NATIONAL RENEWABLE ENERGY LABORATORY

The Relevance of Generation Interconnection Procedures to Feed-in Tariffs in the United States

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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Executive Summary

Feed-in tariffs (FITs) have been used to promote renewable electricity development in over 40 countries throughout the past two decades. These policies generally provide guaranteed prices for the full system output from eligible generators for a fixed time period (typically 15–20 years). Due in part to the success of FIT policies in Europe, some jurisdictions in the United States are considering implementing similar policies, and a few have already put such policies in place. This report is intended to offer some guidance to policymakers and regulators on how generator interconnection procedures may affect the implementation of FITs and how state generator interconnection procedures can be formulated to support state renewable energy objectives. This report is based on a literature review of model interconnection procedures formulated by several organizations, as well as other documents that have reviewed, commented on, and in some cases, ranked state interconnection procedures.

Significant differences in electricity policies, markets, and regulations between the United States and Europe, however, constrain the implementation of European-style FIT policies for FERC-jurisdictional entities in the United States. FITs in Europe are supported by policies that provide guaranteed and preferred dispatch and interconnection provisions for qualifying renewable electricity generators. European Union Member States have been directed to guarantee the interconnection of renewable generators, to prioritize the dispatch of renewable energy, and to consider requiring the purchase of that energy. European Union Member States also have the option of prioritizing the interconnection of renewable generators, in effect moving them to the front of the generator interconnection queue. Additionally, the costs of interconnecting a new renewable energy generator to the electric grid (at both the transmission and distribution level) are borne mainly by electricity customers. Such priority dispatch or interconnection guarantees or preferences for particular technologies are barred in the United States for generators subject to federal jurisdiction under the Federal Power Act.

Interconnecting new generators to the electric grid in the United States is complicated by state and federal jurisdictional issues. The Federal Energy Regulatory Commission (FERC) has jurisdiction over all transmission systems involved in wholesale power markets and interstate commerce. State regulators have jurisdiction over retail activities and intrastate commerce, which generally involves distribution-level interconnections. For generators subject to FERC jurisdiction, new generators are given non-discriminatory access to interconnection and applications are processed on a first come, first served basis, with no priority given to any particular technology or type of generator. Generators must also obtain dispatch, transmission service, and customers for their energy separate from interconnection. Generators are required to pay the cost for directly connecting their facility to the transmission grid and to provide the initial funding for any necessary transmission upgrades, which are generally later reimbursed. Under FERC rules, dispatch cannot be guaranteed; in competitive wholesale markets, dispatch is based on power prices and the economics of individual generators.

While implementation of a European-style FIT for FERC-jurisdictional entities at the national level in the United States would require significant changes in law and regulation, there are opportunities at the state level for FIT implementation, particularly for small and distributed generation connected to the distribution grid. In order for those to happen, state interconnection policies and procedures need to be reviewed and optimized. There is no single legal framework

for state interconnection policies and procedures but several entities have developed interconnection procedures and model interconnection procedures (also referred to as model rules) that can assist state regulators in creating interconnection procedures for small and distributed generation. The more prominent examples are the FERC Small Generator Interconnection Procedures outlined in FERC Order 2006, California's Rule 21, the Mid-Atlantic Distributed Resources Initiative model rule, and the Interstate Renewable Energy Council model rule. There are significant differences between these four, but common elements include:

- coverage of all generation technologies, interconnection of systems up to at least 10 MW, and standard agreements;
- simplified procedures for small solar PV systems covering most residential installations;
- fast track procedures for systems up to 2 MW;
- a three-part study (feasibility, impact, and facilities) process for interconnection of more complex and larger systems; and
- comprehensive coverage of issues eliminating a utility's ability to create additional and unnecessary rules.

The four differ with respect to whether they include standard agreements for all types of systems and have different capacity limits, timelines, fee levels, insurance requirements, and dispute resolution processes.

As of July 2010, all but eight states—Alabama, Alaska, Idaho, Oklahoma, Mississippi, North Dakota, Rhode Island, and Tennessee—had created some type of state interconnection procedures applying to various entities and containing varying capacity limits. Key state interconnection procedure characteristics that can affect the development of distributed generation include:

- capacity limits,
- standard agreements and application processes,
- expedited processing for smaller systems,
- interconnection costs, and
- insurance requirements.

State interconnection policies can help facilitate the success of state renewable energy policies, including FITs. Four of the five top-ranking states in installed solar electric capacity received grades of B or better from the Interstate Renewable Energy Council, a non-profit organization that evaluates state generator interconnection procedures in the *Freeing the Grid* report. The top five states also have renewable portfolio standards and do not impose capacity limits for net metering.

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1 Introduction

A feed-in tariff (FIT) is an energy policy that has been used to promote renewable energy development in over 40 countries, most prominently in Europe. Although the details differ, a FIT essentially provides a guaranteed payment in $/MWh for electricity and renewable energy credits for the energy output from an eligible generator for a guaranteed period of time (typically 15–20 years; see Table 1). Payment amounts may be differentiated by technology, project size, resource quality, or other project-specific variables (Cory, Couture, and Kreycik 2009).

Due in large part to the success of FIT policies in Europe and elsewhere, various jurisdictions in the United States have begun to consider implementing FIT policies, and a few have put FIT policies in place.[1] FIT policies, in various forms, have been utilized in Europe for at least a decade and are widely considered to have been effective in advancing renewable energy development (Cory and Couture 2009). Currently, FITs are used as the primary renewable energy support mechanism in 20 of the 27 European Union Member States.[2] As of 2008, 75% of global photovoltaic (PV) capacity and 45% of global wind capacity were developed under FIT policies (DB Climate Advisors 2010). Germany implemented its current FIT policy in 2000 and has seen substantial renewable energy growth over the last decade. Renewable electricity generation rose from 4.8% of Germany's electricity mix in 1998 to 16.1% in 2009, with approximately 77% of the renewable electricity receiving payments under Germany's FIT (German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety 2010). In 2009, new solar PV installations were dominated by European countries (see Table 1).

Table 1. Top Countries for New Solar Electric in 2009

Country	MW Installed in 2009	Cumulative Capacity End of 2009	FIT in Place	Duration of FIT Contract
Germany	3,800	9,677	X	20 years
Italy	700	1,158	X	20 years
Japan	484	2,628	X	15 years
United States	481	2,108		
Czech Republic	411	465	X	15 years
Belgium	292	362		
France	285	465	X	20 years
Spain	180	3,595	X	25 years

Sources: SEIA 2010 and Klein et al. 2008.

The European Union has established a shared renewable energy target of 12% overall share of energy from renewable sources by 2010 and 20% by 2020. The directive instructs European Union Member States to guarantee the interconnection of renewable energy facilities and to

[1] California, Vermont, Oregon, Washington, and Wisconsin have enacted various FIT-type policies. For more information see Cory and Couture 2009.
[2] Concerns often raised with FITs are the potential cross-subsidization of one ratepayer class versus another and whether FITs may negatively impact electricity rates to the particular detriment of certain customer classes such as low-income customers and energy-intensive industries. These concerns are beyond the scope of this report.

guarantee and prioritize the dispatch of renewable energy.[3] The directive also grants European Union Member States the option to prioritize renewable energy interconnection; i.e., allow renewable energy projects to jump to the head of the interconnection queue. Germany, Spain, and Denmark have opted to prioritize the interconnection of renewable energy facilities (IPA Energy and Water Economics 2008). Along with guaranteed interconnection and prioritized dispatch, most European Union Member States apply a purchase obligation, wherein the relevant receiving entity (generally the grid operator) must purchase all renewable generation. Additionally, a significant portion of the transmission upgrade costs and, in some countries, the direct connection costs are borne by electricity customers, rather than the interconnecting generator (IPA Energy and Water Economics 2008).

In the United States, jurisdiction over electric power is divided between the Federal Energy Regulatory Commission (FERC) and the states. FERC has jurisdiction over wholesale electricity and transmission rates and service, while states have jurisdiction over retail rates, distribution service, and siting. Rates and service for wholesale power and transmission must meet statutory requirements and receive FERC approval for being just and reasonable and not unduly discriminatory. FERC also has jurisdiction over generator interconnections that are at transmission-level voltage or involve wholesale power transactions. FERC created standard generator interconnection procedures and agreements for all generators and transmission customers, but these specifically state that interconnection does not guarantee electricity sales or dispatch.[4] Power purchase contracts are obtained separately from interconnection and transmission. Interconnection service must also be comparable and non-discriminatory (FERC 2003). There is no technology-specific priority rank in interconnecting generators such as renewable energy technologies or in dispatching such technologies. Therefore, European-style FIT policies are not compatible with U.S. non-discriminatory open-access transmission and interconnection requirements where dispatch cannot be guaranteed or prioritized. Jurisdictional issues, electricity regulation, and FERC policies complicate the implementation of European-style FITs in the United States.

For retail electric service and transactions, state-level interconnection policies are an important, if not essential, tool for meeting state renewable energy requirements or other state policies. There is, however, no single legal framework for state interconnection policies and procedures, although several model interconnection procedures are available to build from. As of July 2010, all but eight states—Alabama, Alaska, Idaho, Mississippi, North Dakota, Oklahoma, Rhode Island, and Tennessee—had created some type of state interconnection procedure applying to various entities and containing varying capacity limits (DSIRE 2010).

This report examines interconnection procedures in the United States, how those procedures relate to FIT policies in the United States and Europe, and options for state-level interconnection procedures.[5] Section 2 discusses electricity regulation in the United States and Europe, Section 3 describes federal and state generation interconnection procedures, Section 4 describes model state interconnection procedures, and Section 5 compares these model procedures. Section 6

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[3] Interconnection refers to the technical requirements and legal procedures whereby an electric generator interfaces with the electricity grid.
[4] FERC's role and jurisdiction is discussed in greater detail in Section 2.
[5] Another report examines the legal issues surrounding the implementation of a FIT in U.S. wholesale power markets. See Hempling, et al. 2010.

considers the evolution of state generator interconnection procedures, while Section 7 elaborates on issues and barriers to generator interconnection. Section 8 discusses how generator interconnection procedures can help enable the successful implementation of state renewable energy policies, and Section 9 concludes the report.

This report does not address issues and procedures related to net metering, but rather, the focus is on generation interconnection. Additionally, the report focuses on interconnection policies and procedures rather than technical standards. Technical codes and standards consist of the technical requirements for safely interconnecting new generating facilities to the electric grid while maintaining reliability.[6]

2 Electricity Regulation in the United States and Europe

This section broadly describes the differences in electricity regulation and industry structure between the United States and Europe.

United States

In the United States, the Federal Power Act (FPA) grants FERC jurisdiction over interstate commerce with respect to energy (both electricity and fuels), which is generally understood as jurisdiction over all aspects of wholesale power markets.[7, 8] Related to wholesale generator interconnection, FERC issued Order 2003 in 2003 (followed later by 2003A, 2003B, and 2003C) to establish the standard procedures governing large generator interconnection, including the standard Large Generator Interconnection Procedures and the standard Large Generator Interconnection Agreement, for all FERC-jurisdictional facilities with a capacity greater than 20 MW (FERC 2003). This was later followed by Order 2006, which established the Small Generator Interconnection Procedures and the standard Small Generator Interconnection Agreement for FERC-jurisdictional facilities up to 20 MW (FERC 2005).

Transmission providers are obligated to process all generator interconnection requests in a non-discriminatory manner and connect generators to their transmission grid as detailed in their

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[6] The technical aspects of interconnection are governed by codes and standards developed by various organizations, mainly the North American Electric Reliability Corporation, the National Fire Protection Association, and the Institute of Electrical and Electronics Engineers (IEEE).

[7] FERC jurisdiction over wholesale transmission, however, applies only to entities that own, control, or operate interstate transmission facilities, primarily the 176 investor-owned utilities (IOUs). FERC cannot require non-jurisdictional utilities, principally electric cooperatives that are borrowers of funds from the Rural Utilities Service, as well as municipal utilities and public power agencies to file generation interconnection agreements. However, FERC has stated that some of these entities own or operate facilities used or capable of being used for transmission in interstate commerce, and therefore are "transmitting utilities" under the FPA. In addition, FERC jurisdiction over Federal Power Marketing Administrations is limited, and FERC jurisdiction does not extend to regions not engaged in interstate commerce: the part of Texas under the Electric Reliability Council of Texas and the states of Alaska and Hawaii.

[8] FERC, in conjunction with states, also administers the Public Utility Regulatory Policies Act of 1978 (PURPA) that allows certain cogeneration and renewable energy "qualifying facilities" that meet certain eligibility requirements to sell power to utilities at a utility's avoided cost of generating the power itself or purchasing the power. Utilities are also required to interconnect with qualifying facilities. PURPA has diminished relevance these days as the Energy Policy Act of 2005 (EPAct 2005) allows utilities to petition FERC to be removed from the obligation to buy power from future qualifying facilities if certain conditions are met. As discussed later, EPAct 2005 amended PURPA to include a new standard for interconnection.

FERC-approved Open Access Transmission Tariffs (OATTs; FERC 2003). Once interconnected, however, the transmission provider is not obligated to actually receive and transmit the electricity generated by the supplier. It is up to the generator to obtain a buyer for their energy and to arrange a transmission service schedule, subject to transmission availability and pricing. Guaranteeing interconnection, therefore, does not equate to receiving transmission service or guaranteeing electricity dispatch. Under the FPA and FERC regulations, utilities cannot grant priority to interconnecting generation by technology type in the United States. Additionally, under FERC rules, generation owners in the United States are typically required to pay the costs of interconnecting their facilities to the transmission grid, generally both direct connection facilities and any necessary network upgrades; although in most instances, transmission owners or operators reimburse the transmission network upgrade costs to generators through transmission service credits or as financial transmission rights (FTRs), if available (FERC 2003).[9]

FERC jurisdiction does not include entities involved in retail-only activities and intrastate commerce, which generally involves distribution system-level interconnections and distributed generation facilities. Distribution level interconnection policies are therefore governed by state laws and procedures. FERC does have jurisdiction over a distributed generation facility's interconnection (and a wholesale power transaction) if that facility is participating in the wholesale energy market.

Distributed generation facilities that interconnect to the grid at the distribution level generally are facilities with a capacity of 2 MW and smaller. However, distributed generation can include larger facilities if those facilities are interconnected with a distribution system that is capable of accepting the output from the facility. The interconnection jurisdiction issue is complicated by the fact that some states have created interconnection procedures for small and distributed generation while eight states have not. If a facility interconnection falls under FERC jurisdiction, then FERC-jurisdictional utilities in states without small or distributed generation interconnection procedures follow the FERC pro-forma small generator interconnection procedures for all facilities up to 20 MW. For interconnections that fall under state jurisdiction, when a state has not implemented interconnection procedures, both FERC-jurisdictional utilities and non-FERC jurisdictional utilities (e.g., most municipal electric utilities, rural electric cooperatives, and federal government facilities) are able to create their own interconnection policies and procedures, leaving facility owners with no recourse but to accept whatever conditions the utility imposes.

Europe

In September 2001, the European Parliament issued Directive 2001/77/EC concerning the promotion of electricity produced from renewable energy sources (The European Parliament and the Council of the European Union 2001). Directive 2001/77/EC set a target for the European Union to collectively reach a 12% share of renewable energy by 2010. This target was increased in 2007 with the enactment of a mandatory target that 20% of overall energy consumption be

[9] FERC Order 2003 states that the credits (or FTRs) are restricted to transmission service on the relevant transmission provider's system and only with respect to the particular interconnecting generating facility, as long as that facility has achieved commercial operation and continues to operate. The refund is to be spread over five years. As discussed later, FERC allows more discretion to Regional Transmission Organization (RTOs) in allocating costs for transmission upgrades.

from renewable energy generation by 2020 for all European Union Member States (European Energy Commission 2010). Directive 2001/77/EC also addressed grid access issues. Article 7 states:

> Without prejudice to the maintenance of the reliability and safety of the grid, Member States shall take the necessary measures to ensure that transmission system operators and distribution system operators in their territory guarantee the transmission and distribution of electricity produced from renewable energy sources. They may also provide for priority access to the grid system of electricity produced from renewable energy sources. When dispatching generating installations, transmission system operators shall give priority to generating installations using renewable energy sources insofar as the operation of the electricity system permits (The European Parliament and the Council of the European Union 2001, Article 7.1).

European grid operators not only guarantee grid interconnection for renewable energy generators, but they are also required to guarantee and prioritize the dispatch of that energy. Along with guaranteed dispatch, the majority of European Union Member States have imposed a purchase obligation for renewable energy, meaning that the relevant grid operator, energy supply company, or electric consumers are required to buy the electricity generated by renewable energy generators. The article allows European Union Member States to also prioritize interconnection of renewable energy facilities, something that has been implemented in Germany, Spain, and Denmark. Put more directly, various countries have employed a "connect and manage" approach by prioritizing the interconnection of renewable energy technologies and using strong grid codes and energy curtailment, as needed, to maintain grid reliability.

Grid connection charges in Europe are mainly paid for by electricity customers. Additionally, some European Union Member States have special rules for renewable energy generators. Denmark has lower connection charges for renewable generators. On-shore wind facilities in designated areas only pay for direct connection facilities to the boundaries of the wind farm, and off-shore wind facilities pay only for connection to the nearest land point. In Germany, off-shore wind facilities pay only the on-site direct connection costs. In Italy, all renewable energy generators pay a 50% lower fee for interconnection (IPA Energy and Water Economics 2008).

Summary

There are significant differences between electricity policies, markets, and regulations in the United States and Europe, and absent unforeseen federal statutory changes to the FPA, large-scale European-style FITs applying to FERC-jurisdictional entities cannot be implemented in the United States. FITs in Europe are supported by policies that include guaranteed and preferred dispatch and interconnection for renewable generators, while no such dispatch or interconnection guarantees or preferences for particular technologies are available in the United States. U.S. states looking to implement FITs may wish to focus on small and distributed generation connected to nonfederal-jurisdictional facilities and examine other types of FITs as outlined in several recent reports.[10] To facilitate deployment, U.S. states may wish to examine interconnection procedures to ensure they do not impose procedural barriers to interconnecting generators, such as unnecessary requirements and excessive costs.

[10] See Cory, Couture, and Kreycik 2009; Cory and Couture 2009.; Hempling et al. 2010; and KEMA 2008.

3 Generator Interconnection Procedures in the United States

Many FITs in Europe apply to both distributed and utility-scale facilities and some FIT proposals in the United States have included consideration of utility-scale facility eligibility; therefore, this section includes an overview of large generator interconnection procedures under FERC jurisdiction.

Large Generator Interconnection Procedures

The majority of large generation (greater than 20 MW) interconnections in the continental United States are subject to FERC jurisdiction. As noted earlier, with Order 2003, FERC created the standard Large Generator Interconnection Procedure (LGIP) and the standard Large Generator Interconnection Agreement (LGIA). Under the LGIP, the review of generator interconnection requests (submitted to the relevant transmission operating entity) is conducted in phases through a series of studies, each involving more detail and financial commitment from the interconnecting generator. Transmission providers assign generator interconnection queue positions according to the date and time that an interconnection request is received. The interconnection queue position then determines the order in which the series of interconnection studies are conducted and interconnection construction costs are allocated. Interconnecting customers are responsible for the full costs of their studies, all of which require an initial deposit.

Under the LGIP, three interconnection studies are conducted, each consisting of increasingly more detailed engineering assessments that examine the technical considerations of interconnecting the particular project to the grid at a certain point while maintaining system reliability and not exceeding the operating limits of the grid.[11] The *feasibility study* consists of a high-level evaluation of whether the project is feasible at the customer's desired point of entry into the grid. The *interconnection system impact study* is a more detailed version of the feasibility study and evaluates the impact of the proposed project on system reliability. The *interconnection facilities study* identifies what equipment, engineering, procurement, and construction work will be required to connect the proposed generating project to the grid and estimates the interconnection cost and time required.[12] The end result is the LGIA that is then subject to approval from FERC.

FERC Order 2003 defines two types of construction costs: direct connection facilities and network upgrades. Direct connection facilities consist of all equipment and construction required to connect the new generating facility to the first point of interconnection with the transmission grid. Network upgrades consist of equipment and construction required to reinforce the existing transmission system in order to accommodate the new generation project. Generation facility owners are responsible for the cost of all direct connection facilities between the generator and the transmission grid and must also pay for the up-front costs of network upgrades, for which they generally are later reimbursed (plus interest) in the form of transmission credits or, if applicable, financial transmission rights.

[11] As defined by the North American Electric Reliability Corporation FERC-approved standards.
[12] Some entities have received FERC approval to modify their LGIPs and may include more or less studies, though the end result of the studies is essentially unchanged. For more detailed information on large generator interconnection procedures, see Porter et al. 2009.

FERC Order 2003 allows transmission providers to create variations to the standard LGIP that are superior to the standard procedures described above. FERC determines on a case-by-case basis whether a procedure is "superior." In addition, FERC has granted "independent entity" variation for regional transmission organizations (RTOs) and independent system operators (ISOs)—again on a case-by-case basis—whereby RTOs and ISOs are free to depart from FERC Order 2003 as FERC views RTOs and ISOs as independent of any market participant. Most of the nation's RTOs and ISOs have gained approval from FERC to modify their LGIPs. These modifications have included increasing the initial study deposit amounts, including group studies, and adding requirements for generation developers to meet certain milestones prior to being able to proceed to subsequent study stages (Porter et al. 2009).

Small and Distributed Generator Interconnection Procedures

Small generators are generally considered as those having a capacity of 20 MW or less. State-level interconnection procedures for non-FERC jurisdictional projects have set various size limits ranging from less than 100 kW to 80 MW facilities, while some procedures contain no specified size limits and can therefore be used to interconnect any project as long as the interconnection does not fall under FERC jurisdiction. Table 2 outlines the various state procedure size limitations. Facilities sized 20 MW or smaller do not often interconnect to transmission lines that fall under FERC jurisdiction, but because connecting generation facilities in the 5 to 20 MW range to the distribution system may be difficult, some generation facilities in this capacity range do connect to FERC-regulated transmission lines.

Table 2. State Interconnection Procedure Size Limitations

Size Limit	States
No size limit	California, Hawaii, Indiana, Kentucky, Maine, Massachusetts, Michigan, New Jersey, North Carolina, Pennsylvania, Vermont
80 MW	Iowa, New Mexico
20 MW	Connecticut, Nevada, Ohio, Virginia, Washington
15 MW	Wisconsin
10 MW	Arizona*, Colorado, District of Columbia, Illinois, Maryland, Minnesota, Oregon**, South Dakota, Texas
2 MW	Florida, New York, Utah***
1 MW	Delaware
Under 500 kW	Arkansas, Georgia, Kansas, Louisiana, Missouri, Montana, Nebraska, New Hampshire, South Carolina, Wyoming
No state procedures	Alabama, Alaska, Idaho, Oklahoma, Mississippi, North Dakota, Rhode Island, Tennessee

*Arizona Corporate Commission procedures are still voluntary and recommended only. Utilities in Arizona have implemented various size limits.
**Oregon imposes a separate 25 kW size limit on residential net-metered systems and has adopted standard interconnection procedures and agreements for facilities over 20 MW.
***Utah imposes a separate 25 kW size limit on residential net-metered systems.
Note: West Virginia implemented interconnection procedures in July 2010, too late to be included in the analyses in this report.
Source: Network for New Energy Choices 2009.

The majority of small residential and commercial systems interconnect with utility-level distribution systems and are therefore under the jurisdiction of state-level regulations or, if unavailable or non-applicable, to utility-imposed interconnection guidelines. Facilities up to

2 MW in capacity rarely interconnect with anything other than utility-level distribution systems, which can include medium voltage class equipment.

4 Model Interconnection Procedures in the United States

Over the last decade, the renewable energy industry, states, and utilities have cooperated in creating model interconnection procedures for regulators to use when developing state procedures. The more prominent examples are the FERC Small Generator Interconnection Procedures (SGIP), California Rule 21, the Mid-Atlantic Distributed Resources Initiative (MADRI) model rule, and the Interstate Renewable Energy Council (IREC) model rule. FERC's SGIP and California Rule 21 are not technically "models"; they were created as procedures to be put into actual practice. These procedures have, however, been used by some states as a model for developing their interconnection procedures and, therefore, are often referred to as model procedures. The SGIP was influenced by the Small Generation Resource Interconnection Procedures developed by the National Association of Regulatory Utility Commissioners (NARUC) in 2003 and submitted to FERC early in the Order 2006 proceeding. The NARUC procedures were also the genesis of the IREC and MADRI rules but have not been updated since 2003 (NARUC 2003).

FERC Small Generator Interconnection Procedures

In Order 2006, FERC created a simplified SGIP that includes a fast track process for FERC-jurisdictional facilities with a nameplate capacity of 2 MW or less. The FERC SGIP primarily applies to FERC-jurisdictional utilities in states with no state-level procedures. The fast track process involves an initial screening process. If the proposed facility meets all of the various technical screens, the interconnection request is approved. For facilities between 2 and 20 MW and those that fail to pass the initial screening process, scaled-down versions of the same basic studies as required in the LGIP must be performed: a feasibility study, a system impact study, and a facilities study. The deposit requirements are much smaller for SGIP facilities, but the interconnecting customer is still responsible for the cost of the studies. Interconnecting customers are also responsible for fully funding any necessary transmission system upgrades and the resulting Small Generator Interconnection Agreement (SGIA) is subject to FERC approval (FERC 2005).

California Rule 21

California Rule 21 was one of the first state interconnection procedures to be created and was developed through a stakeholder process that began in October 1999. In December 2000, the California Public Utility Commission (CPUC) issued a decision approving the Rule 21 tariff language and directed California's three investor-owned utilities (IOUs) to adopt the tariff language (CPUC 2000). Several municipalities have voluntarily modeled their interconnection rules after Rule 21, including Riverside Utilities Department, the Los Angeles Department of Water and Power, Sacramento Municipal Utility District, Mountain Utilities, and Bear Valley Electric (Cooley et al. 2003).

California Rule 21 does not specify a size limit and states that the tariff applies to all facilities intending to connect to the electric grid over which the CPUC has jurisdiction. This allows for facilities of any size to connect to the grid in California as long as the interconnection does not fall under FERC jurisdiction.

Rule 21 also does not include any expedited review processes based on project size. The same procedures are used regardless of project capacity. There is, however, an initial review process consisting of eight screening criteria, and projects under 11 kW automatically satisfy three of the eight screens. Any project that passes the initial screens qualifies for a simplified interconnection. California Rule 21 is discussed in more detail in a case study in the Appendix.

Mid-Atlantic Distributed Resources Initiative

MADRI was established in 2004 by the public utility commissions of Delaware, the District of Columbia, Maryland, New Jersey, and Pennsylvania, along with the Department of Energy (DOE), the Environmental Protection Agency (EPA), FERC, and the PJM Interconnection.[13] The MADRI model interconnection procedures were developed through a stakeholder process and finalized in November 2005. The model was created as an alternative to the FERC SGIP and is meant to be used as a guide for states to develop their own interconnection procedures specific to their particular jurisdictional needs.

The MADRI procedures contain four levels of review based on the size[14] of the project:

- Level 1 is for inverter-based systems with nameplate capacities of 10 kVA or less;
- Level 2 is for inverter-based systems with nameplate capacities up to 2 MVA including any 10 kVA and smaller systems that did not pass the screens for Level 1;
- Level 3 is for all systems up to 10 MVA in size including those that did not pass the Level 1 and/or Level 2 screens; and
- Level 3A, which is unique to the MADRI model, is a potentially expedited review procedure for systems that will not be exporting power to the grid. This level grants utilities discretion to connect non-exporting systems up to 10 kVA to their distribution grids if they determine there will be no adverse impacts. States using the MADRI model can also consider utility-supplied alternative text that allows Level 3A to apply to systems up to 50 kVA in size (MADRI 2005).

Though not entirely adopted by any state, the MADRI model has been used to develop interconnection procedures in Illinois, Maryland, Oregon, and Pennsylvania.

Interstate Renewable Energy Council

IREC is a non-profit organization created in 1982. IREC works on creating renewable energy programs and policies promoting the adoption of uniform guidelines, standards, and quality assessment and has been involved in rulemaking for distributed power interconnection, workforce development, consumer protection, and stakeholder coordination. The IREC model procedures were originally developed in 2005, finalized in November 2006, and updated and revised in 2009.

The IREC procedures have four levels, three of which are based on project size:

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[13] PJM is the regional transmission organization that administers and operates the electric transmission grid and wholesale markets in the Mid-Atlantic region.

[14] MADRI defines project size according to kilovolt amperes (kVA). VA is the amount of apparent power in an electrical circuit, equal to the product of voltage and current. For DC systems, VA equals the real power (watts), but for AC systems, VA may differ from watts as the voltage and current may be out of phase.

- Level 1 contains a set of simplified screens for inverter-based systems with a capacity of 25 kW or less;
- Level 2 is a set of screens for systems with a capacity of 2 MW or less, including those below 25 kW that did not pass Level 1 screening;
- Level 3 is for systems that have a capacity of 10 MW or less and will not be exporting power to the grid; and
- Level 4 is for all systems that did not qualify for the Level 1, Level 2, or Level 3 interconnection review processes (IREC 2009).

The IREC procedures drew on the previous models developed by FERC, MADRI, and NARUC. The IREC model is an attempt to incorporate the best approaches and features found in the work done to date on interconnecting distributed generators.

5 Comparing the Model Interconnection Procedures

This section compares the four main models for small and distributed generation interconnection procedures and is drawn from a paper from the Solar America Board for Codes and Standards, *Comparison of the Four Leading Small Generator Interconnection Procedures* (Keyes and Fox 2008**),** and from the 6th edition of IREC's *Connecting to the Grid* report (Varnado and Sheehan 2009).

All resources and technologies qualify for interconnection under the model procedures. None call for statewide coverage, acknowledging that state jurisdiction over municipal utilities, cooperatives, and public utility districts varies greatly among the states. California Rule 21, for example, is limited to only the IOUs. Table 3 outlines some different characteristics of the model procedures.

Table 3. Comparing Model Interconnection Procedure Characteristics

Capacity Limits	FERC SGIP	Covers facilities up to 20 MW.
	Rule 21	No size limit specified.
	MADRI	Covers facilities up to 10 MVA.
	IREC	No size limit specified.
Standard Agreements and Procedures	FERC SGIP	Standard form interconnection agreement and application process for all system sizes.
	Rule 21	Several different standard forms based on system ownership and size.
	MADRI	Standard form interconnection agreement and application process for all system sizes.
	IREC	Standard form interconnection agreement and application process, plus a simplified process and agreement for inverter-based systems up to 25 kW.

Fast Track Process	FERC SGIP	Simplified fast track process for smaller facilities up to 2 MW.
	Rule 21	Same initial screening process for all project sizes; then expedited procedures apply to projects that pass screens.
	MADRI	Four distinct levels based on project size, each with progressively more extensive requirements. Simplified lower levels restricted to inverter-based systems only.
	IREC	Four distinct levels based on project size, each with progressively more extensive requirements.
Timelines	FERC SGIP	Requires the transmission provider make "reasonable effort" to meet the schedules established in the procedures. Ranges from 10 business days to notify customers about their application's status to 30 business days for completing interim studies and 45 days for completing final facilities study.
	Rule 21	A utility must inform the customer about the adequacy of their application within 10 business days and complete the initial review within 20 business days.
	MADRI	Same as SGIP for Level 1 applications but slightly longer timeframes for Level 2 and above.
	IREC	Similar to SGIP but grants 13 business days for application review.
Fees	FERC SGIP	A set fee for fast track process projects with a smaller fee for 10 kW and smaller inverter-based systems. Fees for non-fast track projects are based on the cost of the studies.
	Rule 21	Set fee for the initial review with an exemption for net-metered systems, providing for a free review. Net metering restricted to PV, wind, fuel cells, and biogas from manure or anaerobic digestion facilities.*
	MADRI	Requires cost-based fees and leaves the determination of applicable amounts to each utility or state.
	IREC	Similar to SGIP fees but with slightly smaller amounts.
Insurance Requirements	FERC SGIP	Requires owners of 10 kW inverter systems to follow applicable state insurance requirements. For larger projects, owners must carry sufficient general liability insurance to account for all reasonable foreseeable direct liabilities arising from the system being installed.
	Rule 21	Not automatically required for all systems; California utilities have implemented various general liability insurance requirements. Not required for net-metered solar and wind facilities up to 30 kW.
	MADRI	Additional liability insurance not required.
	IREC	Additional liability insurance not required.

Dispute Resolution	FERC SGIP	Allows for the use of FERC's Dispute Resolution Service if a project proponent disagrees with a utility's determination.
	Rule 21	Project sponsor can appeal to the CPUC. Project sponsors must first write a letter to the utility and meet with an authorized utility representative to attempt to resolve the dispute, which can last 45 days, followed by a second 45-day period if either party requests an extension. Failing resolution, the project sponsor can submit a written request to the CPUC for mediation, which will last another 90 days. If the dispute is still not resolved, the project proponent must apply to the CPUC's Customer Complaints division.
	MADRI	No defined dispute resolution process. This is left to the utilities.
	IREC	Contains a set short timeline for discussions by the parties to attempt to resolve disputes. Failing resolution, the parties can request that the state utility commission rule on the dispute.

*California net metering restricts PV, wind, and fuel cell facility size to 1 MW or less; biogas size to 10 MW or less for up to 3 digesters at the same facility; no more than 50 MW of biogas and 112.5 MW of fuel cells statewide; and no more than 5% of a utility's peak demand.

Sources: Keyes and Fox 2008; Varnado and Sheehan 2009.

Although facilities between 10 and 20 MW tend to be connected at the transmission system level, this is not always the case. Facilities that can be classified as "qualifying facilities" (QFs) that sell all of their output to the local utility can be exempt from FERC jurisdiction and would need to rely on state interconnection procedures.[15] The MADRI procedures, therefore, can result in a gap in coverage for facilities in this size range. The standard form interconnection agreement and application procedures help to ensure equal treatment for all customers, but having several different standard forms based on system size (or other determinants) can be cumbersome and confusing, especially for small system owners. The level of fees imposed can also have a significant effect on project development. The MADRI procedures requirement for cost-based fees could result in higher fees being assessed on early entrants, before utilities gain the experience and the staff necessary to efficiently process interconnection requests.

6 Evolution of State Interconnection Procedures in the United States

State interconnection procedures have evolved over the last decade, helped in part by the Energy Policy Act of 2005 (EPAct 2005), which included a new Public Utility Regulatory Policies Act (PURPA) standard for interconnection.[16] EPAct 2005 directed state regulatory authorities (with

[15] QFs are defined by the Public Utility Regulatory Policies Act of 1978 (PURPA) as small power production facilities of 80 MW or less whose primary energy source is renewable (hydro, wind, or solar), biomass, waste, or geothermal resources or as cogeneration facilities of any size that sequentially produce electricity and another form of useful thermal energy (such as heat or steam) in a way that is more efficient than the separate production of both forms of energy.

[16] PURPA was passed in 1978 as part of the National Energy Act. Among other things, PURPA created the QF designation and obligates electric utilities to purchase QF energy at avoided cost rates. EPAct 2005 allows utilities to petition FERC to be exempt from mandatory QF purchases if certain conditions are met. PURPA also includes Section 111 that requires states to consider, but not necessarily adopt, different issues and standards. EPAct's directive on interconnection services was added as an amendment to Section 111 of PURPA.

respect to their jurisdictional utilities) and each non-regulated electric utility to consider interconnection procedures in accordance with Section 1254, which states the following:

- Each electric utility shall make available, upon request, interconnection service to any electric consumer that the electric utility serves.
- Interconnection service is for an electric consumer whose onsite generation facility on the customer's premises must be connected to the local distribution facilities.
- Interconnection services shall be offered based on IEEE standards (as they may be amended from time to time).
- Services offered shall promote current best practices of interconnection for distributed generation (Soderberg 2005).

EPAct 2005 only required that state regulatory agencies consider and/or conduct hearings on implementing interconnection procedures to meet the above objectives. This prompted states to examine interconnection issues and eventually led some to adopt or to amend and improve existing interconnection procedures. While some states already had interconnection procedures in place, since EPAct 2005, several other states have created and adopted interconnection procedures including Arizona (Arizona's procedures are voluntary), Colorado, Connecticut, Delaware, District of Columbia, Florida, Illinois, Kansas, Kentucky, Maine, Maryland, Missouri, Nebraska, New Mexico, North Carolina, South Carolina, South Dakota, and Washington.

The DOE's Office of Energy Efficiency and Renewable Energy (EERE) and Office of Electricity Delivery and Energy Reliability (OE) developed a set of best practices for states to consider when examining and establishing interconnection procedures. These best practices are described below:

- Require that agreements and procedures for interconnection wholesale service "shall be just and reasonable, and not unduly discriminatory or preferential" (per EPAct 2005). Treat independent generators and utilities similarly in terms of state requirements.
- Create simple, transparent interconnection applications for small generators up to 2 MW (per FERC Order 2006).
- Standardize and simplify interconnection agreements for small generators and, if possible, interconnection applications.
- Set minimum response and review times for interconnection applications.
- Provide expedited procedures for certified interconnection systems that pass initial technical screens.
- Establish low processing fees for small generators. Interconnection request deposits should be credited toward the cost of the feasibility study, as per FERC Order 2006.
- Set liability insurance requirements commensurate with levels typically carried by the respective customer class.
- Require compliance with IEEE 1547 and UL 1741.

- Minimize administrative requirements unless a requirement is standard practice for similar electrical work.
- Develop administrative procedures for implementing interconnection requirements on a statewide basis through rulemaking or other regulatory mechanisms for state-jurisdictional utilities to apply uniformly to all regulated electric distribution companies in the state. Where practical, state interconnection administrative procedures should reflect regional best practices and be comprehensive in scope. Administrative procedures should also be transparent to both small generators and electric distribution utilities (Varnado and Sheehan 2009).

As of July 2010, all but the following eight states have adopted some form of interconnection standards with varying capacity limits: Alabama, Alaska, Idaho, Mississippi, North Dakota, Oklahoma, Rhode Island, and Tennessee (DSIRE 2010).[17] Some states, such as California, New Jersey, Oregon, and most recently, Maine and Virginia, have conducted extensive proceedings in an effort to update their interconnection standards for enabling distributed renewable energy development.

IREC and the Network for New Energy Choices periodically release a report entitled *Freeing the Grid*, which examines state net-metering and interconnection standards and identifies best and worst practices (Network for New Energy Choices 2009). *Freeing the Grid* contains a ranking system and assigns a letter grade to each state's procedures. The rankings are based on the following criteria:

- Set fair fees that are proportional to a project's size.
- Cover all generators in order to close any state-federal jurisdictional gaps.
- Screen applications by degree of complexity and adopt simplified rules for residential-scale systems and expedited procedures for other systems.
- Ensure that policies are transparent, uniform, detailed, and public.
- Prohibit requirements for extraneous devices, such as redundant disconnect switches, and do not impose additional liability insurance requirements above and beyond what is typically carried by the respective customer class.
- Apply existing relevant technical standards, such as IEEE 1547 and UL 1741.
- Process applications in a timely manner utilizing standardize and simplify forms (Network for New Energy Choices 2009).

Table 4 summarizes IREC's state rankings for interconnection procedures as found in the 2009 Edition of *Freeing the Grid* and outlines the issues that lead to the results.

[17] West Virginia was in the process of finalizing their procedures and subsequently approved them in July 2010.

Table 4. State Interconnection Procedure Scores from *Freeing the Grid,* 2009 Edition

Score	States	Issues
A	Virginia	Covers all utilities and systems sized up to 20 MW. Still requires a set amount of insurance and the decision on a UEDS* is left to utilities.
B	California, Colorado, District of Columbia, Illinois, Maryland, Massachusetts, Nevada, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, South Dakota	Limits coverage to IOUs: CA, IL, NV, NJ, NC, OR, PA
		Limits size: 10 MW—CO, DC, OR, MD, SD; 5 MW—PA; 2 MW—NY
		Requires additional insurance: CO, DC, IL, MA, NC, SD Left to utilities' discretion: NM
		Requires UEDS: DC, IL, MD, NY, PA Left to the utilities' discretion: CA, CO, MA, NV, NM, NC, OR, SD
C	Arizona, Florida, Michigan, New Hampshire, Ohio, Vermont	Limits coverage to IOUs: AZ, FL, OH
		Limits size: left to utilities' discretion—AZ; 2 MW—FL; 100 kW—NH
		Non-standard procedures that vary by utility: AZ
		Requires additional insurance: FL, MI Left to utilities' discretion: AZ, VT
		Requires UEDS: FL, OH, VT Left to utilities' discretion: MI
D	Connecticut, Delaware, Indiana, Texas, Washington, Wisconsin	Limits coverage to IOUs: all except IN; WI limits to IOUs and municipal utilities
		Limits size: 15 MW—WI; 10 MW—TX; 1 MW—DE
		Requires additional insurance: CT, IN, WA, WI Left to utilities' discretion: TX
		Requires UEDS: all, but WA allows utilities to provide waivers
F	Arkansas, Georgia, Hawaii, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Missouri, Montana, Nebraska, South Carolina, Utah, Wyoming	Limits coverage to IOUs: HI, IA, KS
		Limits to only a few resource types: GA, IA, KY, MO, MT, WY
		Limits size: 10 MW—MN; 2 MW—UT; 300 kW—AR, LA; 200 kW—KS; 100 kW—GA, MO, SC; 50 kW—MT; 30 kW—KY; 25 kW—NE, WY
		Requires additional insurance: MN, MO, SC Left to utilities' discretion: AR, HI, IA, LA, MT, WY
		Requires UEDS: AR, HI, IA, KY, LA, MN, SC, WY Left to utilities' discretion: GA, KS, MO, MT, NE, UT
No interconnection procedures (at time of publication)		Alabama, Alaska, Idaho, Mississippi, North Dakota, Oklahoma, Rhode Island, Tennessee, West Virginia

*UEDS—utility external disconnect switch
Note: Maine was still developing interconnection standards at the time the report was published but did subsequently adopt those standards in January 2010. Maine's new procedures are based largely on the IREC model.
Source: Network for New Energy Choices 2009.

7 Review of Issues and Barriers to Interconnection

How certain issues are addressed, or not addressed, when implementing state interconnection procedures can affect the development of distributed generation. Some of these issues include capacity limits; standard form agreements and application processes; expedited processing for smaller systems; interconnection costs; and insurance requirements. The issues reviewed in this section draw from the detailed discussions in the 6th edition of IREC's *Connecting to the Grid* report (Varnado and Sheehan 2009) and the Solar Electric Power Association's (SEPA) survey, *Residential Photovoltaic Metering and Interconnection Study* (Letendre and Taylor 2008).

Capacity Limits

Several states have incorporated capacity limits into their net-metering statutes or their interconnection procedures. Setting a low capacity limit can leave a gap in regulatory oversight, which may limit the development of certain projects that are not wholesale generators and therefore not FERC-jurisdictional, yet too large to be able to apply under state interconnection procedures. Eleven states—California, Hawaii, Indiana, Kentucky, Maine, Massachusetts, Michigan, New Jersey, North Carolina, Pennsylvania, and Vermont—have created procedures (or amended existing ones) that do not have capacity limits, thereby allowing state interconnection procedures to potentially be used by projects of any capacity not falling under FERC jurisdiction. Nine states—Arkansas, Georgia, Kansas, Louisiana, Missouri, Nebraska, New Hampshire, South Carolina, and Wyoming—have set very low capacity limits, making interconnection procedures applicable to only a small segment of customers (Varnado and Sheehan 2009).

Standardized Forms

Standard form agreements can facilitate generator interconnection by ensuring that project applicants know exactly what to expect and what is required with respect to their application. Standard form agreements also expedite utility processing of requests as employees become more familiar with interconnection rules and requirements. Most states with interconnection procedures—30 of the 40 states plus the District of Columbia (as of June 2010)—had adopted standard form agreements (DSIRE 2010).[18] In addition, most state interconnection procedures have created several levels of review and documentation based on system size with simplified processes for smaller inverter-based systems. Of the 39 states plus the District of Columbia with interconnection procedures, 14 have limited their generator interconnection procedures to systems 2 MW in size or smaller.[19] Of the remaining 26, 20 contain different levels of review based on project size and expedited procedures for facilities 2 MW or smaller (Varnado and Sheehan 2009).

The SEPA survey notes that the majority of utilities surveyed have interconnection applications and agreements less than 10 pages long for small PV customers and processing times averaged about one month. Incomplete documentation from customers was the most oft-cited cause of interconnection delays, and SEPA stated that more standard requirements, updated documents and materials, and clearer communication between the relevant utility, customers, and inspectors would address these problems. One example is IREC's 2009 model interconnection procedures,

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[18] Arizona's procedures are guidelines only and so are not included in the assessments in this section.
[19] West Virginia implemented their procedures in July 2010, too late to be included in the analyses in this report.

which included a two-page agreement of generator interconnection terms and conditions for certified, inverter-based systems up to 25 kW in capacity. Several states use a one- or two-page interconnection agreement for very small distributed generation systems, particularly those used for net metering (Varnado and Sheehan 2009).

Fees and Charges

Though some fees and charges are necessary, the imposition of unnecessary or excessive fees and charges may impede or stop the development of distributed generation systems. Interconnection costs for distributed generators can include related application and connection fees and engineering, technical, and equipment charges. Some utility inspection fees for small PV systems have reportedly approached $900 (Varnado and Sheehan 2009). Such fees could be removed or minimized with more incorporation and recognition of technical standards and codes such as IEEE 1547 and UL 1741.[20] However, most of the utilities responding to the SEPA survey stated they did not charge residential customers fees to connect a net-metered PV system to their distribution grid and of those that do, the fees are usually less than $100.

Some utilities have included other costs, such as metering charges, ranging from $4 to $8 per month, for a second meter. These charges were more frequent before net-metering policies became prevalent. Typically, states now require utilities to furnish a second meter if the net-metered system needs one, and some require customers to either pay for the meter or to share some of the costs (Varnado and Sheehan 2009).[21]

Utilities have also imposed standby demand charges to have equivalent capacity available in case of customer system failure. These standby charges can be substantial, ranging from $2 to $20 per kW for small PV systems. Because of concerns that such standby charges may impede development of distributed renewable energy generation facilities, 21 states (as of July 2009) prohibited standby charges for customers with small-scale PV systems (Varnado and Sheehan 2009).

Liability Insurance

According to IREC, additional liability insurance has been a “major battleground” in developing interconnection procedures for small distributed generation. States and utilities have wanted to include additional liability insurance requirements to protect the utility and its employees from accidents that could be attributed to the distributed generation system. But most small businesses and homeowners already carry liability insurance under their standard insurance policies. Furthermore, IREC reports that liability claims from malfunctioning customer-sited renewable energy systems are very infrequent. To date, there have been no known insurance claims for utility damages from any of the over 50,000 solar installations in the United States; therefore, some states have eliminated the requirement to carry additional insurance or have specified how much general liability insurance a project owner must carry instead of requiring additional insurance for the distributed generation system (Fox, Keyes, and Sheehan 2008).

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[20] IEEE 1547 is one of a series of technical standards for distributed generation interconnection. UL 1741 includes a list of UL certified equipment.

[21] For example, a net-metered system may need a second meter to measure and record the outgoing energy if the existing meter is not capable of performing this function.

Dispute Resolution

Dispute resolution procedures can also be important factors for small and distributed generation development. In the absence of an adequate dispute resolution process, project sponsors have no option but to seek legal or regulatory recourse that may be costly and time consuming. Small and distributed generation project sponsors, especially at the residential level, would likely not pursue this course of action, opting instead to abide by the utility's rulings or, if the financial burden is too high, to abandon the project.

8 Enabling Development of Renewable Energy and Distributed Generation

Simplifying and streamlining interconnection has been a primary consideration for states developing interconnection procedures. California and New York were the first two states to develop interconnection standards. New York implemented its Standard Interconnection Requirements in 1999 and California its Rule 21 standard in 2000. Nevada used California Rule 21 as a model when developing its standards. New Jersey participated in the creation of the MADRI rules but then opted to develop their own interconnection standards, drawing in part on the IREC model. Oregon adapted and improved on the MADRI rules for their non-net-metered interconnection standards (discussed in more detail in the Appendix), which are now being considered as a model for other states. Colorado and Arizona relied in part on the FERC SGIP when creating their standards. The Appendix contains in-depth case studies of three states with comprehensive interconnection procedures—California, New Jersey, and Oregon.

Almost all of the net-metering and interconnection procedures implemented at the state level are restricted to renewable energy and clean energy technologies. This includes solar, wind, biomass, landfill gas, small hydro, combined heat and power, municipal solid waste, anaerobic digestion, and ocean energy. Some interconnection procedures limit eligible technologies to just a few types, usually solar, wind, biomass, and small hydro. This is in keeping with state policy goals for increasing renewable energy development.

Well-crafted interconnection procedures can contribute to the successful implementation of state renewable energy objectives. Indeed, a strong correlation appears to exist between the growth of renewable energy generation, particularly solar energy, with Renewable Portfolio Standard (RPS) requirements, expansive net-metering policies, and interconnection procedures that incorporate many of the identified best practice features.[22] To focus on just a sub-set of state policies, 29 states plus the District of Columbia, as of June 2010, have enacted state RPSs, and another seven states have renewable energy goals (DSIRE 2010). Of the states with an RPS or a renewable energy goal, 16 states plus the District of Columbia have solar, distributed generation provisions such as specific set-asides for solar and distributed generation, or renewable energy credit multipliers (DSIRE 2010). In addition, as of June 2010, 43 states plus the District of Columbia have enacted net metering (DSIRE 2010). Table 5 shows the total amount of grid-connected solar electric installed by state through the end of 2009, including both small- and large-scale PV and concentrating solar power.

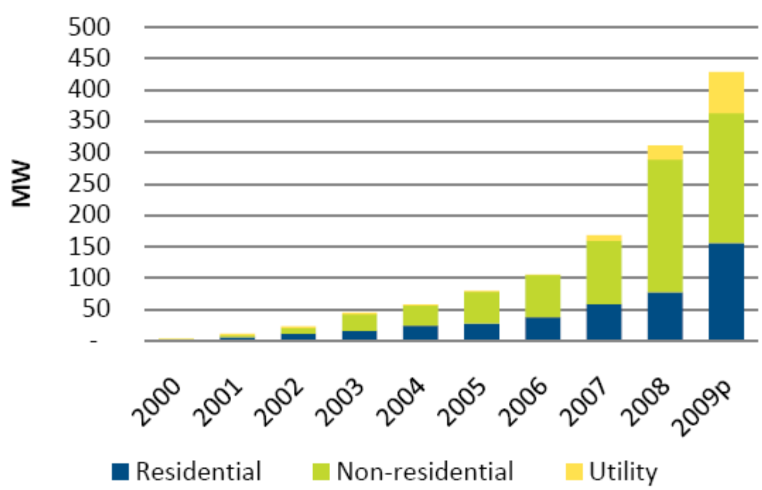
[22] Renewable energy incentives also play a significant role in encouraging development. A full analysis of the causes of renewable energy development is beyond the scope of this paper. The intent here is to point out that these policies can all work together to enable renewable energy deployment in a state.

Table 5. Installed Grid-connected Solar Electric Capacity by State Through 2009 (MW)

Capacity Installed in 2009			Cumulative Capacity in 2009		
Rank	State	MW	Rank	State	MW
1	California	220	1	California	1,102
2	New Jersey	57	2	New Jersey	128
3	Florida	36	3	Nevada	100
4	Arizona	23	4	Colorado	59
5	Colorado	23	5	Arizona	50
6	Hawaii	14	6	Florida	39
7	New York	12	7	New York	34
8	Massachusetts	10	8	Hawaii	27
9	Connecticut	9	9	Connecticut	20
10	North Carolina	8	10	Massachusetts	18
	Others	29		Others	78
Total		441	Total		1,655

Source: SEIA 2010.

Figure 1 depicts all installed grid-connected PV capacity by residential and non-residential customers between 2000 and 2009 (preliminary estimate by SEIA). Additionally, an estimated 40 MW of off-grid PV capacity was added in 2009 (SEIA 2010).



Source: SEIA 2010. Note: 2009 total is a projected amount (p).

Figure 1. Grid-connected PV capacity through 2009 (MW)

The five states with the greatest cumulative solar electric capacity all have requirements, have comprehensive net-metering programs, and, with the exception of Arizona, achieved a score of B on their interconnection procedures in the 2009 edition of *Freeing the Grid*. They gave Arizona a C, mainly due to the generator interconnection procedures never having been finalized. Several years ago, Arizona began a proceeding to examine interconnection procedures, but to date they remain as recommendations only. Arizona utilities, however, have individually adopted interconnection procedures. Additionally, three of the top five states have included a solar requirement in their RPS: New Jersey—2.12% by 2021; Colorado—0.8% by 2020; and Nevada—1.5% by 2025. Arizona has included distributed generation requirements, which states that 4.5% of the electricity supply must come from customer-sited facilities by 2025 (DSIRE 2010).

9 Conclusion

Generator interconnection policies and procedures impact how and what type of FITs can successfully be implemented in the United States. FITs have been successful in Europe, leading to significant advances in renewable energy development in several countries. But the implementation of European-style FITs in the United States is constrained by legal and regulatory policies that determine interconnection procedures. European Union Member States have been directed to guarantee the interconnection of renewable generators, to prioritize the dispatch of renewable energy, and to consider requiring the purchase of that energy. European Union Member States also have the option of prioritizing the interconnection of renewable generators—in effect, moving them to the head of the queue. Additionally, the cost of interconnecting a new renewable energy generator to the electric grid is borne mainly by electricity customers.

In the United States, new generators under FERC jurisdiction must be given non-discriminatory open-access to interconnection with no priority given to any particular technology or type of generator. Generators must also obtain dispatch, transmission service, and customers for their energy separate from interconnection. Generators are also required to pay the cost for directly connecting their facility to the transmission grid and to provide the initial funding for any necessary network upgrades. Under FERC rules, dispatch cannot be guaranteed.

The guaranteed interconnection and dispatch preferences for generators under European-style FITs are incompatible with the FPA and established FERC regulations. The development of a national-level FIT or state-level FITs for large generators connecting to the FERC-jurisdictional transmission system would require changes to the FPA.[23] State-jurisdictional interconnection rules and procedures affecting distributed renewable generation facilities can be changed by states to align with state-level renewable energy goals and FIT policies. States seeking to implement FITs may wish to focus on creating FIT-type policies at this level.

[23] FERC jurisdiction under FPA applies to all wholesale markets engaged in interstate commerce. A recent FERC order affirmed FERC's jurisdiction in this regard. The CPUC requested that FERC issue a declaratory order finding that a feed-in tariff for cogeneration facilities does not invoke FERC jurisdiction under the FPA. FERC ruled that the feed-in tariff constitutes an attempt to set wholesale rates. FERC stated the CPUC's feed-in tariff "will not be preempted by the FPA and PURPA as long as: (1) the CHP generators from which the CPUC is requiring the Joint Utilities to purchase energy and capacity are QFs pursuant to PURPA; and (2) the rate established by the CPUC does not exceed the avoided cost of the purchasing utility" (FERC 2010a). In response to a request for clarification from the CPUC, FERC clarified that "a multi-tiered avoided cost rate structure is consistent with the avoided cost rate requirements set forth in PURPA...(and) if a state required a utility to purchase 10 percent of its energy needs from renewable resources, then a natural gas-fired unit...would not be relevant to determining avoided costs for that segment of the utility's energy needs." (FERC 2010b, 13). FERC also explained that the CPUC could include in their determination of avoided costs the expected costs for avoiding upgrades to the distribution or transmission system, as long as those costs are based on an actual determination of expected costs (FERC 2010b).

States may also wish to examine their interconnection policies and procedures to ensure that these are aligned with their overall renewable energy goals and policies. The various model rules have been used by numerous states to inform interconnection development proceedings. The *Freeing the Grid* report studied state interconnection procedures and formulated some lessons learned including:

- Ensure fees are fair and proportional to a project's size.
- Cover all generators in order to close any state-federal jurisdictional gaps.
- Screen applications by degree of complexity and adopt "plug-and-play" rules for residential-scale systems and expedited procedures for other systems.
- Ensure that policies are transparent, uniform, and detailed.
- Prohibit requirements for additional insurance and extraneous devices, such as redundant disconnect switches.
- Apply existing relevant technical standards, such as IEEE 1547 and UL 1741.
- Process applications quickly; a determination should occur within a few days.
- Standardize and simplify forms.

Appendix

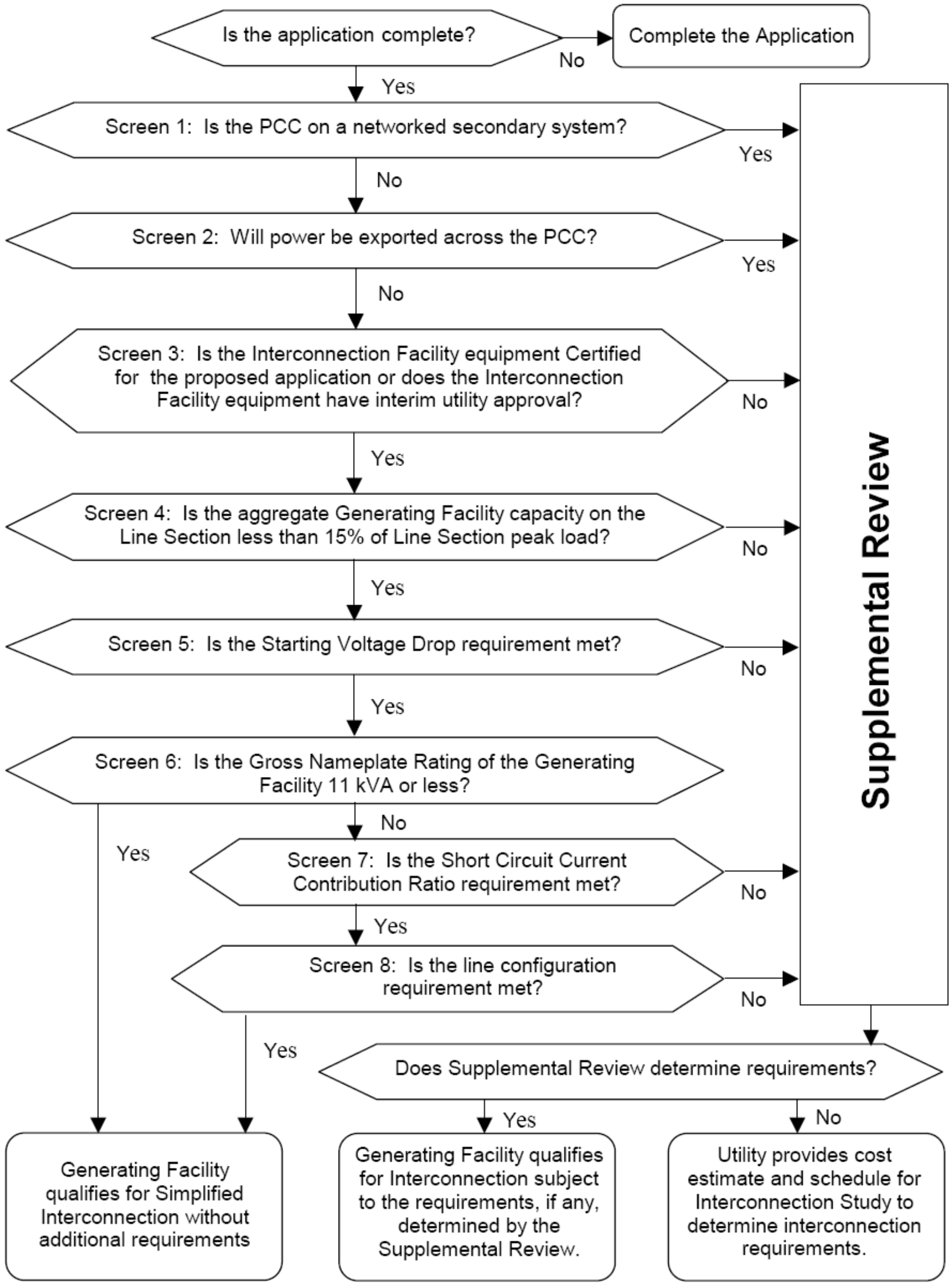
State Interconnection Procedures Case Studies

California

CPUC approved California Rule 21 in 2000 making California one of the first states to adopt a comprehensive state interconnection policy. Rule 21 was developed with the aim of streamlining the state's interconnection protocols through simplification and standardization and to encourage the installation of renewable energy generation facilities. As one of the first comprehensive procedures developed for state-jurisdictional generation facilities, and because it included model tariff language, Rule 21 has become a model for other states' policies.

Rule 21 details the standard interconnection, operating, and metering requirements for state-jurisdictional generation systems. There is no specified system capacity limit under Rule 21. The amount of general liability insurance that project proponents are required to carry are established by CPUC and determined by the size and type of the proposed project, with some projects not needing any insurance beyond standard policies. Net-metered solar and wind systems, for example, do not require any additional insurance. The technical requirements for distribution-level generation installations in California are similar to the technical requirements established in IEEE 1547, such as those concerning voltage and frequency fluctuations, flicker, DC injection, harmonics, protection devices, and islanding. The testing and certification requirements include the IEEE standards as well as the UL standards.

Under Rule 21, applicants begin at the same point in the review process regardless of project capacity and are later sorted by the complexity of the interconnection. The interconnecting utility conducts an Initial Review Process to determine if the generation facility is eligible for a simplified interconnection. Under a simplified interconnection, no supplemental review or interconnection studies are required. If the initial review process is not passed, a supplemental review process follows. If the applicant passes the supplemental review process, interconnection may be permitted if certain requirements are met. If it fails, however, an interconnection study will be pursued, with the costs determined by the utility and paid for by the system owner. A basic outline of the screening process can be found in Figure A-1.



Source: Cooley et al. 2003.

Figure A-1. California Rule 21 screening process

California Public Utilities Code 2827 specifies that small PV and wind turbine generation systems under 1 MW, which is the capacity limit in California to qualify for net metering, are exempt from installing additional controls, performing or paying for additional tests, and purchasing additional liability insurance. This is provided they comply with the applicable safety and performance standards of the National Electric Code, IEEE, accredited testing laboratories including UL, and CPUC rules regarding safety and reliability. Although utilities are required to supply a two-way meter for net-metered systems, a system owner will be only be required to pay for it if they choose time-of-use metering. California's requirements for an external disconnect switch varies by utility and system size.

A 2005 report found that while it took roughly a year for utilities to approve interconnection requests prior to the adoption of Rule 21, it was taking less than three months to do so by 2003 (Michel and Prabhu 2005). The same report stated that interconnection fees decreased for most of the applicants from about $5,000 to between $800 and $1,400 after Rule 21 was approved. Between January 2001 and June 2006, 533 renewable energy projects, totaling 606.8 MW, were authorized to interconnect under Rule 21 (California Energy Commission 2006).

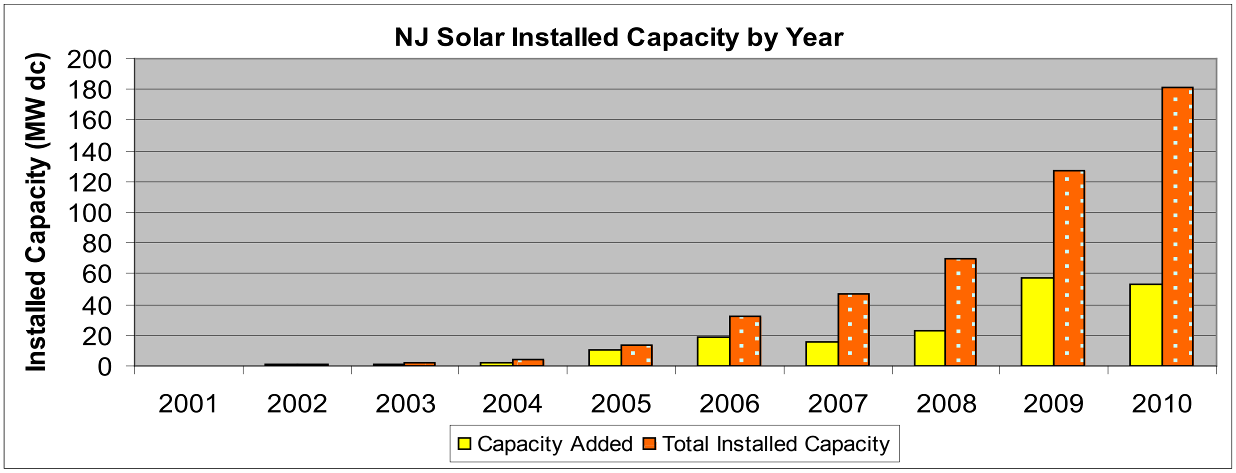
New Jersey

New Jersey was one of several states involved in the development of the MADRI model generator interconnection procedures, which were published in 2004, though New Jersey opted to create their own standards rather than adopt the MADRI model. Motivated by the state's RPS, set at 20% renewable energy by 2020, New Jersey's Board of Public Utilities (BPU) had already adopted interim interconnection standards in 2001, which were then finalized in 2004. The New Jersey standards have been amended several times, most recently in 2010.

Interconnection requests in New Jersey are reviewed at three different levels, based on size and certification. Level 1, for which there is no fee for interconnection, is applicable to inverter-based systems that have a capacity rating of up to 10 kW. Level 2 applies to systems with up to 2 MW of capacity. For both Levels 1 and 2, the systems must be certified as meeting IEEE 1547 and UL 1741 standards. At Level 2, the interconnection could include a fee of $50 plus an additional $1 per kW of capacity. The costs of any additional reviews or modifications to the utility distribution system, based on estimates prepared by the electric utilities, may also be included, but are subject to a case-by-case review. Charges for engineering work that takes place as part of an additional review are capped at $100 per hour. At Levels 1 and 2, utilities are not permitted to require the customer-generators to buy additional liability insurance, to install further controls or external disconnect switches not included in the equipment package, or to require additional testing. The Office of Clean Energy in the BPU has developed standardized interconnection forms with stakeholder input. The forms for Level 1 have been in use for several years, and the forms for Levels 2 and 3 are currently being finalized.

Level 3 is comprised of those systems that do not qualify for review at either Levels 1 or 2. Level 3 systems could be subject to a $100 fee, plus an additional $2 per kW of capacity and direct costs from any impact or facilities studies. Similar to Level 2, the costs for engineering work done as part of an impact or facilities study for Level 3 are capped at $100 per hour. Also, the costs are borne by the applicant if the electric distribution company has to install any facilities to accommodate the interconnection.

From 2001 through 2009, 4,943 renewable energy technology projects were installed in New Jersey, totaling about 165 MW. The majority of these projects have been solar, which comprise about 126 MW of the total installed capacity during that time period (see Figure A-2).



Source: New Jersey Clean Energy Program 2010; Includes New Jersey solar installations for 2010 as of 6/30/10.

Figure A-2. New Jersey installed solar capacity by year

Oregon

Oregon's net-metering law was enacted in 1999 and amended in 2005 to add biomass and allow the Oregon Public Utility Commission (Oregon PUC) to expand the net-metering facility size for Oregon's two primary IOUs, Portland General Electric (PGE) and Pacific Power & Light Company (dba PacifiCorp). The net-metering law applies to solar power, wind power, hydropower, fuel cells, and biomass resources used to generate electricity. Utilities must allow net-metering facilities with a generating capacity up to 25 kW. The law applies to all utilities in the state, although the law allows Idaho Power to adhere to net-metering rules set by the Idaho Public Utilities Commission. Except for IOUs, a utility may limit net metering when the cumulative generating capacity of all net-metered systems in its service area reaches 0.5% of its historic single-hour peak load. PGE and PacifiCorp may not limit the aggregate capacity of net-metered systems in their service territories unless ordered to do so by Oregon PUC.

The law contains a handful of provisions addressing interconnection requirements. Net-metering systems must meet all applicable safety and performance standards established in the state building code. Those standards must be consistent with the applicable portions of the National Electric Code, IEEE standards, and an accredited laboratory, such as UL. Utilities may not require additional tests or the purchase of additional liability insurance, though it is specified that utilities are not legally responsible for any loss, injury, or death related to the interconnection of a net-metered system.

In 2007, the Oregon PUC established standard interconnection requirements for net-metered facilities for PGE and PacifiCorp. The Oregon PUC opted to base its interconnection rules for net-metered systems on the MADRI model standards. Rather than adopt the model procedures verbatim, however, Oregon made some modifications, resulting in Oregon's unique generator interconnection procedures.

For net-metering in PGE's and PacifiCorp's territories, the Oregon PUC retained the minimum capacity limit for individual residential systems at 25 kW and expanded that limit to 2 MW for non-residential systems. The interconnection procedures require a standard application and a standard agreement. The installation of grid-connected PV systems rose 330% in 2008 in Oregon, increasing PV capacity from 1.1 MW_{DC} to 4.8 MW_{DC} (Sherwood 2009).

There are three levels of review for the interconnection of PGE and PacifiCorp's net-metered systems. Certified, inverter-based systems with a capacity of up to 25 kW that are in compliance with UL 1741 and IEEE standards are reviewed under Level 1. This is provided that the systems have passed certain technical screens, a requirement for all three levels. At this first level of review, utilities are not permitted to levy application fees or other charges. Level 2 extends to certified systems of up to 2 MW that are not qualified for review under Level 1. At this level, utilities are permitted to charge fees, with a cap of $50 plus $1 per kW of system capacity. In addition, utilities may recover the costs for any additional reviews that are required and the costs for any upgrades to the electric distribution system, provided they are considered to be within reason. For both Level 2 and Level 3, a cap of $100 per hour is imposed on costs associated with engineering work done for an impact study or an interconnection facilities study. Systems that are ineligible for review under Levels 1 or 2 and have a maximum capacity of 2 MW are reviewed under Level 3. Utilities may charge fees up to $100 plus $2 per kW of the system's capacity, as well as the costs for any impact or facilities studies. The applicant is also responsible for the costs of any distribution system upgrades the utility has to install to accommodate the interconnection.

The Oregon PUC also established interconnection standards for other distributed generators under its jurisdiction, primarily PURPA facilities. All three investor-owned utilities—PGE, PacificCorp, and Idaho Power—are subject to these regulations. To date, interconnection regulations have been adopted for facilities up to 10 MW and for facilities over 20 MW (based on the FERC interconnection regulations for large generators). Interconnection regulations for facilities between 10 and 20 MW have not yet been adopted.

Oregon adopted the interconnection rules for non-net-metered small generator facilities up to 10 MW in 2009. The Oregon interconnection procedures for these systems have four levels of review. All systems must adhere to the IEEE 1547 and IEEE 1547.1 standards, unless otherwise specified by the Oregon PUC. The levels are divided by capacity with varying application fees. Level 1 includes facilities up to 25 kW, with the application fees capped at $100, while Level 2 extends to facilities ineligible for Level 1 that have a capacity of up to 2 MW, and an application fee limit of $500. The rules for Levels 1 and 2 parallel the rules set in place by the Oregon PUC for net-metered systems. Levels 3 and 4 both limit the application fees to $1,000. Level 3 covers those non-exporting systems with a nameplate capacity up to 10 MW that are ineligible under Levels 1 or 2, and Tier 4 covers other systems ineligible for Tiers 1, 2, or 3 with a capacity of 10 MW or less. Additional charges could apply but the applicant must review and provide written consent for any charges beyond the application fee.

Oregon's net-metering law does not explicitly require external disconnect switches for net-metered systems but conversely does not prohibit their inclusion. Therefore, some utilities require them. The Oregon PUC allows PGE and PacifiCorp to require external disconnect switches except for inverter-based systems with a capacity of 25 kW or less.

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14. ABSTRACT *(Maximum 200 Words)*
Feed-in tariffs (FITs) have been used to promote renewable electricity development in over 40 countries throughout the past two decades. These policies generally provide guaranteed prices for the full system output from eligible generators for a fixed time period (typically 15–20 years). Due in part to the success of FIT policies in Europe, some jurisdictions in the United States are considering implementing similar policies, and a few have already put such policies in place. This report is intended to offer some guidance to policymakers and regulators on how generator interconnection procedures may affect the implementation of FITs and how state generator interconnection procedures can be formulated to support state renewable energy objectives. This report is based on a literature review of model interconnection procedures formulated by several organizations, as well as other documents that have reviewed, commented on, and in some cases, ranked state interconnection procedures.

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