DER Selection for Microgrid Applications

By: Michael Higginson
Summary

Microgrid systems include local generation. Often, this generation is from distributed energy resources (DERs). When selecting DERs for microgrid applications, several factors need to be considered. This presentation will discuss many technical considerations and challenges of DER selection based on real-world microgrid experience. Some of these challenges include the resource power and energy delivery capabilities, steady-state performance, response to system events such as load swings and faults, paralleling limitations, and power system grounding. In summary, this presentation will discuss challenges that must be considered when selecting DERs for integration in microgrid systems.
Distributed Energy Resources + Microgrids

• DERs and Loads
• Operate grid-tied or islanded
Microgrid DER Selection: Key Points

- Active power and energy considerations
- Response to system events
- Paralleling and interconnection challenges
Generator: Active Power & Energy Considerations

**Power Output**
- Minimum output
- Maximum output

**Energy**
- Fuel availability

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<tr>
<th>ISO 8528</th>
<th>Load</th>
<th>Hrs/yr</th>
<th>Variable</th>
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<tbody>
<tr>
<td>Emergency Standby Power</td>
<td>70%</td>
<td>200</td>
<td>Yes</td>
</tr>
<tr>
<td>Prime Rated Power</td>
<td>70%</td>
<td>8760</td>
<td>Yes</td>
</tr>
<tr>
<td>Limited-Time Prime Power</td>
<td>100%</td>
<td>500</td>
<td>No</td>
</tr>
<tr>
<td>Continuous Operating Power</td>
<td>100%</td>
<td>8760</td>
<td>No</td>
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Battery Energy Storage System: Active Power & Energy Considerations

**Power Output**
- Inverter and battery limited

**Energy**
- Battery limited
- Charge cycles
Renewable Generation: Active Power & Energy Considerations

Power Output
- Intermittency
- Timing

Energy
Response to System Events: Faults

Protection Impacts

- Fault current level
  - Traditional devices
  - CT selection
- Directionality

<table>
<thead>
<tr>
<th>Grid-Tied Max Fault Current (kA)</th>
<th>Islanded Max Fault Current (kA)</th>
<th>Islanded Min Fault Current (kA)</th>
<th>Max Load Current (kA)</th>
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</thead>
<tbody>
<tr>
<td>5.0</td>
<td>0.5</td>
<td>0.02</td>
<td>0.05</td>
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Response to System Events: Faults

Generators
- Decrement curves
- Frequency

Inverters
- Limited current output
- Ride-through
Response to System Events: Load and Generation Mismatch

- Loss of generation
- Black start
- Load acceptance
Response to System Events: Load and Generation Mismatch

- Loss of generation
- Black start
- Load acceptance

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Voltage Drop</th>
<th>Frequency Drop</th>
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<tbody>
<tr>
<td>Generators Only</td>
<td>40.5%</td>
<td>19.1%</td>
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<tr>
<td>Generators + BESS</td>
<td>24.5%</td>
<td>6.0%</td>
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Paralleling and Interconnection Challenges: Grounding + Unbalance

- System grounding while islanded + grid-tied
  - Grounding transformers impact fault current while grid-tied
- Many system loads are unbalanced
  - Generator rotor ripple
  - Inverter DC bus ripple
Paralleling and Interconnection Challenges: Load Sharing

- Isochronous
  - Load sharing controllers
- Droop
- Baseload

Example Generator Droop Curve
Paralleling and Interconnection Challenges: Harmonics

- Inverter Harmonics
- Generator Pitch
Paralleling and Interconnection Challenges: Synchronization
Microgrid DER Selection: Key Takeaways

**Active power and energy considerations**
- Capacity and duration of islanding

**Response to system events**
- Faults or load and generation mismatch

**Paralleling and interconnection challenges**
- Load sharing, harmonics, synchronization, and grounding
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</tr>
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<td>Chair</td>
<td>Mandy Olson</td>
<td><a href="mailto:akolson@burnsmcd.com">akolson@burnsmcd.com</a></td>
<td>Burns &amp; McDonnell</td>
</tr>
<tr>
<td>Communications</td>
<td>Kyle Thomas</td>
<td><a href="mailto:kyle.thomas@dom.com">kyle.thomas@dom.com</a></td>
<td>Dominion</td>
</tr>
<tr>
<td>Communications Secretary, newsletter,</td>
<td>Chris Mertz</td>
<td><a href="mailto:Christopher.G.Mertz@dominionenergy.com">Christopher.G.Mertz@dominionenergy.com</a></td>
<td>Dominion</td>
</tr>
<tr>
<td>Events</td>
<td>Josh Snodgrass</td>
<td><a href="mailto:Josh.Snodgrass@powereng.com">Josh.Snodgrass@powereng.com</a></td>
<td>Mott Macdonald First Energy</td>
</tr>
<tr>
<td>Events</td>
<td>Jack Duncan</td>
<td><a href="mailto:jack.duncan@mottmac.com">jack.duncan@mottmac.com</a></td>
<td>First Energy</td>
</tr>
<tr>
<td>Events</td>
<td>Jessica Haines</td>
<td><a href="mailto:JHAINES@firstenergycorp.com">JHAINES@firstenergycorp.com</a></td>
<td>Worley Parsons</td>
</tr>
<tr>
<td>International Support</td>
<td>Jack Duncan</td>
<td><a href="mailto:jack.duncan@mottmac.com">jack.duncan@mottmac.com</a></td>
<td>First Energy</td>
</tr>
<tr>
<td>International Support</td>
<td>Jessica Haines</td>
<td><a href="mailto:JHAINES@firstenergycorp.com">JHAINES@firstenergycorp.com</a></td>
<td>Worley Parsons</td>
</tr>
<tr>
<td>Marketing</td>
<td>Yazan Alsmadi</td>
<td><a href="mailto:ymalsmadi@aep.com">ymalsmadi@aep.com</a></td>
<td>AEP</td>
</tr>
<tr>
<td>Membership</td>
<td>Jessica Haines</td>
<td><a href="mailto:JHAINES@firstenergycorp.com">JHAINES@firstenergycorp.com</a></td>
<td>Worley Parsons</td>
</tr>
<tr>
<td>Mentoring</td>
<td>Jessica Lau</td>
<td><a href="mailto:Jessica.Lau@nrel.gov">Jessica.Lau@nrel.gov</a></td>
<td>NREL</td>
</tr>
<tr>
<td>Mentoring</td>
<td>Saeed Kamalinia</td>
<td><a href="mailto:saeed.kamalinia@sandc.com">saeed.kamalinia@sandc.com</a></td>
<td>S&amp;C Electric Company</td>
</tr>
<tr>
<td>Mentoring</td>
<td>Jonathan Marmillo</td>
<td><a href="mailto:jmarmillo@genscape.com">jmarmillo@genscape.com</a></td>
<td>Genscape</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Nikia Munson</td>
<td><a href="mailto:nikia.munson@powereng.com">nikia.munson@powereng.com</a></td>
<td>POWER Engineers</td>
</tr>
<tr>
<td>Members-At-Large</td>
<td>Ryan Quint</td>
<td><a href="mailto:Ryan.Quint@nerc.net">Ryan.Quint@nerc.net</a></td>
<td>NERC</td>
</tr>
<tr>
<td>Members-At-Large</td>
<td>Kojo Sefah</td>
<td><a href="mailto:ksefah@misoenergy.org">ksefah@misoenergy.org</a></td>
<td>MISO</td>
</tr>
<tr>
<td>Members-At-Large</td>
<td>Diana Lee</td>
<td><a href="mailto:deelizlee@gmail.com">deelizlee@gmail.com</a></td>
<td></td>
</tr>
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Questions?
usnc-ngn@cigre.org