload Support	Support users in writing ruby scripts to complete batch uploads	$15,000-$20,000	Annual
Data Quality Assurance	Performing data quality checks could range from very minimal to significant costs, depending on the level of scrutiny.	$5,000-$30,000	Annual
Customer Support	Fielding inquiries from stakeholders.	$0-$40,000	Annual
Total Estimated Cost		**$500,000** **$40,000-$230,000**	**One-time** **Annual**

5.2 Leveraging Existing Infrastructure

A new platform that can be leveraged is the Technology Performance Exchange (TPE), which was funded by the DOE Federal Energy Management Program (FEMP), DOE Buildings Technology Office (BTO), and the Bonneville Power Administration (BPA). Leveraging the existing database removes the need to build the web infrastructure at an estimated cost of $500,000. The TPE, therefore, offers an inexpensive and ready means for transferring the list to a national platform.

The TPE is a centralized, Web-based portal for finding and sharing energy performance data for commercial building technologies. This exchange enables technology suppliers, third-party testing laboratories, and other entities to submit product performance data that technology evaluators can use in their assessments to inform fact-based procurement decisions. Individuals who manufacture, supply, test, or evaluate technologies can use data entry forms to upload standardized, product-specific energy performance data. The exchange also allows technology evaluators to quickly and easily identify who submitted data, when the data were submitted, and how the data were derived. Technology evaluators can leverage the raw data contained in the TPE to greatly reduce the time required to evaluate technology performance, and improve the quality of their assessments.

The TPE was built to address the need for commercial building engineers and utilities to access high-quality equipment performance data in a range of energy efficiency and renewable energy. As of October 2013, the exchange included PV module information from the Energy Commission list. Inverter information will be added to the TPE in November 2013. Table 3 shows the cost for maintaining the list information within the TPE infrastructure and providing customer service for users.

Table 3. Estimated Costs for a National Online Database if TPE is leveraged

Item	Description	Estimated Cost	Frequency
Database Infrastructure	Leverage the existing TPE database	$0	NA
Infrastructure Maintenance	Perform security updates and address system glitches if needed	$20,000-$30,000	Annual
New Technology Categories/ Enhancements	Add new technology category infrastructure to the database	$25,000-$30,000	As needed
Data Collection/Population	The TPE allows stakeholders to upload data	$0	NA
Batch Upload Support	Support users in writing ruby scripts to complete batch uploads	$15,000-$20,000	Annual
Data Quality Assurance	Performing data quality checks could range from very minimal to significant costs, depending on the level of scrutiny.	$5,000-$30,000	Annual
Customer Support	Fielding inquiries from stakeholders.	$0-$40,000	Annual
Total Estimated Cost		**$40,000-$150,000**	**Annual**

Allowing registered users to upload information keeps data population costs low, but could compromise the quality of the data. NREL has instituted the following quality assurance controls to ensure high-quality data is input into the database:

TPE Quality Assurance Controls

- Each technology category (PV Modules, Inverters, etc.) is defined by a corresponding data entry form, which sets the parameters that the TPE will accept. This allows an apples-to-apples comparison among products.
- Quantitative parameters have minimum and maximum limits to prevent egregious typos.
- Users must register with the TPE in order to download data.
- Each piece of contributed data is tagged with the name of the submitting organization, the submission date, and the derivation method (chosen from an enumerated list of predetermined options).
- In order to upload data, users must register with the TPE and associate with an organization.
- NREL vets each organization to ensure they represent a manufacturer, a third-party testing laboratory, or a contributing evaluator.

- The ability to add products is restricted to manufacturers or an NREL administrator. Once a product is included in the TPE, other parties (such as test laboratories) may input information about the product. (Note that NRTLs must have permission to submit data on behalf of their customers. This may require a change in NRTL contracting language.)
- Manufacturers can only add performance data to products produced by their organization.
- Each organization "owns" the data it provides. Thus, manufacturers cannot remove performance data associated with one of their products if they weren't the ones to contribute it.
- Manufacturers can remove their own products, which also removes any performance data associated with those products.
- As part of the terms of use, when third-party testing laboratories are added to the TPE, they agree to only contribute performance data derived from tests that they are accredited to perform. The laboratories are able to identify their accreditations on their TPE organization page.
- Users can sort results within each technology category according to a set of filters, which include the data contributor type (manufacturer data, third-party test lab data, or contributing evaluator data).
- When viewing a particular product, each submitted performance data point is visible, even if multiple organizations have contributed the same type of data to a particular product. This could happen if the manufacturer indicates that its PV module is rated to X watts, but testing by a third-party laboratory indicates that it is actually Y watts.

More information on the TPE can be found at http://www.nrel.gov/docs/fy13osti/56457.pdf.

5.3 Potential Funding Models

There are many potential funding models to explore. An important consideration is the likely longevity of each funding model. This section describes various funding models, provides examples, and lists the considerations for each model.

5.3.1 The Coalition Model

Under the coalition model, a group of interested organizations would pool resources to maintain a national equipment eligibility list. Although this model provides an equitable means for sharing fiscal responsibility for maintaining the list, it is more difficult ro ensure sustainable funding when many parties are involved. Multiple small transactions and the need to maintain multiple funding partners' interest could lead to high administrative and transaction costs. Organizations that view maintenance of the information as a benefit to all stakeholders would likely be the best candidates.

There are successful examples of the coalition model in the wind industry. However, differences between the wind and solar industries must be evaluated when considering whether a state coalition model would be efficient and effective for the PV industry. The largest consideration is the difference in the scale of the project and level of effort involved with maintaining a national PV eligible equipment list vs. a wind eligible equipment list. The wind industry has far fewer turbine models on the market than the PV industry has modules and inverters. In addition, many more states offer residents PV incentives than wind incentives, and the number of residents installing PV is much larger than those installing small and mid-sized wind.

Interstate Turbine Advisory Council (ITAC)

The Clean Energy States Alliance (CESA) operates the Interstate Turbine Advisory Council (ITAC), which advances the adoption of small and mid-sized wind turbines in the United States. ITAC fosters collaboration among wind incentive programs across eight states and publishes a list of small and mid-sized wind turbines that meet the performance, reliability, acoustic, and warranty service standards agreed upon by the council. ITAC does not set standards. Rather, it ensures turbines meet the Small Wind Standards set by the American Wind Energy Association. Wind manufacturers, incentive program administrators, and wind technology owners benefit from uniform standards across states and incentive programs.

More information is available at www.cleanenergystates.org/projects/ITAC/.

NREL findings indicate that 16 states rely on the list for incentives or state income tax credit programs. Some of the states interviewed indicated that a small amount ($10,000 or less) of funding each year would be desirable to maintain the list. However, many states indicated that they have no financial means for list maintenance or that they do not consider this a high enough priority to allocate resources to it. Member organizations serving states or the PV industry may be a better target for long-term sustainable funding. If organizations such as the Solar Energy Industries Association (SEIA), The Solar Foundation, or the Clean Energy States Alliance (CESA) determine that a national database supports most of their membership base, they may be interested in supporting the effort financially. The cost of maintaining the list could be shared by multiple organizations representing states and the PV industry.

5.3.2 The State-Mandated Model

For many years, the California Legislature directed the California Energy Commission to support the maintenance of the PV eligible equipment list with ratepayer funds assessed on Californian's utility bills. The State of Florida employs a hybrid public-private funding model that covers 30% of program costs through an administrative fee on the testing itself and 70% from Florida taxpayers.[21] Public utility commissions could be directed by state legislatures to mandate that utilities require all PV equipment be certified as part of the utility interconnection screening process.

[21] Office of program policy analysis and government accountability report No. 09-17: http://www.oppaga.state.fl.us/MonitorDocs/Reports/pdf/0917rpt.pdf

5.3.3 The Private Sector Model

The private sector model assumes that a for-profit or non-profit organization finds enough value in the data to commit to sustainable funding for maintenance of that data. Member organizations serving states or the PV industry may be a good target for long-term sustainable funding for a national database.

> **Solar Ratings and Certification Corporation (SRCC)**
>
> SRCC is a national non-profit with the charge of creating and maintaining an independent certification program for solar thermal equipment. To date, the organization has more than 200 participating equipment manufacturers with over 2,700 collectors and solar water heating systems certified under the SRCC certification and rating program. More information can be found at www.solar-rating.org/ratings/index.html.

5.3.4 The Federally-Funded Model

With the power to issue national solicitations and the ability to direct technical resources at national laboratories, the federal government is in a strong position to support a national list platform. It also has the brand recognition to institute a designation for equipment that meets certain thresholds or requirements. Product ratings and performance standards are common for many product categories. The DOE and Environmental Protection Agency (EPA) have worked together to promote highly efficient brands through Energy Star for many years. DOE provides the technical expertise regarding product testing and requirements, and EPA markets and manages the program. EPA also has experience documenting performance of vehicle technologies through its miles per gallon (MPG) ratings. Discussions with EPA in September 2013 revealed that the agency is not likely to include power-producing products within Energy Star (which focuses on energy efficiency) and would not document performance of a technology unless required by Congress to do so. The DOE may be interested in supporting the effort if they deem the information as a public good that should be supported with taxpayer money.

Table 4 outlines the strengths and weaknesses associated with each funding model described in this paper. These are important considerations for choosing the optimal path forward.

Table 4: Strengths and Weaknesses of Different Funding Models

Funding Model	Strengths	Weaknesses
Coalition Model	Allows for equitable cost sharing by those benefit. Provides a venue for broader input into requirements for inclusion on the list.	Gaining consensus on requirements for inclusion on the list is more difficult with many parties involved. Sustaining needed funding levels could be more complex with many parties involved. Administration costs may be high.

State-Mandated Model	Provides the most state control over eligible equipment requirements.	Could cause more market fragmentation if different states have different requirements. Political will and ability to fund the activity could change, causing an "on and off" cycle on the requirements.
Private Sector Model	Opens possibility for sustainable funding if an organization finds revenue opportunities.	High potential for data to be sold to stakeholders who benefit from it being freely available today.
Federally-funded Model	Enables the federal government to issue a solicitation to find the most cost-effective provider.	Consensus on the scope, objectives, and purpose of a national list could be difficult if multiple programs or agencies provide funding. Long-term funding is subject to Congressional appropriations.

6.0 Conclusion

The Energy Commission eligible equipment list has provided value to the solar marketplace for well over a decade. Transitioning to a national list in a database format will promote consistency across states and provide a more equitable solution for meeting the needs of many diverse stakeholders. This paper serves as a starting point for a national discussion about the next evolution of the list. Changes in the Energy Commission's requirements may affect the structure of the online database and the willingness of other stakeholders to adopt the platform. These factors must be considered carefully when determining the optimal path forward. Additional work is to determine the optimal path forward, socialize the potential solutions, identify funding partners, and promote the availability and benefits of a national database.