5.4 Interconnection Standards

Policy Description and Objective

Summary

Standard interconnection rules for distributed generation (DG) systems (renewable energy and combined heat and power [CHP]) are a relatively recent policy innovation used by states to accelerate the development of clean energy supply. CHP is an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source by recovering the waste heat for use in another beneficial purpose. Customer-owned DG systems are typically connected in parallel to the electric utility grid and are designed to provide some or all of the onsite electricity needs. In some cases, excess power is sold to the utility company.

Standard interconnection rules establish uniform processes and technical requirements that apply to utilities within the state. In some states, municipally owned systems or electric cooperatives may be exempt from rules approved by the state regulators. Standard interconnection rules typically address the application process and the technical interconnect requirements for small DG projects of a specified type and size.

Customers seeking to interconnect DG systems to the utility grid must meet the procedural and technical requirements of the local utility company. These requirements address such important issues as grid stability and worker and public safety. With the approval of regulators, utilities establish the conditions that customers seeking to connect DG systems to the grid must meet. These conditions include safeguards, grid upgrades, operating restrictions, and application procedures that may create barriers for some DG projects, particularly smaller systems. Smaller-scale DG systems are often subject to the same, frequently lengthy, interconnection procedures as larger systems even though their system impact is likely to be significantly less. If interconnection procedures are overly expensive in proportion to the size of the project, they can overwhelm project costs to the point of making clean DG uneconomical.

It is for these and other reasons that states are increasingly developing and promoting standardized interconnection requirements and rules for DG. In addition, some states use net metering rules to govern interconnection of smaller DG systems. Net metering is a method of crediting customers for electricity that they generate on site in excess of their own electricity consumption. It allows smaller DG owners to offset power that they obtain from the grid with excess power that they can supply through their grid connection.

Standard interconnection is a critical component of promoting clean DG and has been most successful when coupled with other policies and programs. Consequently, states are promoting clean DG through a suite of related policies, including standard interconnection; addressing utility rates for standby, backup, and exit fees; creating renewable portfolio standards (RPS); and other initiatives. The Energy Policy Act of 2005 (EPAct 2005) directs states to consider their interconnection standards for DG within one year of enactment (by September 2006) and their net metering standards within two years of enactment (September 2007).

The state public utility commission (PUC), in determining utility interconnection rules, can establish uniform application processes and technical requirements that reduce uncertainty and prevent excessive time delays and costs that distributed generation (DG) can encounter when obtaining approval for electric grid connection.

Objective

The key objective of standard interconnection rules is to encourage the connection of clean DG systems (renewable and CHP) to the electric grid in order to obtain the benefits that they can provide without compromising safety or system reliability.

Benefits

Standardized interconnection standards can support the development of clean DG by providing clear and reasonable rules for connecting clean energy systems to the electric utility grid. By developing standard interconnection requirements, states make progress toward leveling the playing field for clean DG relative to traditional central power generation. Standard interconnection rules can help reduce uncertainty and prevent excessive time delays and costs that small DG systems sometimes encounter when obtaining approval for grid connection.

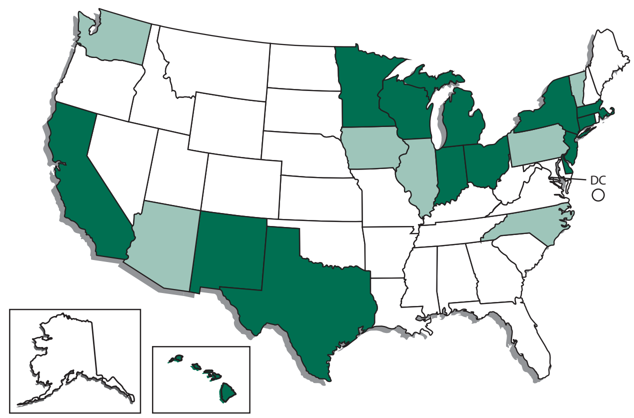
The benefits of increasing the number of clean DG projects include: enhancing economic development in the state,[24] reducing peak electrical demand, reducing electric grid constraints, reducing the environmental impact of power generation, and helping states achieve success with other clean energy initiatives. The application of DG in targeted load pockets can reduce grid congestion, potentially deferring or displacing more expensive transmission and distribution infrastructure investments. A 2005 study for the California Energy Commission (CEC) found that strategically sited DG yields improvements to grid system efficiency and provides additional reserve power, deferred costs, and other grid benefits (Evans 2005). Widespread deployment of DG can slow the growth-driven demand for more power lines and power stations.

States with Interconnection Standards

DG interconnections that do not involve power sales to third parties typically are regulated by states. The Federal Energy Regulatory Commission (FERC) regulates DG interconnections used to export power or for interstate commerce.[25] Since most DG is used to serve electric load at the customer's site, states approve the interconnection standards used for the majority of interconnections for smaller, clean DG systems.

As of November 2005, 14 states had adopted standard interconnection requirements for distributed generators (i.e., California, Connecticut, Delaware, Hawaii, Indiana, Massachusetts, Michigan, Minnesota, New Mexico, New Jersey, New York, Ohio, Texas, and Wisconsin), and seven additional states were in the process of developing similar standards (i.e., Arizona, Illinois, Iowa, North Carolina, Pennsylvania, Vermont, and Washington) (see Figure 5.4.1). While these standards often cover a range of generating technologies,

Figure 5.4.1: States with DG Interconnection Standards



States with interconnection rules

States with proposed interconnection rules

Notes:

- New Jersey also has interconnection standards for net metered renewable DG ≤ 2 MW.
- New Hampshire has interconnection standards for net metered renewable DG ≤ 25 kW.

Maximum System Size for a State Interconnection Standard			
CA	None	NH	25 kW
CT	25 MW	NJ	2 MW
DE	1 MW	NM	10 kW
HI	None	OH	None
MA	None	NY	2 MW
MI	None	TX	10 MW
MN	10 MW	WI	15 MW
NC[a]	100 kW		

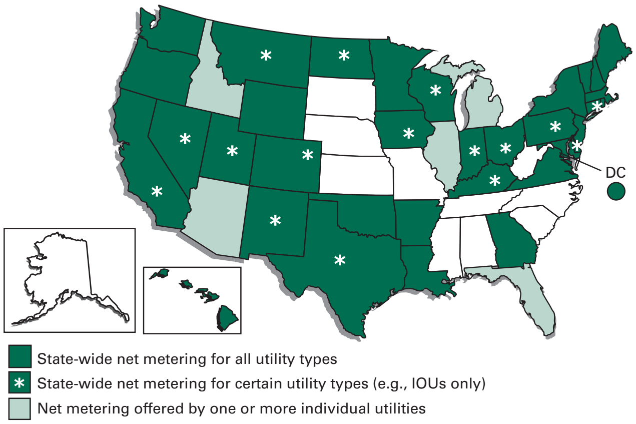
[a] System size is limited to 20 kW for residential customers.

Source: Navigant 2005.

[24] Economic development occurs through the increased number of DG facilities needed to meet electricity demand in the state and inducing companies to invest more in their facilities.

[25] Particularly those installations that are not interconnected to transmission systems or involved in third-party wholesale transactions.

Figure 5.4.2: States with Net Metering Rules



Net Metering System Size Limit (kW) (in some cases limits are different for residential and commercial as shown)			
AR	25/100	MN	40
AZ	10	MT	50
CA	1,000	ND	100
CO	Under development	NH	25
CT	100	NJ	2,000
DC	100/25	NM	10
DE	Varies	NV	30
FL	Varies	NY	10/400
GA	10/100	OH	No limit
HI	50	OK	100
IA	Varies	OR	25
ID	25/100	PA	Varies
IL	40	RI	25
IN	10	TX	50
KY	15	UT	25
LA	25/100	VA	10/500
MA	60	VT	15/150
MD	80	WA	25
ME	100	WI	20
MI	Varies	WY	25

Source: IREC 2005.

most include interconnection of renewable and CHP systems.

In addition to interconnection requirements, many states have adopted net metering provisions. Most states find that smaller DG systems are more likely to produce power primarily for their own use, with exports to the grid tending to be incidental. These DG customers are at an economic disadvantage if the interconnect requirements are excessive. Also, small systems are more likely to have de minimus effects on the physical electric grid and on equity issues among customers, so the requirements needed for large generators are unnecessary in these instances. For these reasons, a simplified process has been adopted.

Net metering provisions can be considered a subset of interconnect standards for small scale projects. As of July 2005, 39 states and Washington, D.C. had rules or provisions for net metering (see Figure 5.4.2). When DG output exceeds the site's electrical needs, the utility may pay the customer for excess power supplied to the grid or have the net surplus carry over to the next month's bill. Some states allow the surplus account to be reset periodically, meaning that customers might provide some generation to the utility for free. Net metering provisions streamline interconnection standards but often are limited to specified sizes and types of technologies.

Some state net metering provisions are limited in scope. For example, net metering rules often apply only to relatively small systems,[26] specified technologies, or fuel types of special interest to policymakers. Some rules lack detailed specifications and procedures for utilities and customers to follow and vary across utilities within the state.[27] Several states, however, have net metering provisions and interconnection rules that provide a complete range of interconnection processes and requirements.[28]

26 Thirty-four of 39 states that have net metering rules limit system sizes to 100 kW or less.
27 States that have variable net metering policies among utilities include Arizona, Florida, Idaho, and Illinois.
28 Some states (e.g., New Hampshire and New Jersey) have developed standard interconnection processes and requirements as part of their net metering provision.

Designing Effective Interconnection Standards

States consider a number of key factors when designing effective interconnection standards that balance the needs of DG owners, the utility company, and the public. These factors include promoting broad participation during standards development, addressing a range of technology types and sizes, and taking into consideration current barriers to interconnection. In addition, it is important to consider state and federal policies that might influence the development and operation of interconnection standards.

Participants

Key stakeholders who can contribute to the process of developing effective interconnection standards include:

- *Electric Utilities.* Utilities are responsible for maintaining the reliability and integrity of the grid and ensuring the safety of the public and their employees.
- *State PUCs.* PUCs have jurisdiction over investor-owned utilities (IOUs) and, in some cases, public-power utilities. They are often instrumental in setting policy to encourage onsite generation.
- *Developers of CHP and Renewable Energy Systems and Their Respective Trade Organizations.* Developers and their customers that will rely on these systems can provide valuable technical information and real-world scenarios.
- *Third-Party Technical Organizations.* Organizations such as the Institute of Electric and Electronic Engineers (IEEE) and certifying organizations like the Underwriters Laboratories (UL) have been active in establishing interconnection protocols and equipment certification standards nationwide.

Complicated Landscape of Interconnection for Distributed Generation

Renewable energy and CHP systems used by commercial or industrial facilities are typically smaller than 10 MW in capacity. When designing and implementing standards for systems of this size, it is important to realize that the size dictates how and by whom interconnection is regulated.

- *10 MW and larger systems: generally regulated by FERC.* Standards are being developed, or have already been developed, for larger systems that are often connected directly to the transmission grid and can be outside of a state's jurisdiction. Historically, most grid-connected generation systems were owned by electric utilities. As a result of restructuring and other legislation (e.g., the Public Utilities Regulatory Policy Act, PURPA), utilities were required to interconnect non-utility generators to the electric grid. States and regulatory agencies such as FERC have begun to develop or have already implemented standard interconnection rules for non-utility generators. However, most of these rules apply to larger generating facilities (> 10 MW).
- *100 kW systems and under: often covered to some degree by state net metering provisions.* Some states have developed provisions for net metering of relatively small systems (i.e., < 100 kW). While these provisions typically are not as comprehensive as interconnection standards, they can provide a solid starting point for industry, customers, and utilities with respect to connection of relatively small DG systems to the electric grid.
- *0.1–10 MW systems: require attention.* This "intermediate" group represents systems that are interconnected to the distribution system but are larger than the systems typically covered by net metering rules and smaller than the large generating assets that interconnect directly to the transmission system and are regulated by FERC. In response to the mounting demands by customers and DG/CHP developers to interconnect generation systems to the grid, utilities increasingly have established some form of interconnection process and requirements. In addition, to increase utility confidence around DG systems, industry organizations such as the IEEE and UL have begun to develop standards that enable the safe and reliable interconnection of generators to the grid. However, there is a need for states to establish standard interconnection rules for generation systems of all sizes.

- *Regional Transmission Organizations (RTOs).* These organizations may have already implemented interconnection standards using FERC requirements for large non-utility generators generally above 10 MW.
- *Other Government Agencies.* Federal agencies (e.g., FERC) and state environmental and public policy agencies can play an important role in establishing and developing interconnection standards.

Some states are bringing key stakeholders together to develop state-based standards via a collaborative process. For example, in Massachusetts, the Distributed Generation Collaborative (DG Collaborative) successfully brought together many diverse stakeholders to develop the interconnection rules now used by DG developers and customers in Massachusetts.

Typical Specifications

Interconnection standards typically specify:

- The type of technology that may be interconnected (e.g., inverter-based systems, induction generators, synchronous generators).
- The required attributes of the electric grid where the system will be interconnected (i.e., radial or network distribution, distribution or transmission level, maximum aggregate DG capacity on a circuit).
- The maximum system size that will be considered in the standard interconnection process.

Standard interconnection rules typically address the application process and the technical interconnection requirements for DG projects:

- The application process includes some or all parts of the interconnection process from the time a potential customer considers submitting an application to the time the interconnection agreement is finalized. For example, rules may specify application forms, timelines, fees, dispute resolution processes, insurance requirements, and interconnection agreements.
- Technical protocols and standards specify how a generator must interconnect with the electric grid. For example, requirements may specify that DG must conform to industry or national standards and include protection systems designed to minimize degradation of grid reliability and performance and maintain worker and public safety.

In addition, some states are developing different application processes and technical requirements for differently sized or certified systems. Since the size of a DG system can range from a renewable system of only a few kW to a CHP system of tens of MW, standards can be designed to accommodate this full range. Several states have developed a multi-tiered process for systems that range in size from less than 10 kW to more than 2 MW. Three states (Connecticut, Michigan, and Minnesota) have classified DG systems into five categories based on generator size. Other states use fewer categories, but also define fees, insurance requirements, and processing times based on the category into which the DG falls. The level of technical review and interconnection requirements usually increases with generation capacity.

In states with a multi-tiered or screen interconnection process, smaller systems that meet IEEE and UL standards or certification generally pass through the interconnection process faster, pay less in fees, and require less protection equipment because there are fewer technical concerns. States that require faster processing of applications for smaller systems ($\leq$ 10 to $\leq$ 30 kW) include California, Connecticut, Massachusetts, Michigan, Minnesota, New York, and Wisconsin. For relatively large DG systems, processes and requirements may be similar or identical to those used for large central power generators. For mid-size systems, states have found they may need to develop several levels of procedural and technical protocols to meet the range of needs for onsite generators, utilities, and regulators.

Constraints

Designing new DG interconnection rules provides an opportunity to resolve recurring barriers encountered by applicants for interconnection of DG systems. These barriers have been well-documented (NREL 2000, Schwartz 2005); three areas in which a DG developer typically confronts problems include:

- *Technical Barriers* resulting from utility requirements (including requirements for safety measures) regarding the compatibility of DG systems with the grid and its operation. For example, customers may be faced with costly electric grid upgrades as a condition of interconnection. Another frequently cited technical requirement that is particularly costly for smaller DG is the visible shut-off switch located outside the premises that can be accessed by the utility to ensure that no power is flowing from the DG unit. These shut-off switches range from $1,000 to $6,000 for small systems (e.g., 30 kW to 200 kW), depending on their location and whether they are installed as part of the original facility design or after the system began operations.
- *Utility Business Practices*, including issues that result from contractual and procedural interconnection requirements between the utility and the project developer/owner. For example, customers may face a long application review period or lengthy technical study requirements, with high associated costs.
- *Regulatory Constraints* arising primarily from tariff and rate conditions, including the prohibition of interconnection of generators that operate in parallel with the electric grid.[29] In some instances, environmental permitting or emission limits also can create barriers. For more information on the barriers posed to DG systems by tariff and rate issues, see Section 6.3, *Emerging Approaches: Removing Unintended Utility Rate Barriers to Distributed Generation*.

Some states are beginning to address these areas of concern through a combination of policy actions and regulatory changes to remove or alter requirements that they believe are not appropriate for the scale of small DG units.

Interaction with Federal Policies

States have found that several federal initiatives can be utilized when designing their own interconnection standards:

- In May 2005, FERC adopted interconnection standards for small DG systems of up to 20 MW. The rulemaking addresses both the application processes and technical requirements. Concurrently, through a separate rulemaking, FERC has addressed an application process and technical requirements for systems under 2 MW. States can use the new FERC standard interconnection rules as a starting point or template for preparing their own standards.[30]
- Under the Public Utilities Regulatory Policy Act (PURPA), utilities are required to allow interconnection by Qualifying Facilities (QFs).[31] Utilities may have standard procedures for such interconnection and some states may regulate such interconnection. New interconnect rules for DG may be more or less favorable than the existing regulations for QFs and also may not be consistent with existing rules for QFs. For example, in Massachusetts the application timelines and fees in the QF regulations are different than the DG interconnection tariff, which could create confusion and delay in establishing an interconnection.
- EPAct 2005 requires electric utilities to interconnect customers with DG upon request. The Act

29 When a CHP system is interconnected to the grid and operates in parallel with the grid the utility only has to provide power above and beyond what the onsite CHP system can supply.

30 FERC's interconnection rules, however, apply only to the third party and wholesale power transactions they regulate. Most DG systems fall under state, rather than FERC, jurisdiction, since most are connected at the distribution-system level and do not involve third-party exports via the utility grid.

31 A QF is a generation facility that produces electricity and thermal energy and meets certain ownership, operating, and efficiency criteria established by FERC under PURPA.

specifies that the interconnection must conform to IEEE Standard 1547, as it may be amended from time to time. In addition, the state regulatory authority must begin to consider these standards within one year of enactment (September 2006) and must complete its consideration within two years (September 2007). However, states that have previously enacted interconnection standards, have conducted a proceeding to consider the standards, or in which the state legislature has voted on the implementation of such standards do not have to meet these time frames.

- EPAct 2005 requires electric utilities to make available upon request net metering services to any electric customer. The state regulatory authority is required to consider net metering within two years of enactment (September 2007) and after three years of enactment must adopt net metering provisions (September 2008). However, states that have previously enacted net metering provisions, have conducted a proceeding to consider the standards, or in which the state legislature has voted on the implementation of such standards do not have to meet these time frames.

Interaction with State Policies

Interconnection standards are a critical complementary policy to other clean energy policies and programs such as state RPS (see Section 5.1, *Renewable Portfolio Standards*), clean energy fund investments (see Section 5.2, *Public Benefits Funds for State Clean Energy Supply Programs*), and utility planning practices (see Section 6.1, *Portfolio Management Strategies*).

Best Practices: Designing an Interconnection Standard

Best practices for creating an interconnection standard are identified below. These best practices are based on the experiences of states that have designed interconnection standards.

- Work collaboratively with interested parties to develop interconnection rules that are clear, concise, and applicable to all potential DG technologies. This will streamline the process and avoid untimely and costly re-working.
- Develop standards that cover the scope of the desired DG technologies, generator types, sizes, and distribution system types.
- Address all components of the interconnection process, including issues related to both the application process and technical requirements.
- Develop an application process that is streamlined with reasonable requirements and fees. Consider making the process and related fees commensurate with generator size. For example, develop a straightforward process for smaller or inverter-based systems and more detailed procedures for larger systems or those utilizing rotating devices (such as synchronous or induction motors) to fully assess their potential impact on the electrical system.
- Create a streamlined process for generators that are certified compliant to certain IEEE and UL standards. UL Standard 1741, "Inverters, Converters and Charge Controllers for Use in Independent Power Systems," provides design standards for inverter-based systems under 10 kW. IEEE Standard 1547, "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems," establishes design specifications and provides technical and test specifications for systems rated up to 10 MW. These standards can be used to certify electrical protection capability.
- Consider adopting portions of national models (such as those developed by the National Association of Regulatory Utility Commissioners [NARUC], the Interstate Renewable Energy Council [IREC], and FERC) and successful programs in other states, or consider using these models as a template in developing a state-based standard. Also, consistency within a region increases the effectiveness of these standards.
- Try to maximize consistency between the RTO and the state standards for large generators.
- Developing consistency among states is important in reducing compliance costs for the industry based on common practices.

Implementation and Evaluation

This section describes the implementation and evaluation of new interconnection standards, including best practices that states have found successful.

Administering Body

While individual states may develop interconnection standards that are then approved by the PUC, utilities are ultimately responsible for their implementation.

Roles and Responsibilities of Implementing Organization

By establishing clearly defined categories of technologies and generation systems, utilities are able to streamline the process for customers and lessen the administrative time related to reviewing interconnection applications. For example, some states create multiple categories and tiers for reviewing applications with established maximum time frames. Across these technology categories, the maximum processing time allowed can vary by more than a factor of five depending on the technical complexity and size of the interconnection. Several states (including California, Connecticut, Massachusetts, Michigan, Minnesota, New York, and Wisconsin) have created tiered application processes based on system size and other factors. They have found that this tiered approach allows smaller systems a streamlined process while maintaining a standard process for larger systems.

- A *streamlined process* that applies to smaller[32] or simpler systems (e.g., inverter-based) could have lower fees, shorter timelines, and fewer requirements for system impact studies. In some cases, states have pre-certified certain devices (i.e., California and New York) or require compliance with UL 1741 or IEEE 1547 and other applicable standards (i.e., Connecticut, Massachusetts, Minnesota, New Jersey, and Texas) to expedite approval.
- Systems in a *standard process* are subject to a comprehensive evaluation. Applicants for these systems are typically required to pay additional fees for impact studies to determine how the DG may affect the performance and reliability of the electrical grid. Because of the higher degree of technical complexity, fees are higher and processing times are longer.

State Examples

There is no single way that states are approaching the interconnection of DG. In fact, there is tremendous diversity among the key elements of interconnection standards recently established at the state level. In the examples presented below, each state has different interconnection *application processes*, including fees, timelines, and eligibility criteria. Greater similarities are emerging among states' *technical requirements*, and this consistency is making it increasingly easier to increase the amount of clean DG in the states.

Massachusetts

In June 2002, the Massachusetts Department of Telecommunications and Energy (DTE) initiated a rulemaking to develop interconnection standards for DG. The policymakers within the DTE established a DG Collaborative to engage stakeholders (including utilities, DG developers, customers, and public interest organizations) to jointly develop a model interconnection tariff.

By adopting this model interconnection tariff, Massachusetts established a clear, transparent, and standard process for DG interconnection applications. The process uses pre-specified criteria to screen applications and establish application fees and timelines for DG systems of all types and sizes. The model interconnection tariff clearly specifies each step within the interconnection process and the maximum permissible time frames for each step. In addition, the model interconnection tariff provides for a

32 States that require faster processing of applications for smaller systems (≤ 10 kW to ≤ 30 kW) include California, Connecticut, Massachusetts, Michigan, Minnesota, New York, and Wisconsin.

Best Practices: Implementing an Interconnection Standard

The best practices identified below will help guide states in implementing an interconnection standard. These best practices are based on the experiences of states that have implemented interconnection standards.

- Consider working as a collaborative to establish monitoring activities to evaluate the effectiveness of interconnection standards and application processes.
- Periodically review and update standards based on monitoring activities, including feedback from utilities and applicants.
- Keep abreast of changes in DG/CHP and electric utility technology and design enhancements, since these may affect existing standards, including streamlining the application process and interconnection requirements.
- Consider working with groups such as IEEE to monitor industry activities and to stay up-to-date on standards developed and enacted by these organizations.

"simplified process" that allows most inverter-based systems that are 10 kW or less and are UL 1741 certified to be processed in less than 15 days without an application fee. Under the "standard process," used for larger DG systems that may have significant utility system impact, the process can take as long as 150 days and involve a $2,500 application fee in addition to other technical study and interconnection costs. The DG Collaborative also agreed to a five-step dispute resolution process in the event the interconnecting applicant is unable to reach agreement with the utility regarding the utility's decisions on the interconnection application.

After the adoption of the model interconnection tariff, the DG Collaborative reconvened to evaluate the reasonableness of the interconnection process by reviewing how the standard was functioning. The DG Collaborative examines application fees and time frames through a database structured to track interconnection applications. Although many applicants have successfully used the existing standard, the DG Collaborative has determined that it should review the application process and screening criteria in the model interconnection tariffs to further improve the process. This level of review is unique among states that have developed interconnection standards.

Web sites:
http://www.mass.gov/dte/restruct/competition/distributed_generation.htm (DTE DG interconnection proceedings)

http://www.masstech.org/policy/dgcollab/

New Jersey

The New Jersey Board of Public Utilities (NJBPU) has developed net metering and interconnection standards for Class I renewable energy systems. These rules became effective on October 4, 2004, and are separated into three levels. Each level has specific interconnection review procedures and timelines for each step in the review process.

- *Level 1* applies to inverter-based customer-generator facilities, which have a power rating of 10 kW or less and are certified as complying with IEEE 1547 and UL 1741.
- *Level 2* applies to customer-generator facilities with a power rating of 2 MW or less and certified as complying with IEEE 1547 and UL 1741.
- *Level 3* applies to customer-generator facilities with a power rating of 2 MW or less that do not qualify for Level 1 or Level 2 review.

Web site:
http://www.bpu.state.nj.us/cleanEnergy/cleanEnergyProg.shtml

New York

New York was one of the first states to issue standard interconnection requirements for DG systems. Enacted in December 1999, the initial requirements were limited to DG systems rated up to 300 kW connected to radial distribution systems.[33] New York recently modified these interconnection requirements to include

33 A radial distribution system is the most common electric power system. In this electric power system, power flows in one direction from the utility source to the customer load.

interconnection to radial and secondary network distribution systems for DG with capacities up to 2 MW.

New York's Standard Interconnection Requirements (SIR) include a detailed 11-step process from the "Initial Communication from the Potential Applicant" to the "Final Acceptance and Utility Cost Reconciliation." Similar to other states with interconnection standards, the New York SIR includes separate requirements for synchronous generators, induction generators, and inverters. Notably, there is no application fee for DG systems rated up to 15 kW. For DG systems larger than 15 kW, the application fee is $350.

Web site:
http://www.dps.state.ny.us/distgen.htm

Texas

In November 1999, the Texas PUC adopted substantive rules that apply to interconnecting generation facilities of 10 MW or less to distribution-level voltages at the point of common coupling. This ruling applies to both radial and secondary network systems.

The rules require that Texas utilities evaluate applications based on pre-specified screening criteria, including equipment size and the relative size of the DG system to feeder load. These rules are intended to streamline the interconnection process for applicants, particularly those with smaller devices and for those that are likely to have minimal impact on the electric utility grid. For example, under certain conditions, if the DG interconnection application passes pre-specified screens, the utility does not charge the applicant a fee for a technical study. If the DG system is pre-certified,[34] the utility has up to four weeks to return an approved interconnection agreement to the applicant. Otherwise, the utility has up to six weeks.

Web site:
http://www.puc.state.tx.us/electric/business/dg/dgmanual.pdf

What States Can Do

States have adopted successful interconnect standards that expedite the implementation of clean energy technologies while accounting for the reliability and safety needs of the utility companies. Action steps for both initiating a program to establish interconnect rules and for ensuring the ongoing success of the rules after adoption are described below.

Action Steps for States

States That Have Existing Interconnection Standards

A priority after establishing standard interconnection rules is to identify and mitigate issues that might adversely impact the success of the rules. Being able to demonstrate the desired benefits is critical to their acceptance and use by key stakeholders. Strategies to demonstrate these benefits include:

- Monitor interconnection applications to determine if the standards ease the process for applicants and cover all types of interconnected systems. States can also monitor utility compliance with the new standards or create a complaint/dispute resolution point of contact.
- If resources permit, identify an appropriate organization to maintain a database on interconnection applications and new DG systems, evaluate the data, and convene key interconnection stakeholders when necessary.
- Modify and change interconnection rules as necessary to respond to the results of monitoring and evaluation activities.

34 A pre-certified system is a known collection of components that has been tested and certified by a qualified third party (e.g., nationally recognized testing laboratory) to meet certain industry or state standards.

States That Do Not Have Existing Interconnection Standards

Political and public support is a prerequisite to establishing standard interconnection rules.

- Ascertain the level of demand and support for standard interconnection rules in the state by both public office holders and key industry members (e.g., utilities, equipment manufacturers, project developers, and potential system owners). If awareness is low, consider implementing an educational effort targeted at key stakeholders to raise awareness of the environmental and, especially, economic benefits resulting from uniform interconnection rules. For example, demonstrate that DG can result in enhanced reliability and reduced grid congestion. A 2005 study for the CEC found that strategically sited DG yields improvements to grid system efficiency, provides additional reserve power, deferred costs, and other grid benefits (Evans 2005). If resources are available, perform an analysis of these benefits and implement a pilot project (e.g., similar to Bonneville Power Authority's [BPA's] "non-wires" pilot program [BPA 2005] or the Massachusetts Technology Collaborative's [MTC's] Utility Congestion Relief Pilot Projects [RET 2005]) that promotes DG along with energy efficiency and voluntary transmission reduction. While this type of analysis is not essential, states have found it to be helpful.
- Establish a collaborative working group of key stakeholders to develop recommendations for a standard interconnection process and technical requirements. Open a docket at the PUC with the goal of receiving stakeholder comments and developing a draft regulation for consideration by the state PUC.
- If necessary, work with members of the legislature and the PUC to develop support for passage of the interconnection rules.
- Remember that implementing interconnection standards may take some years. States have found that success is driven by the inherent value of DG, which eventually becomes evident to stakeholders.
- Consider existing federal and state standards in the development process of new interconnection procedures and rely on accepted IEEE and UL standards to develop technical requirements for interconnection.

Related Actions

- For interconnection standards to be effective, tariffs and regulations that encourage DG need to be in place. If current tariffs and regulations discourage DG, then interconnection standards may not result in DG growth. Tariffs that encourage DG growth may allow customers to sell excess electricity back to the utility at or near retail rates. Key regulations that might discourage successful implementation of DG include high standby charges or back-up rates. Utility financial incentives that promote sales growth can discourage customers from making their own electricity and also discourage DG deployment. For more information on utility financial incentives, see Section 6.2, *Utility Incentives for Demand-Side Resources*.
- Communicate the positive results to state officials, public office holders, and the public.
- Include key stakeholders (e.g., utilities, equipment manufacturers, project developers, potential customers, advocacy groups, and regulators) in the development of the standard interconnection rules. Stakeholders can also contribute to rule modification based on the results of ongoing monitoring and evaluation.

Information Resources

State-by-State Assessment

Title/Description	URL Address
Database of State Incentives for Renewable Energy (DSIRE) is a resource for information on state interconnection policies. The Web site also provides comparative information on policies for each state.	http://www.dsireusa.org
Distribution and Interconnection Research and Development Program. This U.S. Department of Energy (DOE) program provides information and links to interconnection information in each state.	http://www.eere.energy.gov/distributedpower/interconnection_state.html

Federal Resources

Title/Description	URL Address
DOE's National Renewable Energy Laboratory (NREL) actively participates in many of the programs that create national standards for interconnection.	http://www.nrel.gov/programs/deer.html http://www.nrel.gov/eis/ http://www.nrel.gov/eis/standards_codes.html
The U.S. Environmental Protection Agency's (EPA's) CHP Partnership is a voluntary program that seeks to reduce the environmental impact of energy generation by promoting the use of CHP. The Partnership helps states identify opportunities for policy development (energy, environmental, economic) to encourage energy efficiency through CHP and can provide additional assistance to help states implement standard interconnection.	http://www.epa.gov/chp/

National Standards Organizations

Title/Description	URL Address
IEEE has developed standards relevant to many of the technical aspects of the interconnection. In particular, Standard 1547, *Interconnecting Distributed Resources with Electric Power Systems*, provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.	http://grouper.ieee.org/groups/scc21/1547/1547_index.html
UL also develops standards for interconnecting DG. In particular, UL 1741 will combine product safety requirements with the utility interconnection requirements developed in the IEEE 1547 standard to provide a testing standard to evaluate and certify DG products.	http://www.ul.com/dge/ http://www.eere.energy.gov/distributedpower/research/ul_1741.html

Examples of Standard Interconnection Rules

Title/Description	URL Address
IREC has prepared a model interconnection rule and a guide to connecting DG to the grid:	
Model Distributed Generation Interconnection Procedures and Net Metering Provisions	http://www.irecusa.org/connect/model_interconnection_rule.pdf
Connecting to the Grid: A Guide to Distributed Generation Interconnection Issues	http://www.irecusa.org/pdf/guide.pdf
Model Interconnection Tariff. Massachusetts adopted this model interconnection tariff to establish a clear, transparent, and standard process for DG interconnection applications.	http://www.mass.gov/dte/electric/02-38/515tariffr.pdf
Mid-Atlantic Distributed Resources Initiative (MADRI). In a collaborative process, MADRI has developed a sample interconnection standard.	http://www.energetics.com/MADRI/
NARUC has developed Model Interconnection Procedures and Agreement for Small Distributed Generation Resources.	http://www.naruc.org/associations/1773/files/dgiaip_oct03.pdf

Other Resources

Title/Description	URL Address
Distributed Generation in Oregon: Overview, Regulatory Barriers and Recommendations. L. Schwartz, PUC Staff, February 2005. This report by the Oregon PUC addresses barriers for DG.	http://www.puc.state.or.us/elecnat/dg_report.pdf
Making Connections: Case Studies of Interconnection Barriers and their Impact on Distributed Power Projects. This NREL report studies the barriers projects have faced interconnecting to the grid.	http://www.nrel.gov/docs/fy00osti/28053.pdf
Optimal Portfolio Methodology for Assessing Distributed Energy Resources Benefits for the Energynet. CEC, PIER Energy-Related Environmental Research. CEC-500-2005-061-D. This project addresses whether distributed generation (DG), demand response (DR), and localized reactive power (VAR) sources, or distributed energy resources (DER), can be shown to enhance the performance of an electric power transmission and distribution system.	http://www.energy.ca.gov/2005publications/CEC-500-2005-061/CEC-500-2005-061-D.PDF
The Regulatory Assistance Project (RAP) prepared a **Distributed Resource Policy Series** to support state policy efforts, and facilitated the creation of a **Model Distributed Generation Emissions Rule** for use in air permitting of DG.	http://www.raponline.org/Feature.asp?select=13&Submit1=Submit http://www.raponline.org/Feature.asp?select=8&Submit1=Submit
The U.S. Combined Heat and Power Association (USCHPA) brings together diverse market interests to promote the growth of clean, efficient CHP in the United States. As a result, they have been stakeholders in states that have developed standard interconnection rules.	http://uschpa.admgt.com/statechp.html

State Resources

State	Title/Description	URL Address
California	California Public Utilities Commission (CPUC), Distributed Energy Resource Guide: Interconnection.	http://www.energy.ca.gov/distgen/interconnection/california_requirements.html
	CPUC Decision 00-12-037—Decision Adopting Interconnection Standards (Issued December 21, 2000).	http://www.cpuc.ca.gov/word_pdf/FINAL_DECISION//4117.pdf
Connecticut	Connecticut Department of Public Utility Control (DPUC) (DOCKET NO. 03-01-15).	http://www.dpuc.state.ct.us/DOCKHIST.htm
	Connecticut DPUC Decision—Investigation into the Need for Interconnection Standards for Distributed Generation (Issued April 21, 2004).	http://www.dpuc.state.ct.us/FINALDEC.NSF/2b40c6ef76b67c438525644800692943/d7a46f117bea965485256e7d0064e9a1/$FILE/030115-042104.doc
Delaware	Customer-Owned Generation Web site supported by the Delaware Division of the Public Advocate.	http://www2.state.de.us/publicadvocate/dpa/html/self_gen.asp
Hawaii	Customer Generation Interconnection Standards (Rule 14) maintained by the Department of Business, Economic Development, and Tourism.	http://www.hawaii.gov/dbedt/ert/interconnection/interconnection.html
	Docket No. 02-0051—Decision No. #19773 issued November 15, 2002, and Decision No. 20056 issued March 3, 2003.	http://www.hawaii.gov/dcca/areas/dca/dno/
Massachusetts	Massachusetts DTE Distributed Generation Web page.	http://www.mass.gov/dte/restruct/competition/distributed_generation.htm
	Massachusetts DTE 02-38-B—Investigation by the DTE on its own motion into Distributed Generation (Issued February 24, 2004).	http://www.mass.gov/dte/electric/02-38/224order.pdf
Michigan	Michigan Public Service Commission (PSC) Case No. U-13745.	http://www.cis.state.mi.us/mpsc/orders/electric/
	Michigan PSC Decision in Case No. U-13745, In the matter, on the Commission's own motion, to promulgate rules governing the interconnection of independent power projects with electric utilities. Issued July 8, 2003.	http://www.cis.state.mi.us/mpsc/orders/electric/2003/u-13745.pdf
Minnesota	Case File Control Sheet for Minnesota PUC Docket No. E-999/CI-01-1023.	http://www.puc.state.mn.us/docs/log_files/01-1023.htm
	Minnesota PUC, In the Matter of Establishing Generic Standards for Utility Tariffs for Interconnection and Operation of Distributed Generation Facilities under Minnesota Laws 2001, Chapter 212. Issued September 28, 2004.	http://www.puc.state.mn.us/docs/orders/04-0131.pdf
New Hampshire	New Hampshire Code of Administrative Rules, Chapter PUC 900, Net Metering for Customer-Owned Renewable Energy Generation Resources of 25 Kilowatt or Less. Effective January 12, 2001.	http://www.puc.state.nh.us/Regulatory/Rules/PUC900.pdf

State	Title/Description	URL Address
New Jersey	N.J.A.C 14:4-9, Net Metering and Interconnection Standards for Class I Renewable Energy Systems. Effective October 4, 2004.	http://www.state.nj.us/bpu/wwwroot/secretary/NetMeteringInterconnectionRules.pdf
New York	New York PSC DG Information.	http://www.dps.state.ny.us/distgen.htm
	New York PSC Case 02-E1282, Order Modifying Standardized Interconnection Requirements. Effective November 17, 2004.	http://www3.dps.state.ny.us/pscweb/webfileroom.nsf/0/C70957A0FD0B89FD85256F4E007449ED/$File/02e1282.ord.pdf?OpenElement
Ohio	The Public Utilities Commission of Ohio's Web page, Electric Distributed Generation Equipment: How to Connect to the Utility Company's System.	http://www.puco.ohio.gov/PUCO/Consumer/information.cfm?doc_id=115
	Ohio Administrative Code 4901:1-22 Interconnection Services.	http://onlinedocs.andersonpublishing.com/oh/lpExt.dll?f=templates&fn=main-h.htm&cp=OAC
Texas	Public Utility Commission of Texas Interconnection of Distributed Generation Project #21220.	http://www.puc.state.tx.us/rules/rulemake/21220/21220.cfm
	Public Utility Commission of Texas, Distributed Generation Interconnection Manual.	http://www.puc.state.tx.us/electric/business/dg/dgmanual.pdf
	Substantive Rules § 25.211 and § 25.212. Effective December 21, 1999.	http://www.puc.state.tx.us/rules/subrules/electric/index.cfm
Wisconsin	Wisconsin Administrative Code Chapter PSC 119, Rules for Interconnecting Distributed Generation Facilities. Effective February 1, 2004.	http://www.legis.state.wi.us/rsb/code/psc/psc119.pdf

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RET. 2005. Renewable Energy Trust Web Site. Massachusetts Technology Collaborative (MTC): Congestion Relief Pilot Projects. Accessed November 2005.	http://www.masstech.org/renewableenergy/public_policy/DG/resources/CongestionReliefPilots.htm
Schwartz, L. 2005. Distributed Generation in Oregon: Overview, Regulatory Barriers and Recommendations. PUC Staff. February.	http://www.puc.state.or.us/elecnat/dg_report.pdf