Decentralized Power Grids: Successfully Integrating Distributed Generation with Cyber Security

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Decentralized Power Grids

Supplementary power source(s) to the existing centralized power grid

• Energy source(s) located closer to consumption
• Keep the lights on
• Enhance system user economics
• Facilitate renewable energy integration
Decentralize Systems Must:

- Decoupling
- Island Detection
- Maintain Inertia
- Frequency Control
- Load Shedding
- Load Restoration
- Communication
Islanding Possibilities

- Decentralized power to meet requirements
- Cybersecurity implications
- All generations need to maintain synchronization
## Loads Will Have Different Requirements

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Reliability</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Payback Period</td>
<td>Years</td>
<td>Days</td>
</tr>
<tr>
<td>Intermittent Energy Sources</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Inverter-Based Generation</td>
<td>✓</td>
<td>✗</td>
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</tbody>
</table>
Microgrid Point of Interface (POI) Relay

- Grid reconnection
- Seamless islanding and load shedding
- Short- and open-circuit protection
- Power and Power Factor control at POI
DER Relay Provides

- Protection
- Governor and exciter dispatch
- Inverter dispatch
- Parallel controls
- Distributed energy resource (DER) load sharing
- Voltage regulation
- Frequency regulation

POI Multifunction Protective Relay

DER Relay Provides

DER Relay

DER Relay

DER Relay

DERs

POI

Synchronism Check

Dispatch

Close
7:00 AM

Batteries partially drained from lack of solar

Power = Central Grid + Wind

Solar charging batteries
DER – Peak Shaving (Economic)

1:00 PM

High Demand on Central Grid

Disconnect battery charging

Connect batteries and solar into system
DER – Loss of Central Grid

Power Event / Islanding

Shed Load based on priority

Switch Distributive Energy Sources

Wait for generator to start and provide inertia

Bring additional load back on based on generation priority
Balancing Risks

Complicated in energy systems with multiple owners

Important discussion for distributive generation

Not just cyber!
The Cybersecurity Framework’s prioritized, flexible, and cost effective approach helps to promote the protection and resilience of critical infrastructure and other sectors important to the economy.
<table>
<thead>
<tr>
<th>Security Framework</th>
<th>Identify</th>
<th>Protect</th>
<th>Detect</th>
<th>Respond</th>
<th>Recover</th>
<th>Learn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Identify baseline system and prioritize risk to implement selected security controls</td>
<td>Assess implementation and authorize system risks</td>
<td>Monitor continuous monitoring tools</td>
<td>Execute plans, policies, and procedures to analyze and contain situation</td>
<td>Eradicate and recover system to previous state</td>
<td>Review event to improves plans, policies, and procedures</td>
</tr>
</tbody>
</table>

**Risk Management**

**Contingency and Incident Response**
Questions?