Integrating Renewables with Microgrids for Resilience and Regulatory Challenges

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Eaton Corp Research & Technology

Focus Areas of Technology in Electrical Sector

1. Arc Interruption Technologies
2. Electrical Safety Technologies
3. MV Solid State Technologies
4. Power Conversion Technologies
5. Energy Networks Technologies

Develop technologies to provide Eaton's end-to-end power management solutions for MICROGRIDS.

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Microgrids Lab in Menomonee Falls Wisconsin

Equipment Available

1. 100kW Natural gas generator
2. 125kW Diesel generator
3. 60kW Energy storage
4. 25kW PV
5. Two 125kVA Inverters
6. Load banks
7. Weather station
8. System-in-the-loop

Resilience

"The capacity to recover quickly from difficulties"

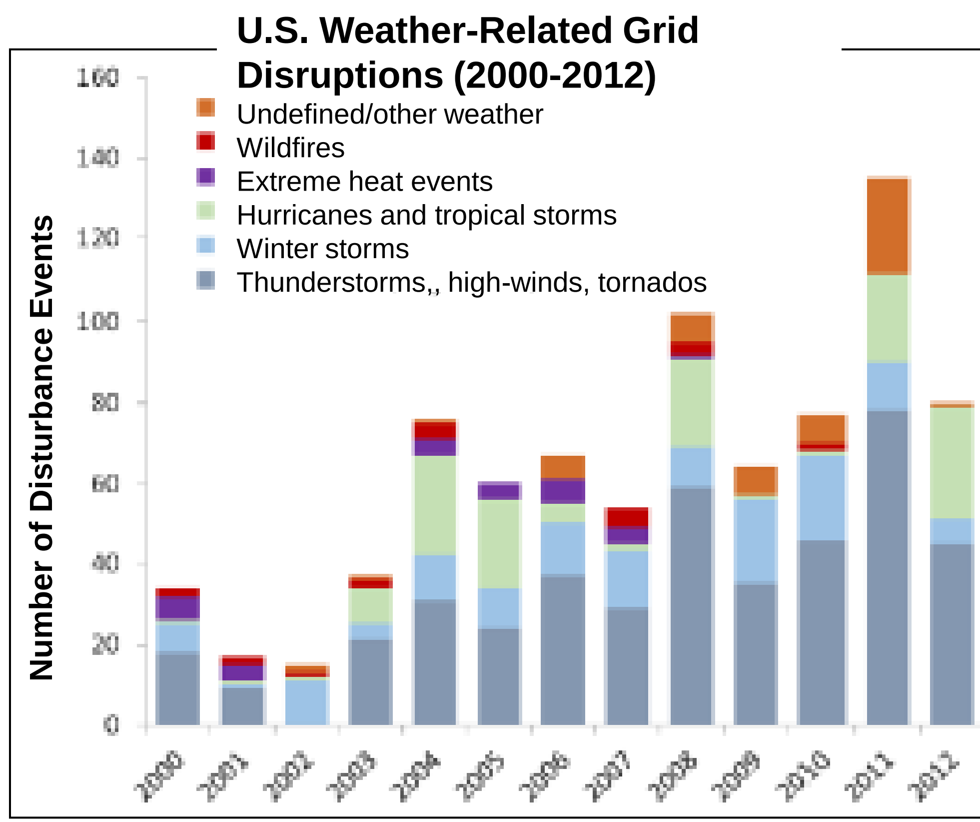
Our Lab in Milwaukee after a flash flood in 2010

1. Lost prototypes ready for UL testing
2. Lost the lab equipment like scopes, meters, power supplies…
3. Had to relocate testing across a 60 mile radius in three locations

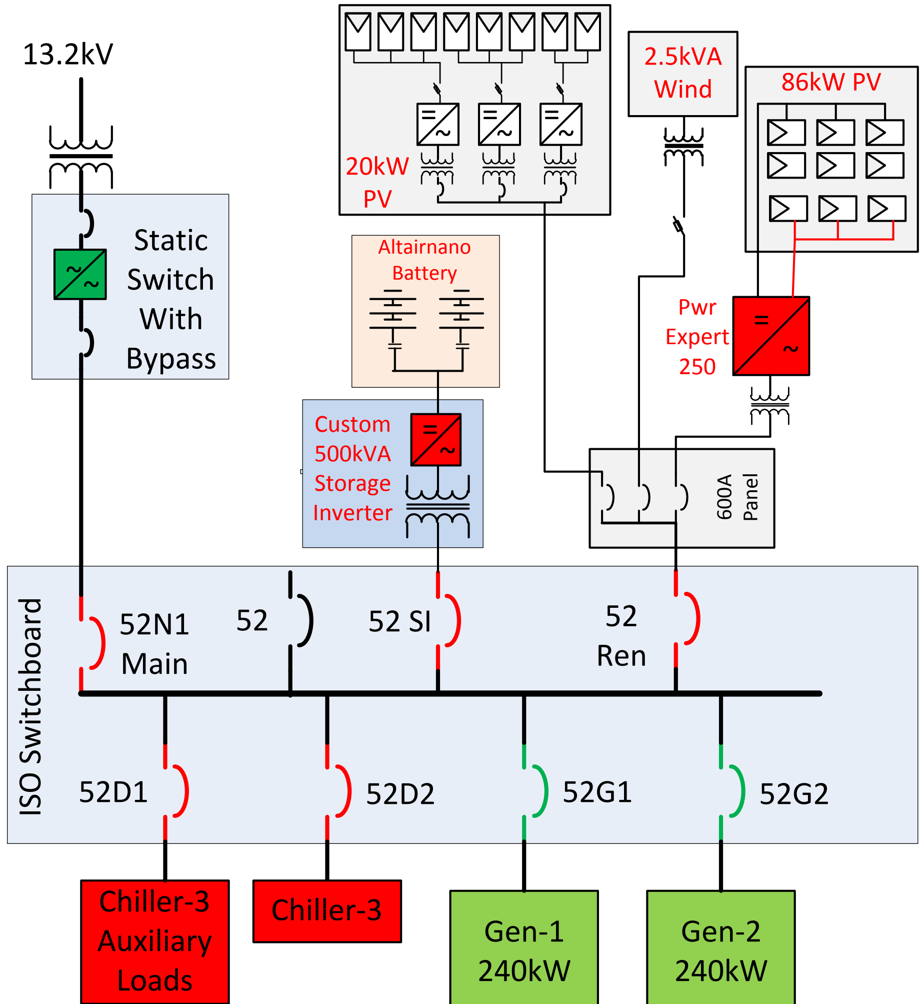
Microgrids and Resilience

<u>Microgrids can</u>

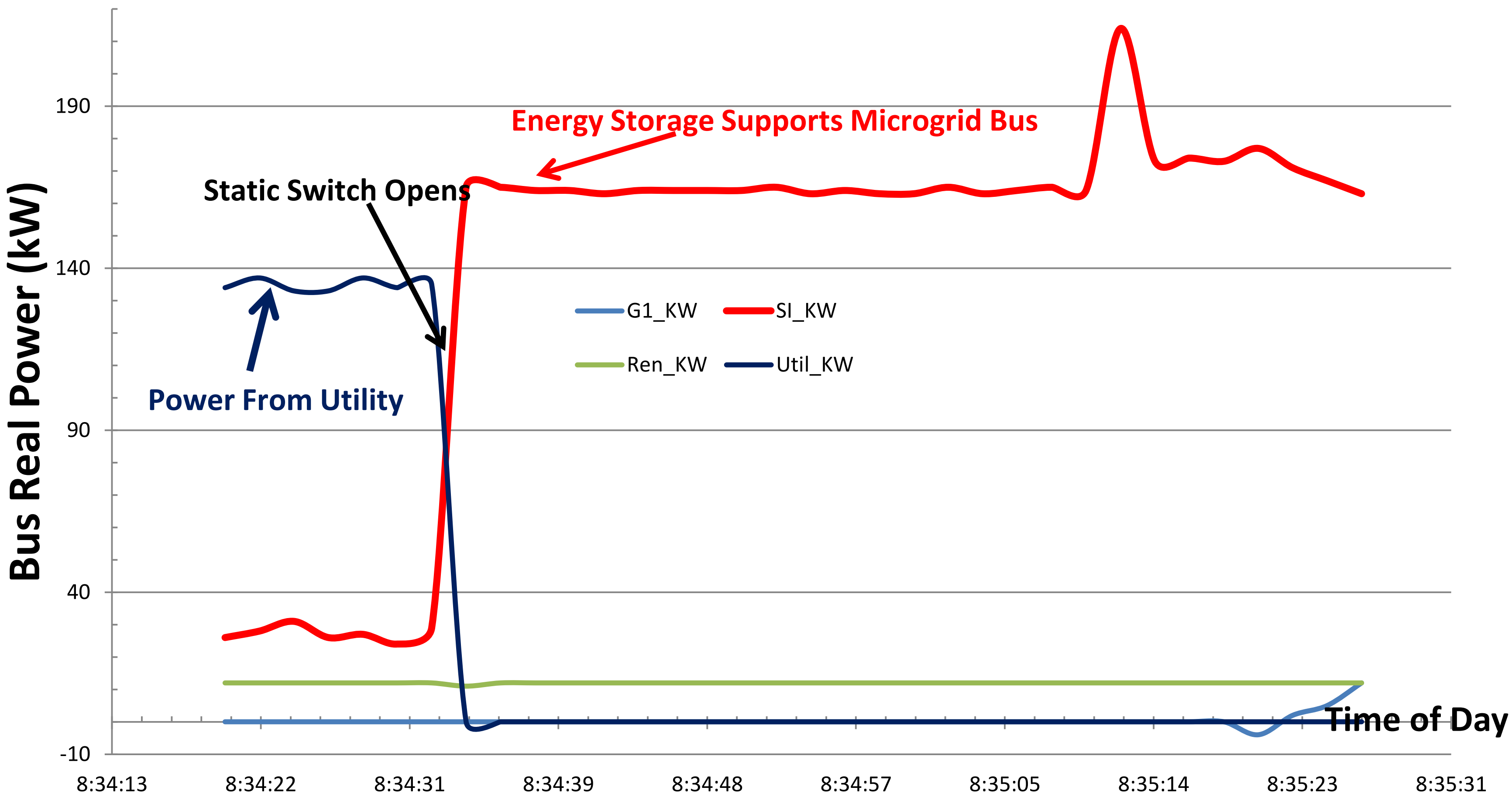
1. Island a set of loads and sources
2. Use existing power infrastructure
3. Can expand area of coverage
4. Can Use all types of sources
5. Can integrate more sources as needed
6. Ensure safety of the supply



Microgrid Installed at Fort Sill Army Base



Seamless Islanding on a Power Outage



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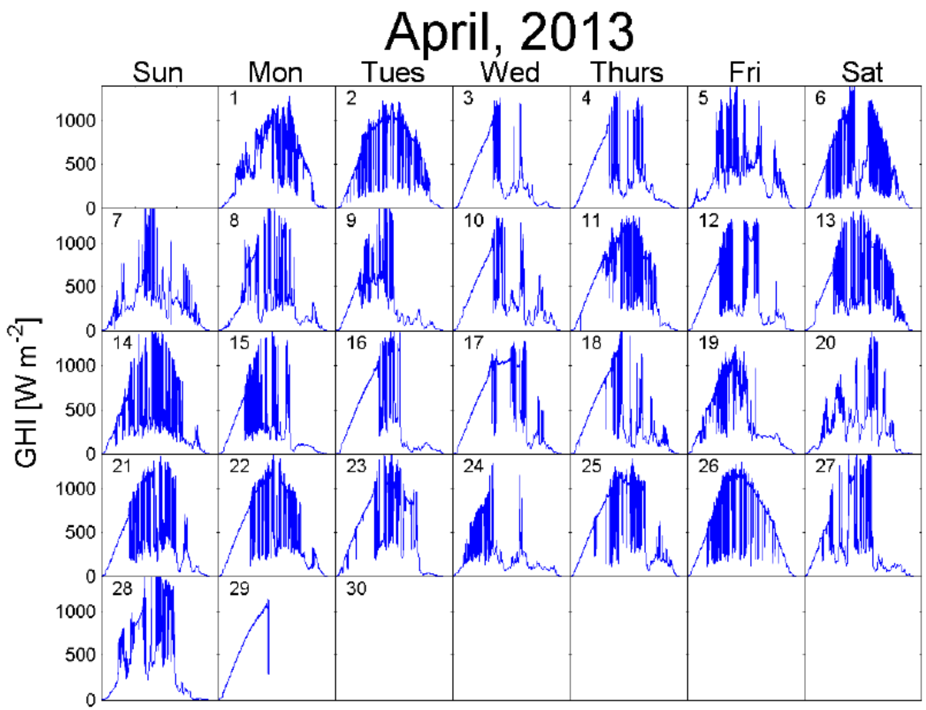
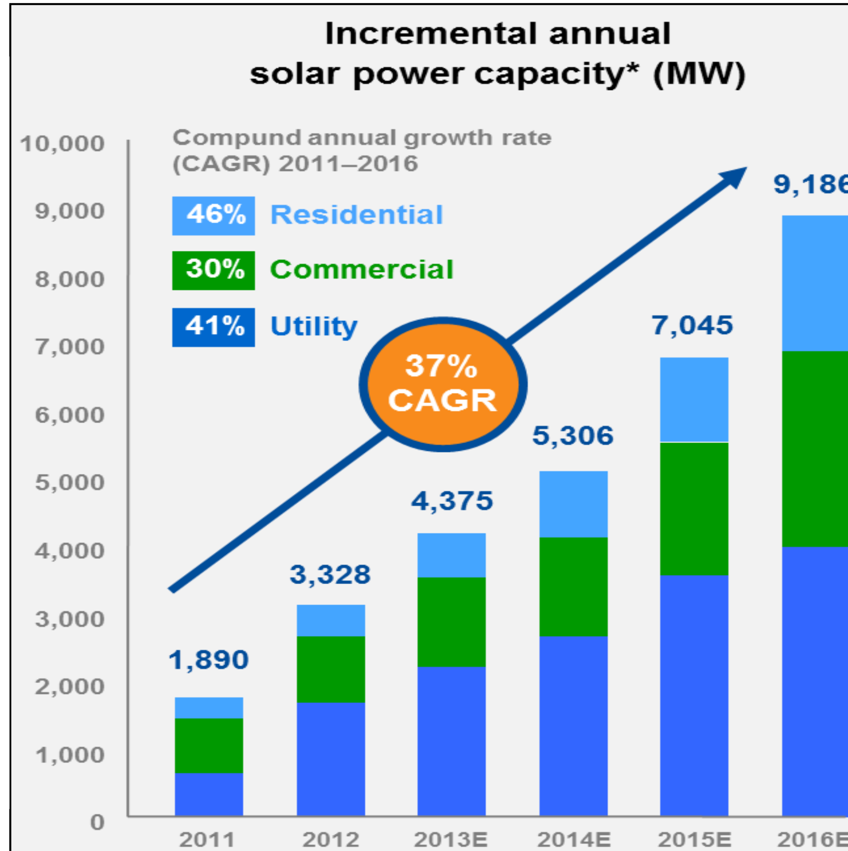
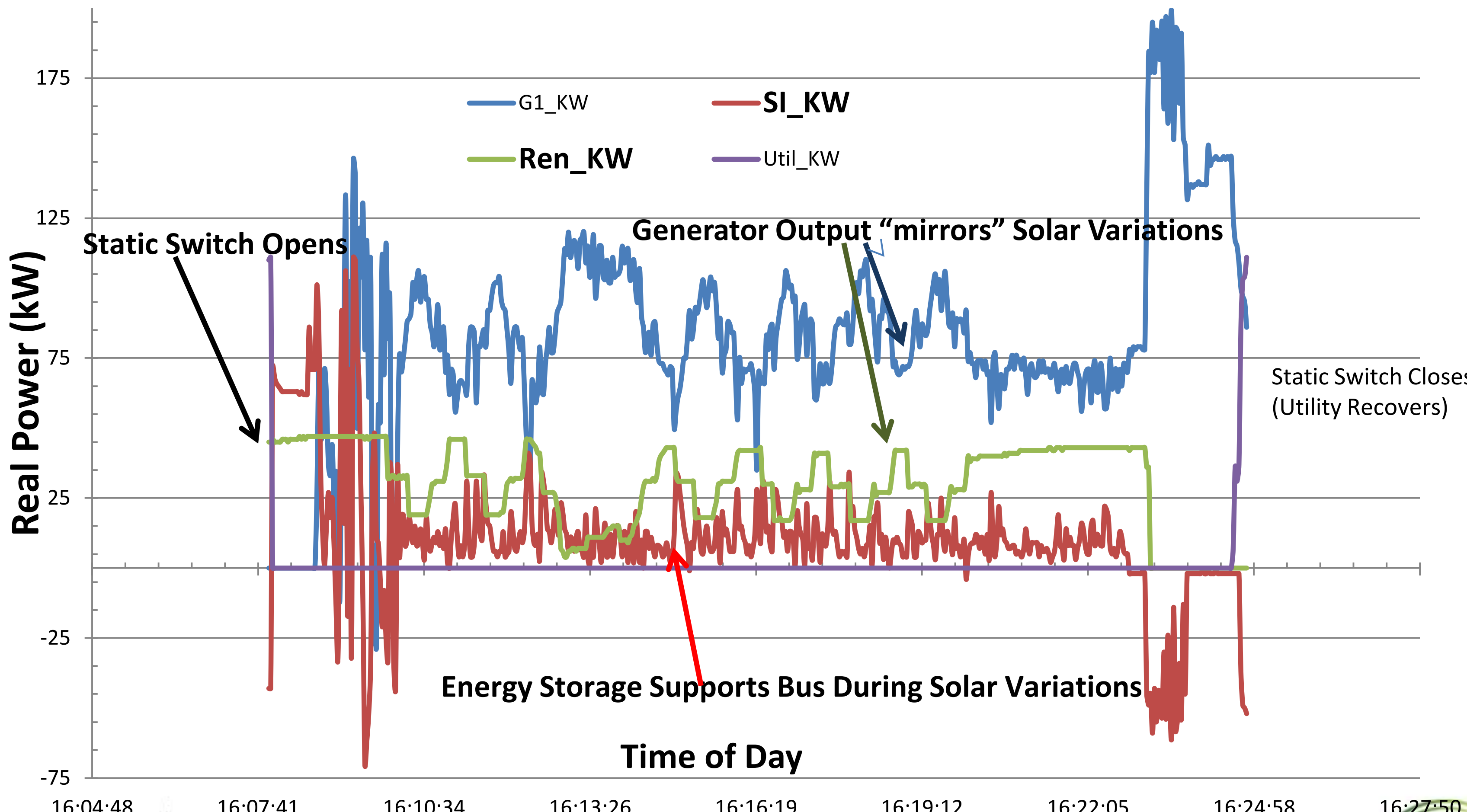
Photovoltaics are Growing but they are Intermittent



Plot showing the Global Horizontal Irradiation (GHI) profile at Mayaguez Puerto Rico



Energy Storage Supports Dynamics of Renewables



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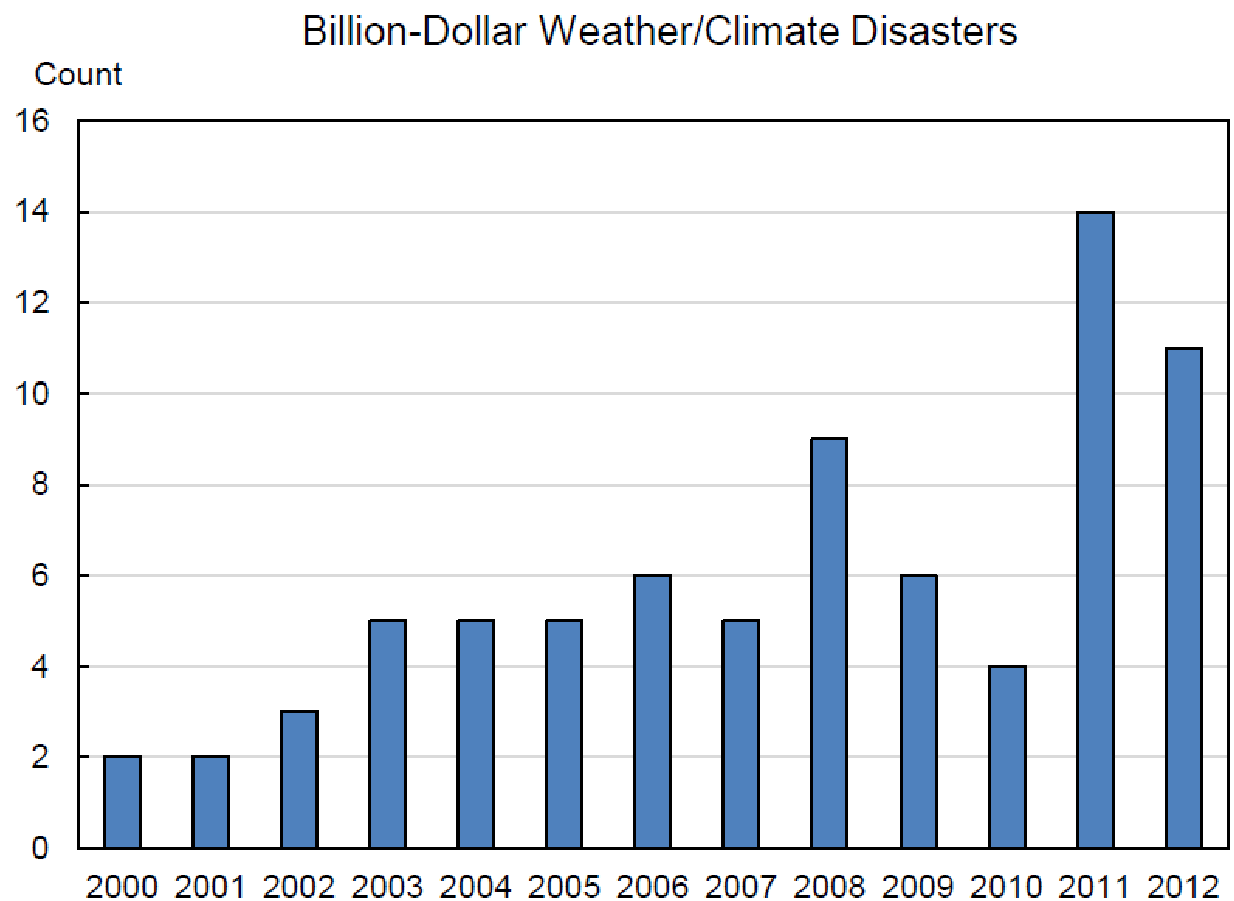
Why Resilience



Source: National Oceanic and Atmospheric Administration (NOAA)

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Microgrid Costs

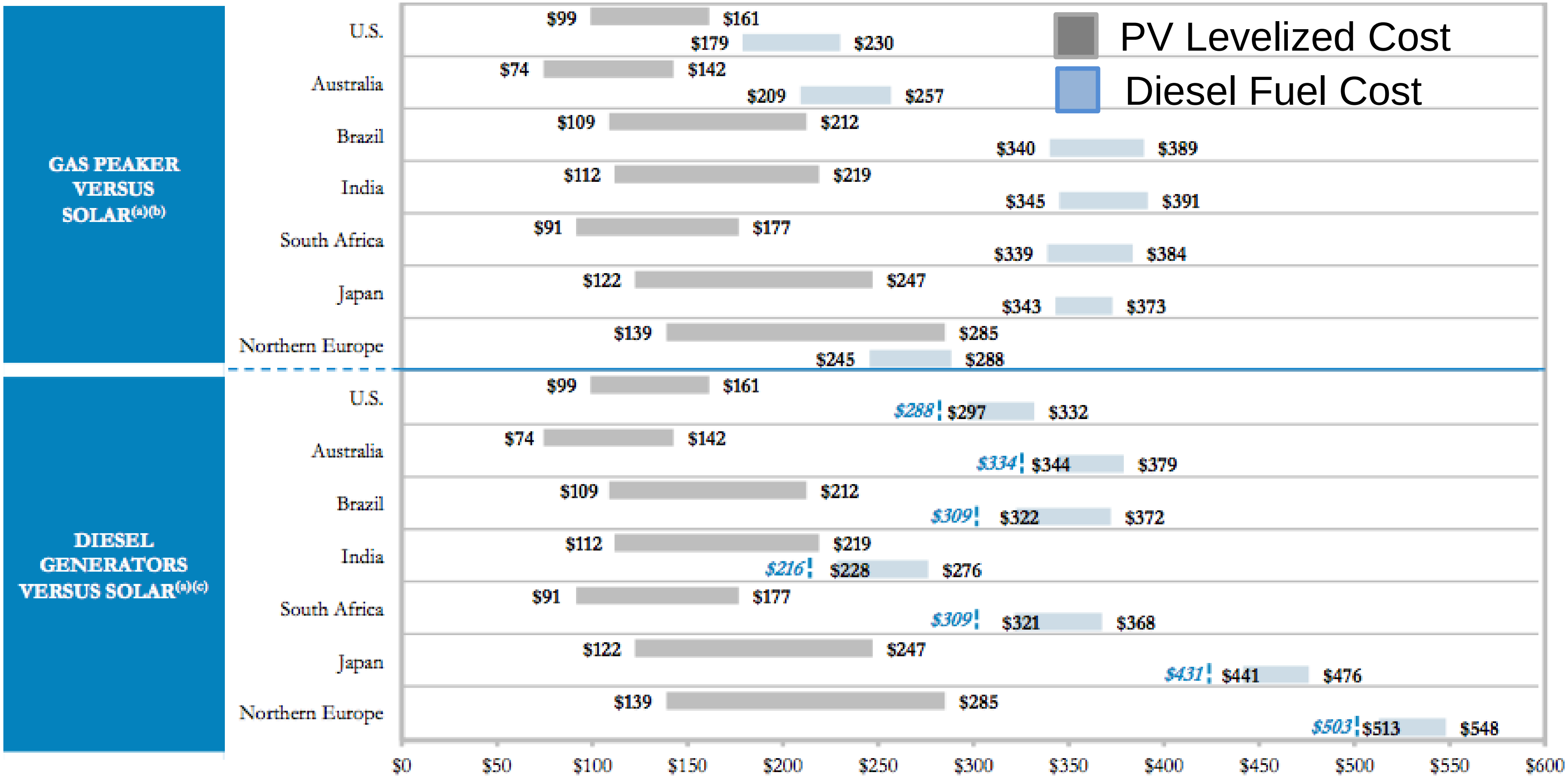
Capex

1. Generator installation
2. Switchgear updates/installation
3. Renewables installation
4. Properly sized Energy Storage with inverter

Opex

1. Fuel Costs
2. Investment costs – Energy storage and renewables are expensive
3. Maintenance

Solar versus Peaking Capacity



Units: $/MWh

http://cleantechnica.com/2014/09/04/solar-panel-cost-trends-10-charts/

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Five S's of Microgrids

1. **Surety** - Preventing loss of access to power and fuel sources
2. **Survivability** - ensuring resilience in energy systems
3. **Supply** - accessing alternative and available renewable energy sources
4. **Sufficiency** - providing adequate power for critical operations
5. **Sustainability** - promoting support for the enterprise, its community, and the environment

Status of Technology

1. **Surety** – Demonstrated powering loads with different source
2. **Survivability** – Onsite storage and managing a mixture of source
3. **Supply** – Ability to integrate high penetration renewables and decreasing fuel usage
4. **Sufficiency** – Load shedding and storage to shift renewable usage to power critical loads
5. **Sustainability** – Expanding the microgrid area to include the community during a disaster

Barriers to Microgrids

1. **Surety** ------------**Identification and integration of resources**
2. **Survivability** ----**Provide multiple sources** (Renewables & CCHP or CHP)
3. **Supply** -----**Encourage markets for alternative power**
4. **Sufficiency** ------**Identify critical infrastructures**
5. **Sustainability** ---**Allow codes to back-feed power into the distribution system**
6. **Economics** ------- **Enable microgrids to participate in ancillary services and replace emergency backup with microgrids**