Wind, Microgrids Storage, & the NEC

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Microgrids – Why Now?

http://www.greentechmedia.com/articles/featured/resiliency-how-superstorm-sandy-changed-americas-grid

Working to have Microgrids and ESS in the NEC for 3 cycles (9 years)

Two Interest Groups
Two Definitions

Utilities (& DOE)

A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode (U.S. Department of Energy Microgrid Exchange Group, 2010).

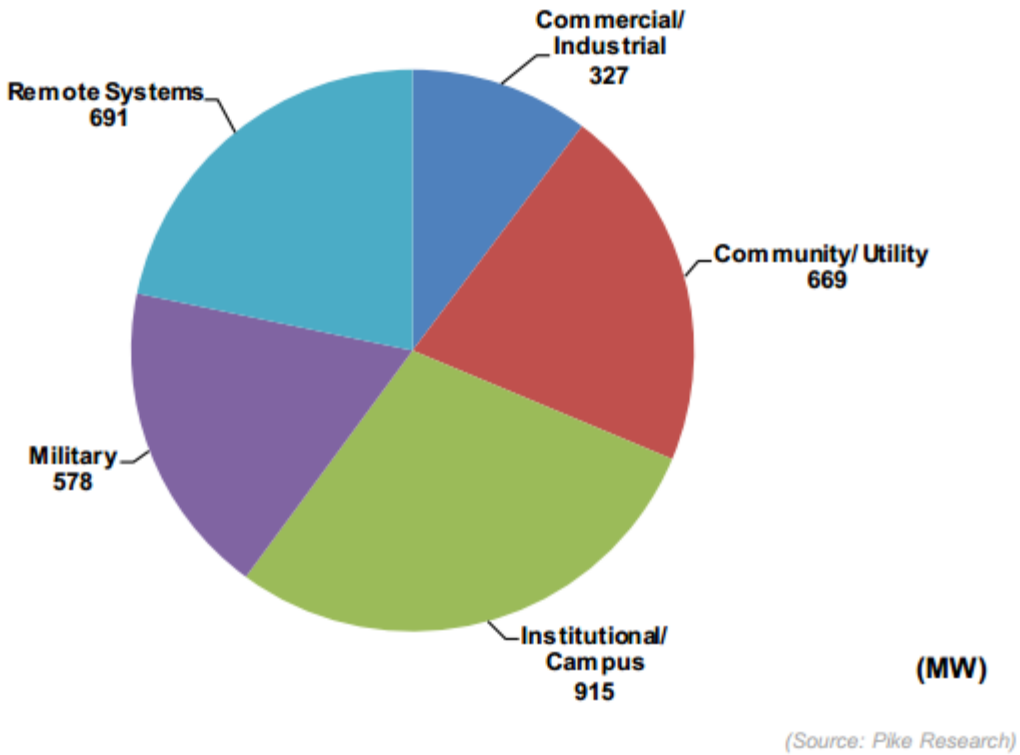
Others (e.g. Navigant Research)

This Navigant Research report analyzes the global market for microgrids in five key segments (commercial/industrial, community/utility, campus / institutional, military, and remote) and two new sub-segments (grid-tied UDMs (Utility Distribution Microgrids) and DC microgrids).

We chose a broader definition:

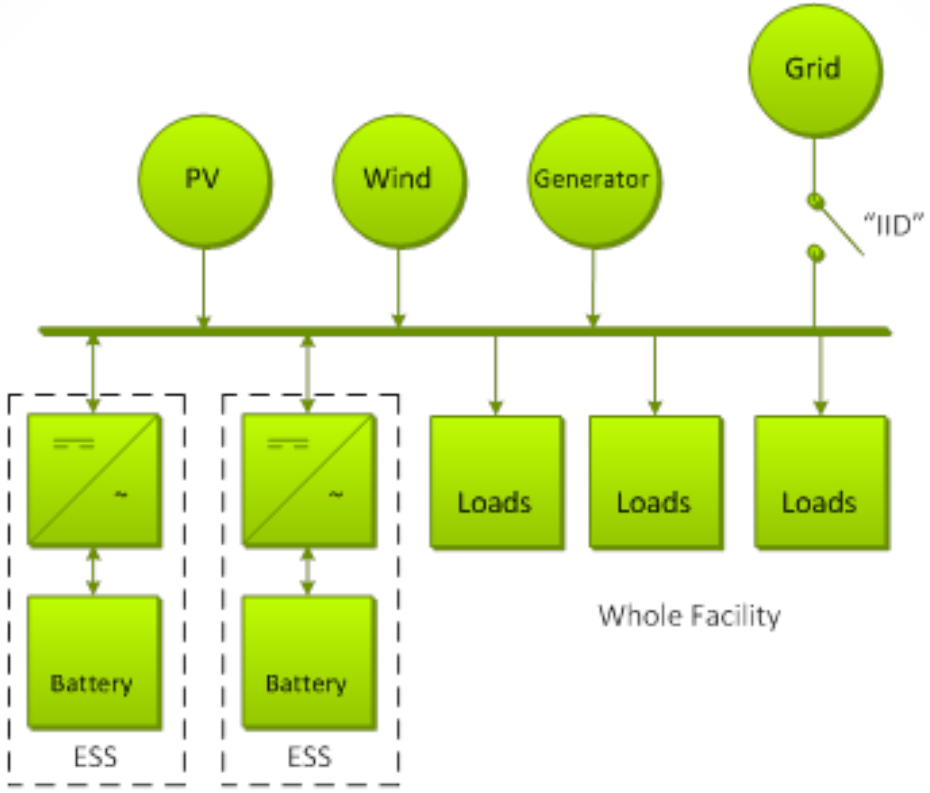
Microgrid. A group of interconnected electric loads and power production sources that comprise an electric power system with a clearly defined electrical boundary. A microgrid may include portions of an electric power system that are normally operated by a utility. Microgrids are also known as minigrids.
[Some microgrids interconnect with utility area power systems. Some microgrids portions of an electric power system that are normally operated by a utility].

Microgrid Capacity by Market Segment, World Markets: 4Q 2012



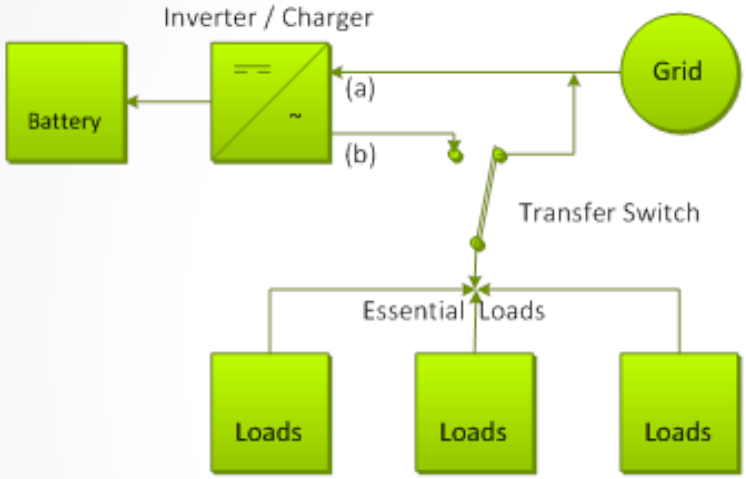
http://microgrid-news.com/pdf/peter-asmus.pdf

Example Microgrid



This is a very simple concept

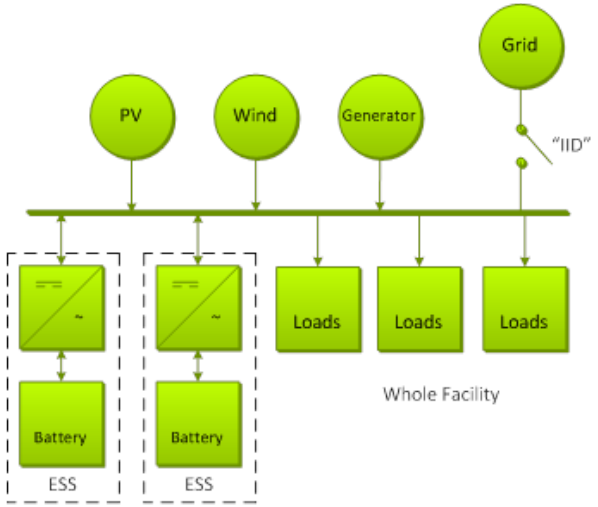
Present Technology
Multi-mode Inverters



Some problems with the multimode approach are:

- Only a subset of building loads are supported
- Essential loads have to be rewired to an emergency sub-panel
- Paralleling multiple units becomes awkward; they all have to be in the same location
- The transfer switch is typically integrated into the inverter and has limited capacity and functionality. It is typically incapable of carrying a full facility load.
- Integration with renewable energy sources is complicated (e.g. dc coupling and separate charge controllers).

Microgrid Concepts

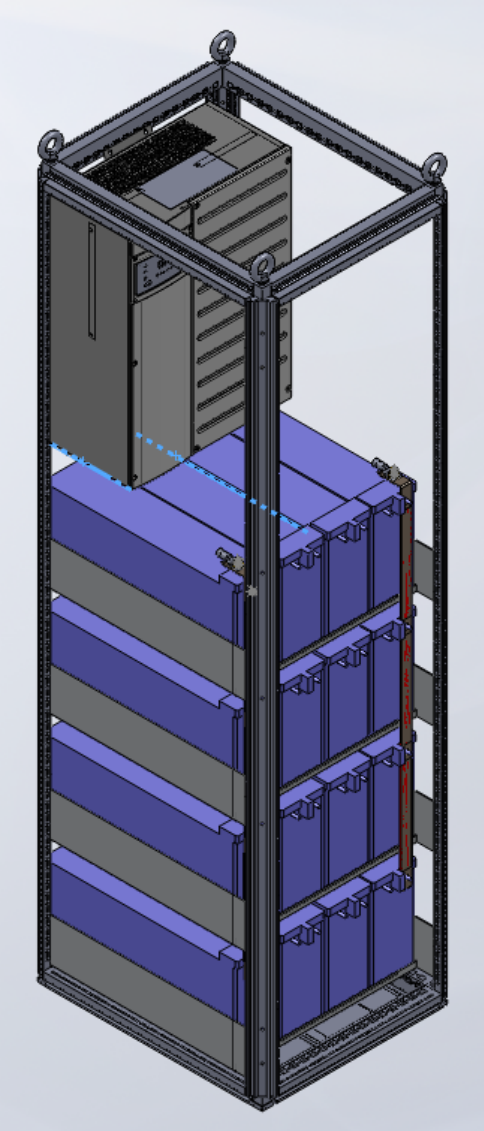


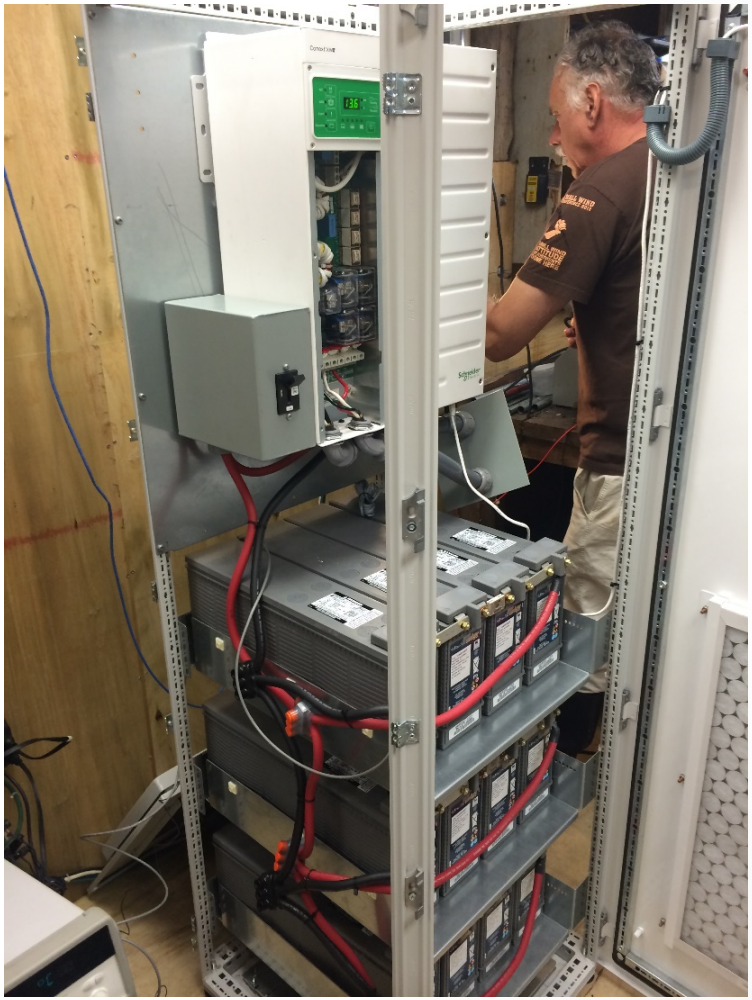
- Energy storage systems (ESS) become separate integrated entities.
- Multiple ESSs can be installed if required.
- Connection to the grid is via an Island Interconnection Device (IID).
- Local energy sources are simply AC-coupled to the ESSs and the grid. Off the shelf inverters or micro-inverters can be used.
- All facility loads can be carried; no rewiring or sub-panels are required.
- IIDs need to be certified – they become the "gate-keeper".
- Generation and load control protocols need to be defined (e.g. use of frequency on the microgrid as a generation signal).

Microgrid / ESS Markets

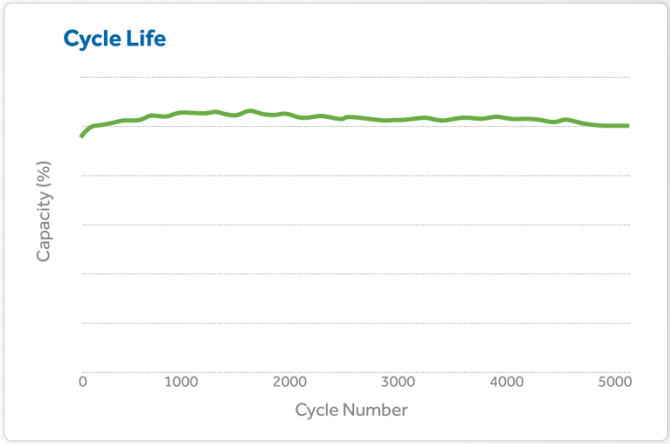
1. Enabling backup power for grid-connect PV & wind systems.
2. ESS as an alternative or addition to standby generators.
3. Renewable energy time shifting / self consumption.
4. Customer load leveling / peak shaving / demand limiting
5. Utility demand response and ancillary services.
6. Microgrids / resiliency
7. Stand-alone / Remote applications.

Varta Lead-Acid ESS





Aquion Batteries

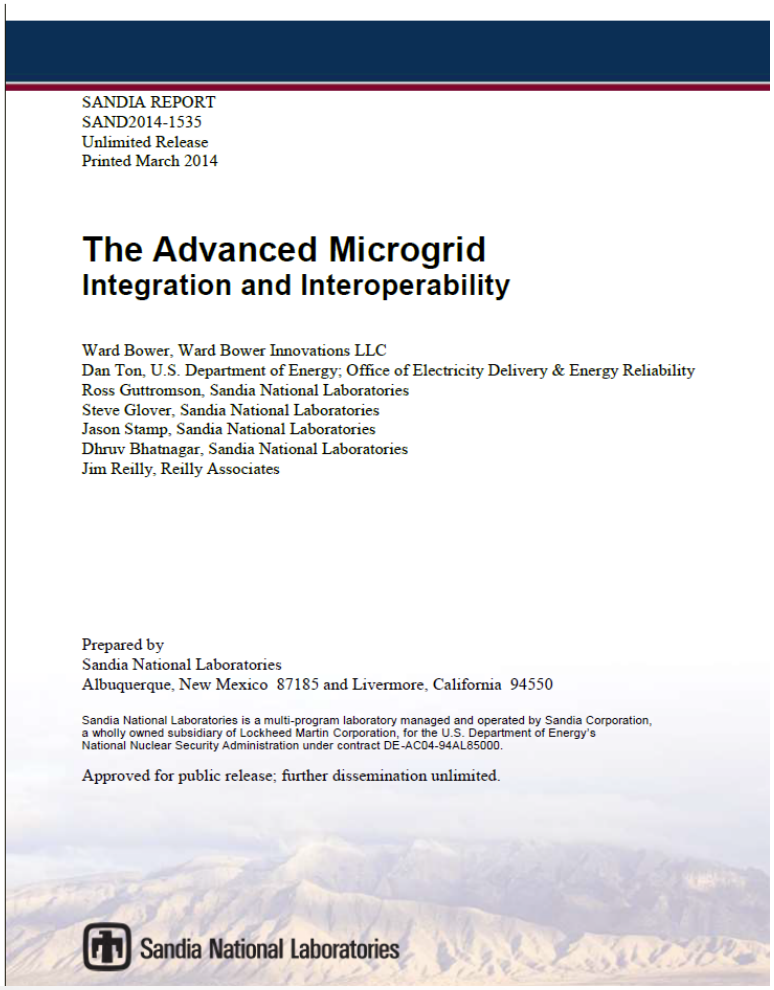


Designing a Stationary Battery from the Ground Up:

1. **Non-Toxic (Sodium Sulfate, MnO2)**
2. **Low Cost**
3. **Long Cycle Life**

The Future (2017 and Beyond)

Article 710 is a first pass at a complex topic.



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The Advanced Microgrid
Integration and Interoperability

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List of Advanced Microgrid Development Impact Areas

8.1 Regulatory Rules and Regulations
8.2 Advanced Microgrid System Adoption
8.3 Consumer Awareness
8.4 Customer Rights
8.5 System Siting and Permitting for Interconnection
8.6 Reliability Parameters
8.7 Cybersecurity
8.8 Market Access for Electric Power
8.9 Retail Participation
8.10 Ownership
8.11 Ownership Rate Structure
8.12 Franchise Rights
8.13 Wholesale Market Access
8.15 Transmission and Distribution Market Access
8.16 Value Proposition
8.17 Externality Pricing
8.18 Utility Revenue and Rate Models
8.19 Financing
8.20 Restrictions
8.21 Grid Resilience
8.22 Regulatory Barriers

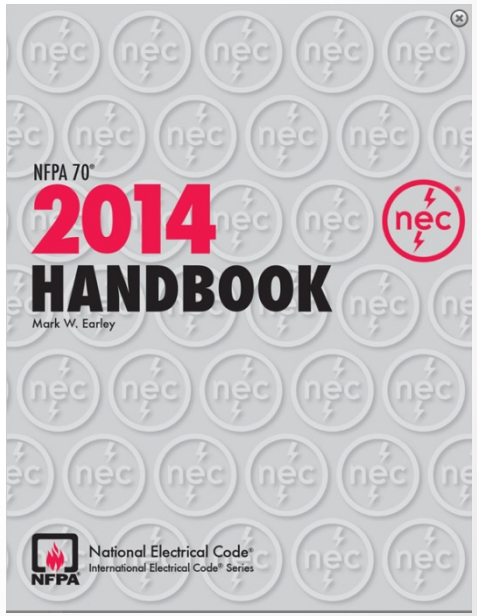
The Future Electric Grid

- Present Electric Infrastructure is sized for peak loads.
- A 200A Service can provide 40 kW.
- Average US consumption is about 25 kWh/day or 1 kW average.
- With local storage, a typical US house could operate with a 10 Amp utility service, and a 2 kW distribution transformer.

NEC 2017 – Overview

- Wind (694) had it easy
- Solar (690) complete re-write
- 690.12 - Solar faces Rapid Shutdown?
- Solar – 691 large PV
- ARTICLE 706 Energy Storage Systems
- 710 Microgrids -> Stand Alone Systems
- 712 DC Microgrids

Vote on 2017 First Draft due 3/27/2015



NEC 2017 – Wind gets a pass

- **Revision PDF**