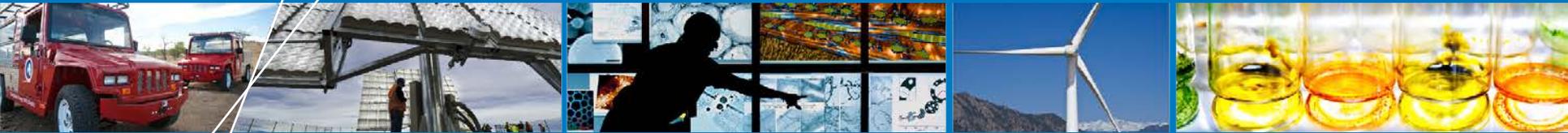


How Microgrids Will Shape the Future



Robert Preus

Small Wind Conference

June 16–19, 2014

Stevens Point, Wisconsin

NREL/PR-5000-62493

What is needed for a microgrid?

- **Control of power and load balance**
 - Controllable power source
 - Controllable load demand
 - Power storage.
- **Control of power quality**
 - Voltage support
 - Frequency support
 - Power factor (var) support.
- **System controls**
- **Ability to synchronize with grid.**

Microgrid function

- **Currently microgrids are being developed for improving reliability or in some cases reducing power cost.**
 - Commonly used for hospitals, fire stations, police, colleges, server farms, etc.
- **They can be financially attractive especially if waste heat is useful and power is expensive.**
- **Primarily fossil-fuel based (natural gas and diesel are common).**

Where does renewable energy (RE) fit in?

- **RE can be anything from a major part, to minor feature, to not included at all.**
- **Financial impact of RE can be very complicated**
 - On the first level it is just a fuel saver.
 - It can be a fuel supply extender.
 - It can be used to enable power or grid support services sales.

What features are valuable in the system?

- **Power control is desirable for both load and generation components.**
- **Power quality support services are essential in at least some components.**
- **Integrated controls that prioritize and control loads will reduce storage and inverter requirements.**
- **RE input forecasting and load forecasting capability for controls will optimize assets.**

What is going on in demand response?

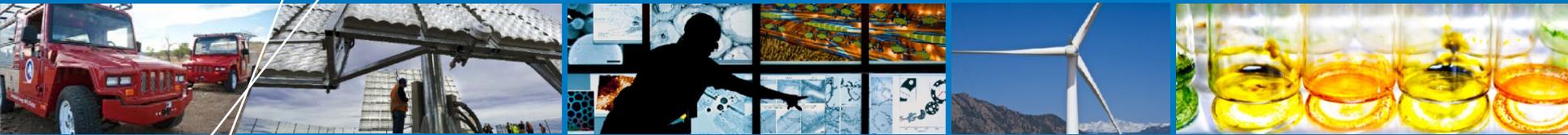
- **Technologies for behind-the-meter demand response and aggregation are being developed and reaching the market.**
 - Three-stage water heaters
 - Refrigerators
 - Heating and air conditioning systems.
- **Staging is another form of demand response.**
 - Clothes washer and dryer
 - Dishwasher.

Add it all together and what is available?

- **Community or home microgrid or off grid**
 - Power by RE possibly with natural gas supplemental input
 - Affordable storage used to stabilize grid quality
 - Smaller inverters will be needed due to staging and demand response.
- **All of these technologies can be integrated at the home, community, or larger level.**

How does distributed wind fit?

- **Microgrid or off-grid communities with photovoltaic and wind or small hydro and wind or other combinations**
 - Individual homes could have wind generators.
 - The community could have wind generators.
- **Wind generators will need to be flexible players with power-limiting capability and the ability to contribute to power quality.**



robert.preus@nrel.gov