State Staff Information Sharing "Surge" Call Summary

"Smart Inverters: A Link Between Smart Grid and Distributed Renewables?"

June 27, 2016

NARUC's Lab hosted a call on Monday, June 27 2016 as part of our new "surge" effort to help link state staffers to learn from each other. The first call focused on smart inverters, and was for state PUC staffers to share experiences and grow their understanding of power sector technologies, markets, and the associated regulatory policies. This document summarizes the discussion.

Jamie Ormond and Marc Monbouquette from the California PUC led a discussion based on their experience with the Golden State's finalization of "Rule 21" that removes all barriers to the interconnection of smart inverters. With that Rule, any smart inverter can interconnect to the grid. This is relevant because smart inverters provide the system visualization and stability characteristics that are important to integrating distributed, intermittent resources like solar PV.

What is an inverter? What is a "smart" inverter? Between solar panels and the grid; there's an inverter that turns DC power into AC power and pushes the power onto the grid. "Dumb" inverters do little more than this conversion, and turn off when grid conditions, voltages, or volt/var control are outside their preset limits to assure grid and solar panel safety. Around 2010, an inverter in eastern Germany sensed a fault that led to other inverters sensing spikes and dips, further leading to cascading outages. The California energy commission began work developing the performance characteristics that would have prevented this event, and worked with the CPUC to start a working group that included engineering stakeholders and the three investor owned utilities. Their workshop in summer 2013 laid out everything that smart inverters can do for the grid, and thereafter the team broke the requirements for smart inverters into three categories (or "phases"):

1. Autonomous functions that inverters can provide without any communications.
2. Communication protocols for SI and utility comm.
3. Advanced functionalities that may or may not require communication

The CPUC issued Rule 21 that allowed inverters meeting the phase 1 engineering characteristics to interconnect to the grid in 2016.

Rule 21 is important because it fits into the existing national technical standards that govern distributed generation interconnection: the IEEE 1547 code had always said "thou shall not do anything when you connect to the grid", with an amendment 1547A "…unless your state says you can". Rule 21 applies to this section.

Phase 2 functions govern the communications aspects of interconnection that enable Phase 3 characteristics. The Phase 2 characteristics enable communications not only with the utility but energy management systems and with 3rd parties, like aggregators.

Phase 3 functions provide more advanced utility visualization and control, especially in response to determined voltage and frequency set points, which enable distributed energy resources linked through these smart inverters to provide material services to the grid. In enumerating the phase 3, there was less workgroup consensus around the functionality that would be included. For now, these are described as options.

While phase 1 functions are mandated, their enumeration did not include new compensation or further contractual obligations between utility and DER developer. Every inverter needs to possess these functions. Phase 3 functions may entail real power reductions or curtailments of devices, and their developers may be hesitant about phase 3 since there is an unclear path to compensation – some developers and manufacturers see phase 3 functions are more of a wish list. Utilities may not see this as mandatory, but with increased penetration these functions may be indispensably helpful to the utilities to manage the grid. Questions about compensation are crucial to bring these phase 3 functions online, and because Rule 21's development has been focused on engineering issues, these questions have not been posed formally at the commission. Instead, it's being pursued in a separate DER compensation process addressing questions of how to value the energy and ancillary services that can be provided by DERs.

In January 2014, the Smart Inverter Working Group (SIWG) provided its Phase I recommendations for autonomous functionalities:

- **Anti-islanding** to trip off under extended anomalous conditions
- **Voltage ride-through** of low/high excursions beyond normal limits
- **Frequency ride-through** of low/high excursions beyond normal limits
- **Volt/var control** through dynamic reactive power injection through autonomous responses to local voltage measurements
- Define **default and emergency ramp rates** as well as high and low limits
- Provide reactive power by a **fixed power factor**
- Reconnect by **"soft-start" methods** (e.g. ramping and/or random time within a window)

The CPUC adopted its Rule 21 decision in June 2016, and the timing for adoption and deployment of phase 1 functions is phased in over 18 months, with the phase 1 functions required for all inverters one year after. An update to technical specifications is also underway (IEEE 1741) and after product testing and certification for inverters is complete and ratified, all California IOUs will be required to interconnect inverters with phase 1 functions. Full roll out of phases 2 and 3 would follow in the next few years. Many unanswered questions remain surrounding market, contracts, regulation that will keep the PUC busy for the next few years.

States on the call shared their experiences with smart inverters and asked questions about the development, rollout and implications of Rule 21. Minnesota is looking at smart inverters though their current and ongoing grid modernization proceedings. It's not an area they are actively pursuing a rulemaking over, and interconnection reform isn't on their current agenda, but smart inverters are a topic that is coming up frequently in that proceeding.

Illinois has been exploring grid modernization in a number of recent activities but hasn't taken on smart inverters yet specifically.

Nevada asked whether California had been more concerned about technical descriptors or more driven by understanding regulatory or market changes that smart inverters would facilitate. California responded that it had focused on technical recommendations. They kept an engineering focus, and anything outside the scope of technical specs was excluded.

Arizona noted that smart inverters had come up a lot in recent proceedings, and their staff had been in pretty close coordination with the engineer staff in California. One area that had arisen in discussion was whether compensation using net metering that is focused on real power, and not on reactive power eliminates a monetary structure for reactive power to be compensated even if it's good for the grid. If those functions are there but no monetary path exists, inverter deployers will be giving away a reactive power service. Califonria's reply was that this was a real issue and that general consensus was that phase 3 functions would get paid, so this remains an active issue.

Arkansas discussed that it has not yet encountered smart inverters and asked whether there had been discussion of using phase 1 capabilities as a prerequisite for participating in netmetering, outside of the engineering discussion of Rule 21. California noted that most developers are using devices that have Phase 1 capabilities and while it isn't a requirement it's becoming much more common in practice, and this may obviate a requirement.

Virginia asked whether the impetus for Rule 21 was a reliability problem in CA as DER penetration increased, or just the warning signs from Germany? California responded, the latter, but also there are technical efficiencies that benefit the utility. One of the three IOUs originated the rule and noted they saw a way to use a customer-site-hosted inverter-based solution to DER integration instead of distribution-side capacitor banks and grid-side solutions.

The District of Columbia asked whether scale matters, and smart inverters are systemically meaningful only at higher penetrations, or whether these requirements help with individual installations.

California thought the technology becomes more important as the resource grows. The way to integrate supply resources is to make those resources visible. Solar power shows up as an uncontrolled, un-optimized "blob" and smart inverters help optimize the grid.

Phase 3 smart inverter functions include the capacity to:

- Monitor Key DER Data
- DER Cease to Energize/Return to Service Request (an emergency trip command the utility can send to a DER in the case of planned work or an emergency response)
- Limit Maximum Real Power Mode
- Set Real Power Mode
- Frequency-Watt Emergency Mode (a command to inverters saying if they sense that system frequency dips below a level, then they need to ramp up)
- Volt-Watt Mode
- Dynamic Reactive Current Support Mode
- Scheduling Power Values and Modes

Phase 1 functions will be rolled out in 2017. The Phase 3 conversation is being turned into a full revision of the IEEE 1547 to include Phases 1, 2, 3. Eventually these advanced functions will be written into underlying grid code and most states draw from IEEE 1547 for their own interconnection requirements. So, although these are California-specific interconnection specs, these functions may be disseminated nationally.

Do you have a question you'd like to convene state staff from around the country to explore? Please contact Miles Keogh, NARUC's Lab Director, 202-898-2217 mkeogh@naruc.org

NARUC Research Lab