Introduction to Interconnection Rules

Utah Public Service Commission
Distributed Generation Interconnection Workshop
December 4, 2007

Wayne Shirley
Director

The Regulatory Assistance Project

50 State Street, Suite 3
Montpelier, Vermont USA 05602
Tel: 802.223.8199
Fax: 802.223.8172

27 Penny Lane
Cedar Crest, New Mexico USA 87008
Tel: 505.286.4486
E-Fax: 773.347.1512

110 B Water St.
Hallowell, Maine USA 04347
Tel: 207.623.8393
Fax: 207.623.8369

Status of Interconnection in the West

- Arizona has no general rule, but has some provisions in context of net metering
- California has own rule, not modeled on other formats
- Colorado an interconnection rule patterned off the FERC rule
- Idaho uses NARUC Model rule as “guideline” for utilities, but has no interconnection rule per se
- Montana has no rule, but is considering exploring the issue through workshops
- New Mexico has just begun interconnection rule proceeding – proposed rule similar to FERC format
- Washington has a very limited rule (up to 300 kW); above 300kW and up to 20 MW handled via studies and individual utility tariffs
- Wyoming has no rule

Major Components of Interconnection

- Technical Standards (see discussion of IEEE 1547 & UL 1741)
- Application Process
- Interconnection Process
- Relationship of Parties

Purpose of Interconnection Rule

- Establish clear criteria for interconnection, including obligations of utility process applications in a timely and fair way
- Provide simplified process for (typically smaller) DG configurations that can be interconnected without significant study or review
- Establish the relationship of the parties during the interconnection application process and during operation of the generating facility
- Provide consistency within the state and, preferably, in the region for both utility and DG developers

Application Process

- Standardized application forms
- Time lines for utility and interconnecting “customer” (developer/operator/consumer, etc.)
- Fast track or simplified reviews for certain types of pre-certified installations
- Pre-specified types of studies for installations that do not qualify for fast track approvals

Evolution of Interconnection Rules

- Early adopters (e.g. Texas (January 2001) and New York – September 2005) established rules when IEEE 1547 was being developed
- FERC issues Small Generator Interconnection Procedure – December 2005
- Mid-Atlantic Distributed Resource Initiative (MADRI) develops “model rule”
- Oregon improves on MADRI Model Rule

FERC Rule

- Creates two fast tracks
  - "Level 1" – under 10 kW inverter-based systems
  - "Level 2" – under 2 MW systems
- Establishes framework for studies – "Level 3"
  - Timing
  - Scope
  - Cost responsibility

MADRI Model Rule

- Began with FERC Rule
- Added “Level 3A” for certain types of non-exporting interconnections

Oregon Rule: Signficant Changes to MADRI

- Started with MADRI Model Rule
- Raised Level 1 size limit to from 10kW to 25 kW
- Renumbered Level “3A” to “3” and Level “3” to “4”
- Added “field certification” concept

Level 1 Process

- File application with utility
- Utility reviews for completeness (10 days)
  - Includes review for Level 1 applicability
    - <25 kW
    - Inverter-based
    - Lab tested (i.e. “certified” equipment package)
  - If incomplete, customer has 10 days to cure
- Once deemed complete, application enters queue
  - Queue used to determine potential Adverse System Impacts based on the relevant screening criteria

Level 1 Screens

- Utility applies screens (15 days from time application deemed complete)
- If interconnection passes screens, utility must approve interconnection and construction and installation commences
- If interconnection fails screens
  - Utility may deem interconnection safe anyway, or
  - Application can move to Level 2, 3 or 4

Application Process: Level 1 Screens

- For interconnection to a radial distribution circuit, aggregated generation, including the proposed Small Generator Facility, on circuit <=15% of the Line Section annual peak load
- For interconnection load side of Spot Network protectors aggregate generation, including Small Generator Facility must not exceed the lesser of 5 percent of a Spot Network's maximum load or 50 kW.
- If interconnected on a single-phase shared secondary service line, the aggregate generation capacity on the shared secondary, including the proposed Small Generator Facility, must not exceed 20 kW.
- If proposed Small Generator Facility is single-phase and interconnected on center tap neutral of a 240 volt service line must not create a current imbalance between the two sides of the 240 volt service of more than 20 percent of the nameplate rating of the service transformer.
- The proposed interconnection must use existing EDC facilities (i.e. no new EDC facilities).

Level 1
Installation & Testing

- Upon completion of installation
  - Customers gives 20 days notice of commissioning
  - Utility can schedule witness testing on 10 days notice
  - Utility can waive test explicitly or by failure to act
- If passes testing, or testing waived, can interconnect
- If fails testing
  - Customer has 30 days (or other mutually acceptable time) to cure
  - Otherwise:
    - Application is withdrawn
    - Customer may move to Level 2, 3 or 4 (keeps queue position if done w/in 15 days)

Completing Interconnection

- Interconnection process is not complete until:
  - Application passes Level 1 screening criteria
  - Small Generator Facility installation is approved by the electric code inspector with jurisdiction over the interconnection
  - The Witness Test, if conducted by the EDC, is successful
  - The Parties execute a Certificate of Completion
- Must also execute separate interconnection agreement and, if applicable, purchase power agreement

Level 1 Operational Status

- The Applicant must notify the EDC before commencing operation
- Must operate the Small Generator Facility in accordance with the executed Interconnection Agreement and the executed Power Purchase Agreement
- Both parties must operate and maintain their equipment in accordance with IEEE 1547, NESC and any Commission requirements

Level 2 Qualifications

- Electric Nameplate Capacity of <= 2 MW
- Proposed Point of Interconnection is to either:
  - A radial distribution circuit, or
  - A Spot Network distribution circuit limited to serving one premise; and
- Interconnection Equipment proposed either Lab Tested Equipment or Field Tested Equipment.

Level 2
Application Process

- Basically same as Level 1
  - Application
  - Screening
  - Testing
  - Documentation

Level 2
Screening Criteria

- For interconnection to radial distribution circuit, aggregate generation, including proposed Small Generator Facility, must not exceed 15 percent of the Line Section annual peak load
- For interconnection to load side of Spot Network protectors, proposed Small Generator Facility and the aggregated other generation must not exceed the lesser of 5 percent of a Spot Network's maximum load or 50 kW.
- The proposed Small Generator Facility, in aggregation with other generation on the distribution circuit, must not contribute more than 10 percent to the distribution circuit's maximum Fault Current at the point on the primary voltage distribution line nearest the Point of Interconnection.

Level 2 Screening Criteria

- Proposed Small Generator Facility, in aggregate with other generation on the distribution circuit, must not cause any distribution protective devices and equipment (including, but not limited, to substation breakers, fuse cutouts, and line reclosers), or other EDC equipment on the T&D System to be exposed to Fault Currents exceeding 90 percent of the short circuit interrupting capability; and the Small Generator Facility's Point of Interconnection must not be located on a circuit that already exceeds 90 percent of the short circuit interrupting capability
- Proposed Small Generator Facility's Point of Interconnection must not be on a Transmission Line
- Proposed Small Generator Facility, in aggregate with other generation interconnected to the distribution side of a substation transformer feeding the circuit where the Small Generator Facility proposes to interconnect, must not exceed 10 MW in an area where there are known, or posted, transient stability limitations to generating units located in the general electrical vicinity (e.g., three or four distribution busses from the point of interconnection)

Level 2 Screening Criteria

- If proposed interconnection is to Primary Line on the distribution system, the interconnection must be according to the screening criteria set forth (A) and (B) (below):
  - (A) If the Small Generator Facility is 3-phase or single-phase and is to be connected to a 3-phase 3 wire Primary Line, it must be connected phase-to-phase
  - (B) If the Small Generator Facility is 3-phase or single-phase and is to be connected to a 3-phase 4-wire Primary Line, must be connected line to neutral and effectively grounded.
- If Small Generator Facility is to be interconnected on single-phase shared service line on the T&D System, the aggregate generation capacity on the shared secondary line, including the proposed Small Generator Facility, must not exceed 20 kW

Level 2 Screening Criteria

- If the proposed Small Generator Facility is single-phase and is to be interconnected on a center tap neutral of a 240 volt service line, its addition must not create an imbalance between the two sides of the 240 volt service of more than 20 percent of the nameplate rating of the service transformer
- The interconnection must only use existing EDC facilities and the Applicant's proposed facilities (with minor exceptions)
- The Small Generator Facility, in aggregate with existing transmission loads must not cause a transmission system circuit to exceed its design capacity on the transmission system circuit directly connected to the distribution circuit where the interconnection is proposed

Level 2 Timelines

- Timelines are same as Level 1
  - 10 days for application completeness review
  - 10 days to cure incomplete application
  - 20 days to apply screens
  - 20 days notice of commissioning
  - 10 days notice of witness testing (& same waiver provisions)

Level 3 Process Qualifications

- For an Application that does not qualify for Level 1 or Level 2 review and meets all of the following requirements:
  - The Small Generator Facility has an Electric Nameplate Capacity rating of 10 MW or less; and
  - The proposed Point of Interconnection is not to a Transmission Line; and
  - The Small Generator Facility does not export power beyond the point of interconnection and utilizes reverse power relays or other protection functions that prevent power flow onto the Area Network

Level 3 Screens

- All Level 2 Screens plus either the Area Network screens or the non-network screens
- Area Network screens:
  - Electric Nameplate Capacity of the Small Generator Facility is <= 50 kW
  - Proposed Small Generator Facility utilizes a Lab Tested, inverter-based equipment package for interconnection
  - The Small Generator Facility utilizes reverse power relays or other protection functions that prevent power flow on to the Area Network
  - The aggregated other generation on the Area Network does not exceed the lesser of 5 percent of an Area Network's maximum load or 50 kW
  - The interconnection must use only existing EDC facilities and the Applicant’s proposed facilities.

Level 3
Non-network Screens

- The Small Generator Facility has an Electric Nameplate Capacity of 10 MW or less;
- The aggregated total of the Electric Nameplate Capacity of all of the generators on the circuit, including the proposed Small Generator Facility, is 10 MW or less;
- The Small Generator Facility does not export power beyond the point of interconnection and employs reverse power relays or other protection functions that prevent power flow onto the T&D System;
- The Small Generator Facility's proposed interconnection must be to a radial distribution circuit;
- The Small Generator Facility is not served by a shared transformer
- The interconnection must use only existing EDC facilities and the Applicant's proposed facilities (with some exceptions).

Level 3 Timelines

- Timelines are same as Levels 1 & 2
  - 10 days for application completeness review
  - 10 days to cure incomplete application
  - 20 days to apply screens
  - 20 days notice of commissioning
  - 10 days notice of witness testing (& same waiver provisions)

Level 4: The “Studies” Path to Interconnection

- Applicable to all interconnections not eligible to interconnect under Levels 1, 2 or 3
- Unit must <=10 MW
- No fast track screening

Level 4 Procedure

- Application and queue rules same as other levels
- Process utilizes a series of meetings and studies to process application:
  - Scoping Meeting
  - Interconnection feasibility study
  - System impact study
  - Interconnection Facilities Study

Scoping Meeting

- Within 10 days of complete application, utility and customer hold a Scoping Meeting
- Purpose of meeting is to review the Application including any existing studies relevant to the Application, (e.g. results from the Level 1, 2 or 3 screening criteria and studies or, if available, the Applicant's analysis of the proposed interconnection using the same criteria as the EDC applies to the Application)
- Parties are expected to bring to the Scoping Meeting such personnel, including system engineers and other resources, as may be reasonably required to accomplish the purpose of the meeting

Scoping Meeting: Outcomes May Include…

- An identification of the need for further studies allowed by interconnection rule
- Possible changes or modifications to the Application to facilitate the interconnection or reduce costs
- No changes at all and the EDC being able to proceed with the application without further studies

Feasibility Study

- If the Parties agree at the Scoping Meeting that an Interconnection Feasibility Study needs to be performed, the EDC has up to 15 business days to complete an Interconnection Feasibility Study Agreement that provides the Applicant with an outline of the scope and a good faith, non-binding estimate of the cost to perform the study.
- If Applicant agrees to the cost estimate, the EDC must perform an Interconnection Feasibility Study. The study must evaluate the effects of the proposed Small Generator Facility on the existing EDC's T&D System and look for possible Adverse System Impacts.

Feasibility Study: Outcomes May Include…

- Initial identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection
- Initial identification of any thermal overload or voltage limit violations resulting from the interconnection
- Initial review of grounding requirements and system protection; and
- Description and estimated cost of Interconnection Facilities and System Upgrades required to interconnect the Small Generator Facility to the EDC in a safe and reliable manner.
- If the Applicant asks that the Interconnection Feasibility Study evaluate multiple potential points of interconnection, the EDC will perform the additional evaluations at the Applicant's expense

System Impact Study

- If the Interconnection Feasibility Study identifies possible Adverse System Impacts from the Small Generator Facility, an Interconnection System Impact Study is required.
- The EDC has up to 15 business days to complete an Interconnection System Impact Study Agreement that provides the Applicant with an outline of the scope and a good faith, non-binding estimate of the cost to perform the study.
- If the Applicant agrees to the cost estimate, the EDC must conduct an Interconnection System Impact Study. The study must evaluate the Adverse System Impacts identified in the Interconnection Feasibility Study, and study other potential impacts including, but not limited to, those identified in the Scoping Meeting.

System Impact Study

- Must consider all generating facilities that, on the date the study is commenced, are directly interconnected with the EDC's system, have a pending higher Queue Position to interconnect to the system, or have a signed Interconnection Agreement.
- Must include, among other things, a short circuit analysis, a stability analysis, a power flow analysis, voltage drop and flicker studies, protection and set point coordination studies, and grounding reviews.
- The Interconnection System Impact Study must state the underlying assumptions of the study, show the results of the analyses, and list any potential impediments to providing the requested interconnection service.
- If the Applicant sponsored a separate independent impact study, the EDC must also evaluate and address any alternative findings from that study.
- The outcome of the System Impact Study must include a report of any Interconnection Facilities and System Upgrades to the EDC's T&D system and any System Upgrades to Affected Systems required to allow the proposed interconnection to occur including an estimate of the equipment costs and standard delivery schedules.

Interconnection Facilities Study

- If System Impact Study finds Interconnection Facilities are necessary EDC must conduct an Interconnection Facilities Study to determine their price and delivery
- The EDC has up to 15 business days after completion of the Interconnection System Impact Study, or a period mutually agreed upon by parties, to develop an Interconnection Facilities Study Agreement that provides the scope and a good faith, non-binding estimate of the cost to perform the study
- Interconnection Facilities Study evaluates the cost of equipment, and the engineering, procurement and construction work (including overheads) to install necessary interconnection facilities and also indentifies:
  - Electrical switching configuration of the equipment (e.g. transformer, switchgear, meters, etc.)
  - Nature and estimated cost of the EDC's Interconnection Facilities
  - System Upgrades required to accomplish the interconnection
  - Detailed estimate of the time required to procure materials and equipment and complete the construction and installation of such facilities
- If Interconnection is denied, EDC must provide written explanation

Level 4: Construction and Installation

- Installation and testing procedures are same as Levels 1, 2 & 3.
- Parties may agree to permit the Interconnection Customer to separately arrange for a third party to design and estimate the construction costs for the required Interconnection Facilities. In such a case, the EDC must review the design and cost estimates of the facilities, under the provisions of the Interconnection Facilities Study Agreement
- If the Parties agree to separately arrange for design and construction estimates, and comply with any security and confidentiality requirements, the EDC must make all relevant information and required specifications available to the Applicant at no cost in order to permit the Applicant to obtain an independent design and cost estimate for the facilities, to be built in accordance with such specifications

Level 4:
Final Approval

- Upon completion of the Interconnection Facilities Study, and with the agreement of Applicant to pay for necessary Interconnection Facilities and System Upgrades identified in the Interconnection Facilities Study as approved by the EDC, and provided the EDC determines, based on studies, that safety and reliability will not be compromised from interconnecting the Small Generator Facility, the EDC must approve the application.

Remote Metering & Monitoring

- Rule of thumb: smaller systems need less remote metering and monitoring
- Judgment call on threshold
- Oregon:
  - No remote monitoring required below 3 MW (Levels 1, 2 &3)
  - May be required is generator >50% of line section annual peak load at EDC discretion

Remote Metering & Monitoring: Protocols

- Communication must be via Private Network Link using a Frame Relay or Fractional T-1 line or other such suitable devic.
- Dedicated Remote Terminal Units, from the Interconnected Small Generator Facility to an EDC's substation and Energy Management System are not required
- A single communication circuit from the Small Generator Facility to the EDC is sufficient
- Communications protocol must be DNP 3.0 or other standard used by the EDC.
- The Small Generator Facility must be capable of sending telemetric monitoring data to the EDC at a minimum rate of every 2 seconds (from the output of the Small Generator Facility's telemetry equipment to the EDC's Energy Management System)

Remote Monitoring & Metering: Data

- Minimum data points Small Generator Facility is required to provide are:
- Net real power flowing out or into the Small Generator Facility (analog)
- Net reactive power flowing out or into the Small Generator Facility (analog)
- Bus bar voltage at the point of common coupling (analog)
- (D) Data Processing Gateway (DPG) Heartbeat (used to certify the telemetric signal quality); and
- (E) On-line or off-line status (digital)

Remote Monitoring & Metering: High Voltage

- If Interconnection Customer operates the equipment associated with the high voltage switchyard interconnecting the Small Generator Facility to the T&D System, if monitoring is required, must provide:
- Switchyard Line and Transformer MW and MVAR values
- Switchyard Bus Voltage
- Switching Devices Status

Other Application Process Issues

- Fees
  - Usually scaled by sized of unit or which “level” the application is processed under
- Utility recordkeeping
- Temporary Disconnection
  - Emergencies
  - Schedule system maintenance
  - Notice to customer required (except where emergency prevents it)

Likely Issues of Contention

- Timelines
  - Best practices now have very tight timelines in the absence of studies – utilities may resist
- Disconnect switches
  - Inverter-based systems can perform the same function as a disconnect switch
  - Small units (e.g. residential and commercial solar PV) have marginal economics that may be undermined by the additional costs of disconnect switches
- Engineering standards and technical issues are largely resolved with IEEE 1547, but utility engineers may still be too wary of DG and want more conservative requirements
  - But, Pacificorp's involvement in Oregon process should be helpful

Interconnection Process

- From construction to operations
- Witness testing
- Commissioning Tests
- Inspections and Certificates of Completion
- Leads to execution/implementation of Interconnection Agreement

Other Application Process Issues

- Alternative Dispute Resolution
  - Usually the existing commission process, if available
  - Shared cost of ADR
- Liability
  - Mutual indemnity
  - Minimum insurance

Related Forms and Documents

- Level 1, 2, 3 & 4 Application Forms
- Interconnection Agreement (the contract between the utility and the customer)
  - Note Level 1 is often a combined, simple, application and Interconnection Agreement
  - Also covers operating obligations
- Form agreements for Feasibility Study, System Impact Study & Interconnection Facility Study

Relationship of Parties

- Insurance
- Dispute Resolution
- Relationship to Other Services:
  - Does not cover standby, backup, distribution charges, etc.
  - Some states have prohibition against utility using knowledge of project to offer discount rates or competing technology to keep customer on regular service
- Rights of curtailment and disconnection

Recommended Next Steps

- Begin with a strawman proposal, such as the MADRI Model rule or the Oregon rule
- Deal with interconnection separately from other issues such as backup and standby tariffs
- To the maximum extent possible, stick with IEEE 1547 and UL 1741 standards for consistency
- Use a stakeholder process to drive toward a final product
- Process needs to address interconnection process and all relate forms and agreements

More Information

- MADRI: http://www.energetics.com/madri
- Oregon Rule and Stakeholder Process:

  http://www.puc.state.or.us/PUC/admin_rules/intercon.shtml
- RAP Website: http://www.raponline.org
- E-mail: rapwayne@aol.com