



Interconnection Guidelines for Distributed Generation

Most electric distribution systems are designed, protected, and operated on the premise of there being a single source of electric potential on each distribution feeder at any given time. Distributed generation (DG) violates this fundamental assumption, and therefore special requirements for connecting to the utility distribution grid are critical to ensure safe and reliable operation. These technical requirements can be complex, blending traditional distribution engineering practices with added attention to power quality concerns and installation needs for advanced DG technologies. Manufacturers, vendors, and end users often see DG interconnection requirements as a huge market barrier, whereas utility engineers consider them to be absolutely necessary. Two decades of spirited debate have done little to bridge this gap.

Now, industry competition, well-publicized power crises, and Wall Street's love affair with DG companies have raised the stakes. In the U.S., many state regulatory bodies are working on uniform DG interconnection requirements to make it easier to win approval for such installations. At the national level, the U.S. Department of Energy is leading the charge to develop uniform guidelines via the IEEE standards process. Similar efforts are under way at the international level.

The lack of substantial field experience with interconnected DG limits our understanding of the potential impacts of DG on distribution system operations. Although most players agree that electric distribution systems can easily accommodate a few DG units, connecting lots of DG to the grid remains a huge concern for utility engineers. They have no practical experience with or knowledge of how the wide-scale application of DG will affect distribution feeders.

E SOURCE and Electrotek are joining forces to help you stay abreast of developments, get the technical information you need, and make the right choices when it comes to DG interconnection.

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Study Benefits

- Study subscribers will get the technical background and tools they need to effectively and safely interconnect DG systems to the electric distribution grid.
- All information on national and international standards activity will be consolidated in a single, convenient, and intuitive subscriber Web site.
- The information gleaned from our study, including the DG Interconnection Application Guidebook, will serve as valuable, cost-effective sources of information for resource-constrained in-house teams charged with researching and making decisions about technical interconnection questions, recommended practices, and standards.

Study Objectives

The study will be aimed at answering the following questions:

- What standards are being developed to deal with DG interconnection issues? When will they be approved, and who will adopt them? How do these standards compare with present energy company practices? Are these standards merely guidelines, or will they become “the law”?
- What are the key technical issues associated with connecting DG systems to the existing electric distribution grid?
- What kind of protection systems (relays, fuses, breakers, and so on) are required for distributed generation systems? How do the protection requirements vary for different technologies, unit sizes, and applications?
- What are the power quality impacts of DG? How does DG equipment respond to system disturbances? What kind of disturbances does DG cause?
- How do various DG technologies perform in real-world power system applications? Are any new issues being raised by early data on actual performance of DG equipment in interaction with the grid?

Scope of Study

We will address the technical considerations for interconnecting DG equipment with the conventional electric utility distribution system and assess guidelines for interconnection as they relate to operational performance, system protection, and safety. In addition, we'll provide tools to help you assess how practical interconnection will be for specific projects and equipment. We will also create a clearinghouse for the many ongoing domestic and international efforts to develop uniform standards for interconnection. To give subscribers immediate information, we'll be providing online access to our team experts for quick consulting. Overall, our study will serve as a comprehensive information resource for anyone dealing with the technical aspects of DG interconnection.

The study will consist of five primary components:

1. DG Interconnection Application Guidebook

In addition to providing information on analytical tools and techniques for addressing technical DG interconnection issues, the Guidebook will explore and explain topics such as system and interface protection, power quality impacts, and safety issues. The Guidebook will also provide up-to-date information on all applicable standards and summarize the status of any that are under development. Technical issues will be illustrated with case study examples and simulation results.

2. Web-Based DG Interconnection Standards Activity Tracking System

The efforts under way to develop standards are complex and diffuse. Many of the standards that are now taking shape refer to other developing standards. For example, the IEEE 1547 subcommittee is developing a standard for DG interconnection that references the IEEE 519 standard for harmonics, which is itself a work in progress. Individual states are creating their own guidelines, as are some international bodies. It is important to track these efforts, but doing so can be an onerous task.

Our Interconnection Standards Activity Tracking System will give you a state-by-state summary of emerging DG interconnection guidelines in the U.S., as well as a rundown on important international standards. The tracking system will organize and analyze these efforts, helping you make sense of what is happening on all fronts and arrive at a better understanding of how these standards could affect you when and if they are adopted. You'll find links to the Web sites of standards groups, plus information such as notes from standards development meetings, significant presentations, standards updates, and industry developments related to DG interconnection. We will be updating this site throughout the course of the study.

3. Online DG Interconnection Quick Consulting Service

Our Quick Consulting Service will make it possible for subscribers to post technical questions and comments related to DG interconnection. Experts from the study team will monitor this online forum, providing answers and guidance. The Quick Consulting Service Web page will also provide a calendar of important events, including upcoming meetings, conferences, and training sessions related to DG interconnection. Major announcements related to interconnection issues (for example, new publications, selected manufacturer's press releases, or new standards releases) will also be posted to this site.

4. Online DG Interconnection Simulation and Case Study Library

Experience is the best teacher. The Simulation and Case Study Library will offer detailed accounts of at least six DG installations, with specific focus given to the technical design and performance of the interconnection. In addition to the technical information, we'll include such supplementary documentation as a detailed description of the DG equipment and the distribution system to which it is connected, operating records, design documents, and monitoring and measurement results, if available. Simulated studies for some DG technologies that have not yet been installed with grid interconnection will also be provided, clearly illustrating a particular aspect of interconnection performance.

For each case study, the online information will include:

- *Detailed description of the installation.* We'll cover technology deployed, equipment ratings, power system characteristics, and protection requirements, as well as implementation and power quality issues that were considered and addressed.
- *Objectives of the installation.* Was DG installed to relieve local capacity constraints, for reliability purposes, or purely as a demonstration? We'll explain the rationale behind each application.

- *Performance monitoring results.* We'll give you summaries of DG unit operations, including steady-state operations (voltage, kilowatt trends), response to power system events, and detailed measurements characterizing the technology, as available. Access to live monitoring of some sites under development will also be provided as available. (For more information, see page 5, Optional Monitoring.)

For each simulated study, the online information will include:

- Results from 10 detailed engineering simulation studies, because actual case study information will not be available for every DG technology.
- We'll summarize the issues identified through the simulations and offer recommendations for the best solutions.
- Early study subscribers will have an opportunity to provide input on which DG technologies will be evaluated in this way.

Online monitoring information as available:

For an additional fee, subscribers may have their DG installation monitored and analyzed by Electrotek. (For more information on this service, see page 5, Optional Monitoring.)

5. Study Web Site

Updates of all deliverables for this study will be available at the study Web site.

Deliverables

- *Study Web site.* Updates for all the deliverables listed here will be available on the exclusive study Web site throughout the project.
- *DG Interconnection Application Guidebook.* Subscribers will receive two printed copies of the Guidebook, along with electronic access to the Guidebook from the study Web site.
- *DG Interconnection Standards Activity Tracking System.* The study Web site will provide live access to our database of interconnection standards. We'll be updating the information on standards development throughout the course of the study.
- *DG Interconnection Simulation and Case Study Library.* As our simulation and case studies are developed, they will also be made accessible on the study Web site. The final comprehensive library will be released to subscribers on CD.
- *Online DG Interconnection Quick Consulting Service.* This online service will allow subscribers to raise and discuss technical and other important interconnection issues. Experts in the field will moderate these discussions and provide answers to questions.
- *An interactive summit.* Study subscribers will be able to send two attendees to this event. Featured speakers will include members of the IEEE standards committee, state regulators, energy service providers, Electrotek and E SOURCE staff. At this event, we'll present preliminary findings and provide training on use of the Web-based resources created for this project.
- *Live access to DG performance monitoring.* We'll provide real-time data for DG installations from around the world, as available.

Subscriptions

In addition to receiving special introductory pricing, those who subscribe to the study before March 15, 2001 will be able to participate in preliminary discussions about the focus of the research. If a minimum number of subscriptions have not been received by March 31, 2001 the schedule and the

deliverables may be adjusted accordingly. A discount of 25% is available for members of The Power Quality Group. A discount of 15% is also available for those who subscribe to either the E SOURCE *Power Quality Series* or the E SOURCE *Distributed Energy Series*.

Optional Monitoring

Because there is no substitute for actual performance data on DG installations for understanding how they perform under real-world conditions, subscribers can opt to include (at a minimal additional cost) up to two specific DG installation sites as case studies for this project. The monitored data from these sites will be accessible to all Interconnection Guidelines for Distributed Generation study subscribers. The benefits of this optional monitoring are:

- *Monitoring of the installations.* Electrotek will work with participants to implement a powerful Web-based monitoring system at the selected sites. The monitoring will include full power quality monitoring on the input and output of the DG units; the data will be made available to participants over the Web. In addition to maintaining the live monitoring Web site and data backups, Electrotek will work with participants to develop monthly performance reports that will be downloadable as PDF files. The selected installations will be monitored for 12 months. Discounts will be provided for the monitoring equipment, and Electrotek will assist with all setup and configuration issues.
- *Models for detailed evaluation of the installations.* Electrotek will create power system models for simulating performance at these facilities. The models will be available to all Interconnection Guidelines for Distributed Generation study participants for use in harmonic performance studies and for system interaction evaluations, as well as for developing protection system designs and transient protection guidelines. These models, which will be appropriate for load flow, short circuit, stability, harmonic, and transient performance studies, could also serve as the basis of models for future installations.

- *Detailed performance report.* At the end of the 12-month monitoring period, Electrotek will issue a final performance monitoring report for each site. Only subscribers to the optional monitoring will receive these detailed reports, which will include an evaluation of expected performance from simulations as well as an evaluation of actual performance from the extended monitoring. Individual events will be analyzed, and all power quality and protection issues will be addressed in the detailed reports. A summary of the performance report will be available to all Interconnection Guidelines for Distributed Generation study subscribers as part of the Online DG Interconnection Simulation and Case Study Library.

The detailed system data for the optional monitoring will remain confidential. However, general models and general information will be released to all Interconnection Guidelines for Distributed Generation study subscribers and included in the Online DG Interconnection Simulation and Case Study Library.

Optional Maintenance

If a minimum number of subscribers are interested, the information on the Interconnection Guidelines for Distributed Generation study Web site could be updated beyond the duration of the project. For a minimal annual maintenance fee, we will update and maintain this comprehensive DG interconnection resource, keeping all the information on the Web site, including the Web-Based DG Interconnection Standards Activity Tracking System, the Online DG Interconnection Simulation and Case Study Library, and the Online DG Interconnection Quick Consulting Service current for those subscribers.

Tentative Project Schedule

The project will start in March 2001.

The Online DG Interconnection Quick Consulting Service and the DG Interconnection Standards Tracking System database will be available within two months of project kickoff; both will be continually updated for the duration of the project.

The installations and technologies for the DG Interconnection Simulation and Case Study Library will be selected at project launch, and initial data will be available online within four months.

The interactive summit to discuss preliminary findings and provide training on the Web-based resources will be held in late 2001.

The DG Interconnection Application Guidebook, will be delivered in the fourth quarter of 2001.

The DG Interconnection Simulation and Case Study Library, as well as the Web-based DG Interconnection Standards Activity Tracking System, will be complete by the end of December 2001.

For More Information

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