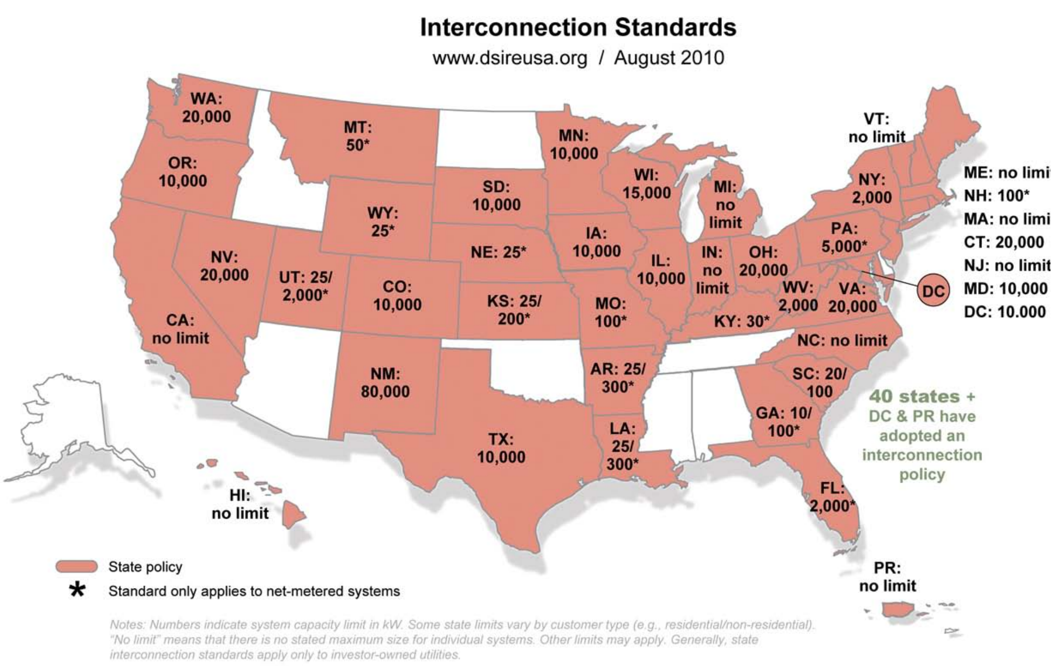
4.1

Interconnection Standards

Interconnection standards specify the technical, legal, and procedural requirements by which customers and utilities must abide when a customer wishes to connect a **photovoltaic** (PV) system to the grid (**electricity distribution system**). State governments can authorize or require their state public utilities commissions to develop comprehensive interconnection standards. Although most utilities fall under the jurisdiction of state public utility commissions, cities with municipal utilities can have significant influence over interconnection standards in their jurisdiction. Some state interconnection standards apply to all types of utilities (investor-owned utilities, municipal utilities, and electric cooperatives); other states have chosen to specify interconnection procedures only for investor-owned utilities. In setting interconnection standards, most jurisdictions require or reference compliance with the **IEEE 1547** Standard for Interconnecting Distributed Resources with Electric Power Systems, adopted in 2003 (see http://grouper.ieee.org/groups/scc21/1547/1547_index.html). As of August 2010, 40 states plus the District of Columbia and Puerto Rico had interconnection standards in place.



The most efficient interconnection standards specify several different levels of review for generation systems of varying size and complexity. Multiple levels of review for interconnection allow owners of small solar electric systems (typically less than 10 kilowatts) to interconnect systems more quickly and inexpensively without having to endure a process designed for larger multimegawatt systems. Some jurisdictions have also determined that larger systems that don't export electricity to the grid (for example, at a large factory, where the PV system's electricity output never exceeds the facility's electricity demand) should require a less rigorous review process than larger systems that do export electricity. In some areas of the United States, electric utilities have not yet adopted interconnection standards for any consumer systems, or have standards in place only for small systems. In areas without comprehensive interconnection standards, customers often find that connecting a solar electric system to the grid can be confusing, difficult, and expensive—sometimes prohibitively so.

Nearly 94% of electricity distribution systems in the United States are **radial electricity distribution systems** where interconnection of **distributed generation** such as PV is common and relatively straightforward. A less common type of electric distribution system, known as a **secondary network distribution system**, is often seen in central business districts in large cities. These network systems are designed to serve large loads, such as high-rise buildings, with exceptionally reliable service. PV systems located within secondary network distribution systems (commonly called "networks") might require more extensive utility review before interconnection, because devices known as network protectors—which maintain reliability on a secondary network—are sensitive to power coming from sources other than the centralized utility. Understanding the capabilities and limitations of the local electric distribution system is important for setting **installation targets** and designing policies that effectively promote solar energy installations.

BENEFITS

Streamlining interconnection standards encourages the installation of renewable energy technologies by defining an appropriate process for grid connection that reduces unnecessary transaction costs while maintaining business and safety standards.

Implementation Tips and Options

The following implementation tips and options include many of the Interstate Renewable Energy Council's (IREC) best practices for interconnection standards.

- Require that all utilities be subject to the interconnection standards, including investor-owned, municipal, and cooperative utilities within a state or local jurisdiction.
- Make all utility customer sectors (residential, commercial, and industrial) eligible to interconnect PV systems.
- Set forth three or four separate levels of review based on system size and complexity.
- Don't limit individual system capacity.
- Minimize application costs, especially for smaller systems (e.g., $50 per application plus $1 per kilowatt).
- Adopt and enforce reasonable, punctual procedural timelines.

- ☐ Use a standard form agreement that's easy to understand. Allow applications and processing to be done online.
- ☐ Establish transparent processes for reviewing the technical aspects of an installation.
- ☐ Eliminate any requirement for an external disconnect switch for smaller, inverter-based systems that export low-voltage electricity onto the grid. Inverters provide the safety measures of an external disconnect switch without the extra cost of installing the switch. The external disconnect switch is not necessary for smaller systems.
- ☐ Eliminate any requirement for liability insurance (above and beyond the coverage in a typical property owner's insurance policy). Prohibit utilities from requiring customers to add the utility as an additional insured party.
- ☐ Allow interconnection to secondary distribution networks with reasonable limitations, where appropriate.
- ☐ Establish a clear path for communications between the local code enforcement officers and the local utility provider to expedite the interconnection process once inspection is complete.
- ☐ Combine the interconnection and permitting applications into one, if possible.

Examples

New York City, New York: Interconnecting Photovoltaics on the City's Network

New York City is home to the most expansive set of secondary network distribution systems in the country. The New York City Solar America City team studied the technical aspects of interconnecting PV systems on the city's networked grid. The city worked with the National Renewable Energy Laboratory (NREL) and local **electric utility** ConEdison to define the maximum technical potential deployment of PV in New York City and to analyze the effect of that amount of PV on the city's networks. The team used NREL's In My Backyard (IMBY) mapping tool to estimate the electricity that could be produced if all suitable rooftop space in 10 sample networks around the city were covered with PV **arrays**. IMBY uses a map-based interface that allows users to specify the exact location of a proposed PV array or wind turbine. Based on the location, system size, and other variables, IMBY estimates the electricity production expected from the system. Comparing IMBY's estimates of hourly PV power generation to actual hourly load levels on each network shows how full PV deployment affects each network.

The team found that in 6 of the 10 networks, under full PV deployment, PV generation could exceed network load and export electricity to the secondary network distribution systems. Exporting was greatest in the middle of the day (when production is highest), on weekends (when building demand is lowest), and during the spring (when building demand is low relative to PV generation). Exporting is most likely in areas with more rooftop space per person; generally, the lower density networks are in the outer boroughs, which are made up of single-family homes and shorter commercial buildings.

The study concluded that low levels of PV penetration on networks generally are acceptable. Based on the results, ConEdison now allows PV systems of less than 200 kilowatts to connect to networks without requiring a comprehensive engineering review. The study is included in an NREL report, *Photovoltaic Systems Interconnected onto Secondary Network Distribution Systems—Success Stories*, available online at www.nrel.gov/docs/fy09osti/45061.pdf.

Santa Clara, California: Establishing Collaboration between City and Municipal Utility

In Santa Clara, the municipal utility, Silicon Valley Power, proved to be a major roadblock for PV system installations. The city of Santa Clara was able to review the permit applications within a few days, but did not have the ability to issue the permits until the engineers of the municipal utility completed their interconnection review. This extended process and frustration from applicants resulted in a strong desire for the city and municipality to work together. The municipal utility eliminated its role in reviewing the interconnection plans for systems less than 10 kilowatts. Dialogue with the city proved not only that the city officials were well suited to review the interconnections, but also that the city and municipality were essentially performing the same reviews. As a result of the utility removing itself from the process, it was able to significantly decrease costs from the labor performed by their engineers. The utility then gave back a portion of its cost savings to the city in the form of sending building officials through the North American Board of Certified Energy Practitioners (NABCEP) training. The building department is now able to avoid consumer frustrations and release permits more quickly.

Visit www.solaramericacommunities.energy.gov for more inspiring examples from communities across the United States.

Additional References and Resources

WEB SITES

Database of State Incentives for Renewables & Efficiency: Rules, Regulations, & Policies for Renewable Energy

www.dsireusa.org/summarytables/rrpre.cfm

This Web site contains summary maps and tables for policies that affect utilities, such as net-metering and interconnection standards. DSIREusa.org, maintained by the North Carolina State Solar Center in partnership with IREC, is the only comprehensive, regularly updated database of state renewable energy incentives in the United States, and also includes information on many local incentive programs. The U.S. Department of Energy (DOE) funds this ongoing effort.

Solar America Board for Codes and Standards

www.solarabcs.org

The Solar America Board for Codes and Standards (Solar ABCs) is a DOE-funded central body created to address solar codes and standards issues.

The Solar Alliance

www.solaralliance.org/

The Solar Alliance is a state-based advocacy group of companies involved in the design, manufacture, construction, and financing of PV systems. The Web site gives the industry perspective on areas critical for building a local solar market, including interconnection standards.

PUBLICATIONS

Model Interconnection Procedures: 2009 Edition

Interstate Renewable Energy Council, November 2009

IREC's model interconnection standard incorporates the best practices of small-generator interconnection standards developed by various state governments, the Federal Energy Regulatory Commission (FERC), the National Association of Regulatory Utility Commissioners (NARUC), and the Mid-Atlantic Distributed Resources Initiative (MADRI).

Report: http://irecusa.org/wp-content/uploads/2009/12/IREC-IC-Model-Final-Nov-8-2009-2.pdf

Freeing the Grid: Best and Worst Practices in State Net-Metering Policies and Interconnection Procedures, 2010 Edition

Network for New Energy Choices, Vote Solar Initiative, Interstate Renewable Energy Council, November 2009

This report outlines the best and worst practices in state net-metering and interconnection policies.

Report: www.newenergychoices.org/uploads/FreeingTheGrid2010.pdf

Photovoltaic Systems Interconnected onto Secondary Network Distribution Systems—Success Stories

National Renewable Energy Laboratory, April 2009

This report examines case studies of PV systems integrated into secondary network distribution systems. It includes findings from case studies conducted in San Francisco, California; Washington, D.C.; Denver, Colorado; and New York City.

Report: www.nrel.gov/docs/fy09osti/45061.pdf

Connecting the Grid: A Guide to Distributed Generation Interconnection Issues, 6th Edition

Interstate Renewable Energy Council, 2009

This guide is designed for state regulators and other policymakers, utilities, industry representatives, and consumers interested in the development of state-level interconnection standards.

Report: www.irecusa.org/wp-content/uploads/2009/10/Connecting_to_the_Grid_Guide_6th_edition-1.pdf

Comparison of the Four Leading Small Generator Interconnection Procedures

Solar America Board for Codes and Standards, Interstate Renewable Energy Council, October 2008

This report reviews four sets of interconnection procedures that regulators often consider when developing state and local procedures. As a framework for review, the report uses the grading criteria developed by the Network for New Energy Choices (NNEC) and used that organization's review of state interconnection procedures.

Report: www.solarabcs.org/interconnection/ABCS-07_studyreport.pdf

Utility External Disconnect Switch: Practical, Legal, and Technical Reasons to Eliminate the Requirement

Solar America Board for Codes and Standards, Interstate Renewable Energy Council, September 2008

This report documents the safe operation of PV systems without a utility external disconnect switch in several large jurisdictions. It includes recommendations for regulators contemplating utility external disconnect switch requirements.

Report: www.solarabcs.org/utilitydisconnect/

Utility-Interconnected Photovoltaic Systems: Evaluating the Rationale for the Utility-Accessible External Disconnect Switch

National Renewable Energy Laboratory, January 2008

This report examines the utility-accessible external disconnect switch debate in the context of utility-interactive PV systems for residential and small commercial PV installations. It focuses on safety, reliability, and cost implications of requiring an external disconnect switch.

Report: www.nrel.gov/docs/fy08osti/42675.pdf