Agenda

- Rule 21 Phase 1 – Autonomous Operation
  - Beginning
  - Revision process
  - Decision

- Rule 21 Phase 2 – Communication and Aggregation
  - Scope and Status

- Rule 21 Phase 3 – Utility Control of DER
  - Scope and Status
Rule 21 Phases

• **Phase 1 – Autonomous Functions**
  - Support Anti-Islanding to trip off under ride-through conditions
  - Provide low/high voltage ride-through
  - Provide low/high frequency ride-through
  - Provide volt/var control in autonomous fashion
  - Provide fixed power factor
  - Reconnect by “soft-start” method

• **Phase 2 – Communications Capabilities for Monitoring, Updating Settings and Control**
  - IEC 61850, SEP2 and DNP3

• **Phase 3 – Interactive Functions**
  - Utility control; directly or through aggregator
Rule 21 Phase 1

History and Status
Rule 21 Beginning

- CPUC adopted Rule 21 in the 1980s to provide interconnection of non-utility owned DEG

- Sept, 2011 the Commission initiated Rulemaking (R.) 11-09-011 to revise Electric Tariff Rule 21 governing PG&E, SCE, SDG&E

- Modifications to support “smart inverters”
  - Generate or Absorb reactive power
  - Aid with voltage and frequency regulation
  - Deliver power in four quadrants
  - In combination with a communication link to control DG and storage in accordance with signals from the utility
Rule 21 Revision Process

- Feb 2013 SIWG Formed
- Jan 2014 SIWG Submitted Phase 1 Recommendations
  - New voltage and frequency ride-through settings
  - Dynamic Volt-var Operations
  - Ramp Rates
  - Fixed Power Factor
  - Soft Start
- Aug, 2014 Industry Comments were Filed
Rule 21 Decision

• Dec, 2014 Decision 14-12-035 issued
  • Establishes mandatory date: shall be the later of December 31, 2015, or 12 months after approval of UL 1741 Supplement SA
  • Replacement Inverters: existing inverters allowed to be replaced with an existing inverter not classified as a Smart Inverter, but of equal or greater ability than the original
  • Volt/Var: Decision asks utilities to provide detailed specifications and make a proposal with in on year’s time
  • Connect/Reconnect Ramp-up Rate: Ramp-up rate adjustable between 1 and 100% per second
  • Adjusted Ride-Through Tables: See below
  • Harmonizing Rule 21 with FERC: ALJ asked utilities to seek approval from FERC
  • Realizing the Value of Smart Inverters: How is the system owner compensated financially? Decision deferred. Future workshops proposed to address subject
## Voltage and Frequency Ride-Through Tables

### Table Hh-1: Voltage Ride-Through Table

<table>
<thead>
<tr>
<th>Region</th>
<th>Voltage at Point of Common Coupling (Vs Nominal Voltage)</th>
<th>Ride-Through Until</th>
<th>Operating Mode</th>
<th>Maximum Trip Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage 2 (HV2)</td>
<td>$V \geq 120$</td>
<td></td>
<td></td>
<td>0.16 sec.</td>
</tr>
<tr>
<td>High Voltage 1 (HV1)</td>
<td>$110 &lt; V &lt; 120$</td>
<td>12 sec.</td>
<td>Momentary Cessation</td>
<td>13 sec.</td>
</tr>
<tr>
<td>Near Nominal (NN)</td>
<td>$88 \leq V \leq 110$</td>
<td>Continuous Operation Indefinite</td>
<td>Continuous Operation</td>
<td>Continuous Operation Not Applicable</td>
</tr>
<tr>
<td>Low Voltage 1 (LV1)</td>
<td>$70 \leq V &lt; 88$</td>
<td>20 sec.</td>
<td>Mandatory Operation</td>
<td>21 sec.</td>
</tr>
<tr>
<td>Low Voltage 2 (LV2)</td>
<td>$50 \leq V &lt; 70$</td>
<td>10 sec.</td>
<td>Mandatory Operation</td>
<td>11 sec.</td>
</tr>
<tr>
<td>Low Voltage 3 (LV3)</td>
<td>$V &lt; 50$</td>
<td>1 sec.</td>
<td>Momentary Cessation</td>
<td>1.5 sec.</td>
</tr>
</tbody>
</table>

### Table Hh-2: Frequency Ride-Through Table

<table>
<thead>
<tr>
<th>System Frequency Default Settings</th>
<th>Minimum Range of Adjustability (Hz)</th>
<th>Ride-Through Until (s)</th>
<th>Ride-Through Operational Mode</th>
<th>Definitive Clearing Trip Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f &gt; 62$</td>
<td>$62 \leq f \leq 64$</td>
<td>No Ride Through</td>
<td>Not Applicable</td>
<td>0.16</td>
</tr>
<tr>
<td>$60.5 \leq f \leq 62$</td>
<td>$60.1 \leq f \leq 62$</td>
<td>299</td>
<td>Mandatory Operation</td>
<td>300</td>
</tr>
<tr>
<td>$58.5 \leq f \leq 60.5$</td>
<td>Not Applicable</td>
<td>Indefinite</td>
<td>Continuous Operation</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>$57.0 \leq f &lt; 58.5$</td>
<td>$57 \leq f &lt; 59.9$</td>
<td>299</td>
<td>Mandatory Operation</td>
<td>300</td>
</tr>
<tr>
<td>$f &lt; 57.0$</td>
<td>$53 \leq f &lt; 57$</td>
<td>No Ride Through</td>
<td>Not Applicable</td>
<td>0.16</td>
</tr>
</tbody>
</table>
Rule 21 Phase 1 Standards Development

- UL 1741 SA
  - Working Group developing Supplemental Amendment
  - Draft was circulated and comments were due July 2015
  - WG in process of addressing comments, estimated completion Oct 2015
  - STP votes on proposal
  - UL publishes standard, November of 2015
  - Rule 21 effectivity date, estimated November of 2016

- IEEE 1547 full revision being updated to include Rule 21 requirements, Q4 2016

- IEEE 1547.1 full revision will address Rule 21 testing, Q4 2017(?)

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Rule 21 Phase 2
Rule 21, Phase 2

• Defines Communication Protocols between Utilities and other Parties
  • IEC 61850 data objects over IEEE 2030.5, SEP2
  • Cyber Security

• IEEE 1815/DNP3 for Direct SCADA Control and Management

• Aggregators can Manage Fleets by Providing Control

• Feb, 2015 SIWG Released Phase 2 Recommendations

• CPUC kicked back the recommendation to IOUs
  • IOUs need to generate common protocol document
  • IOUs need to develop individual Generation and Interconnection Handbooks
Rule 21, Phase 2 CSIP

- From SDG&E, first draft of Common Smart Inverter Profile (CSIP) for California, Draft V0.6.3
  - Goal is to achieve interoperability with simple data model, messaging model, communication profile, and security
  - Based on IEEE 2030.5
  - Group Management
    - System
    - Sub-transmission
    - Substation
    - Feeder
    - Segment
    - Service Transformer
  - 10 points / curve, 8 curves / inverter - This is a departure from the SIWG recommendations
Rule 21, Phase 2 Handbooks

- Individual IOUs need to update Generation Interconnection Handbooks, to include:
  - IEEE 2030.5 implementation guide - Minimum DER Data Exchange Requirements
  - IEEE 2030.5 Optional parameters
  - Data exchange performance requirements
  - Cyber security requirements – Authentication, Authorization, Accountability, and Data Integrity, also key management, certificate authorities and management procedures
  - Cyber security related passwords and cryptographic keys
  - Privacy policies define what is or not publicly available
Phase 3

Just getting started
Phase 3 Scope

- Functions being proposed – Under Utility control, includes storage
  - Monitor DER Status and Output
  - Command DER to Connect or Disconnect
  - Set or Limit Maximum Real Power
  - Set Storage Charge/Discharge
  - Counteract voltage and frequency excursions: Frequency-Watt, Voltage-Watt, and Dynamic Reactive Current Support
  - Scheduling of DER and Storage functions
  - Energy Storage Management and Scheduling
Phase 3 Today

- Aug, 2015, SIWG has Recommendation Document
- Many functions are real power limiting and there is a financial tariff needs to be written to compensate owner/operators
- Sept. 27, 2015, Phase 3 Workshop
  - CPUC Auditorium, San Francisco, CA
- Stay tuned
Resources

- Rule 21 Documents (CPUC R. 11-09-11)
  - SIWG Phase 2 Recommendations, Draft V9, Feb 2015
  - CPUC Decision 14-12-035
  - Rule 21 Ombudsman

- EPRI “Common Functions for Smart Inverters, Version 3”


- IEEE
  - “IEEE 1547a-2014”, Version 20 May 2014

- UL 1741 SA – Not published at this time
Questions