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Charting a Course to Energy Independence

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Let's Talk About Microgrids and Islanding

W. Mike Warwick
Environmental and Energy Directorate
Pacific Northwest National Laboratory

- Presentation Overview
  - Defining terms
  - Characterizing options
  - Exploring risks, benefits, and costs
  - Valuing reliability
  - Provocative question to close

What is a “Microgrid?”

- Everyone seems to want one, but everyone defines it differently.
- A microgrid is perceived to be a smaller version of utility. As such it should have the same characteristics:
  - Specific electrical boundaries (established by the limits of power lines or through switches and relays).
  - Indigenous generation and fuel resources sufficient to supply defined loads.
  - A “management system” that can provide real-time balance of loads and resources and acceptable power quality (PQ).
- This definition doesn’t specify scale (# of loads/resources), size (MW or area), PQ standards, duration of operation, or purpose, all of which are inherent in the many uses of the term.

Microgrid: A Definition

- A self-sufficient electrical system composed of loads and resources that can be managed to maintain balance between demand and supply within acceptable power quality standards.
  - Self-sufficient: Has independent fuel sources within the "island" which is electrically isolated
  - Managed: Has real-time control over resources and possibly loads to ensure load/resource balance
  - Acceptable PQ: Voltage, frequency, etc. *sufficiently* managed to avoid destruction of resources and *most* loads. Note: Deviations from normal standards may occur. Fact is, bigger systems are easier to keep within standards than small ones.

What Are the Benefits?

- Emergency power during grid outages, but
  - Subject to fuel supply/resupply
  - Environmental constraints, both legal and natural
  - Limited to available generation versus demand.
- Alternative to utility power for remote sites or in high utility cost areas
  - Cost stability (subject to fuel prices)
  - Protection against power failures outside “the fence”
  - Protection against fuel shortages, labor strife, civil unrest, etc.

Potential Additional Benefits

- From generation (assuming it meets environmental and fuel cost requirements)
  - Peak-shaving for routine bill savings
  - Interruptible and other rate discounts
  - Sales/credits via net metering or feed-in tariffs
- From Smart-Grid, Gridwise, and like demand management features of EMS
  - Peak-shaving, interruptible rates
  - Demand response credits

Reality Check

- What/how much protection do you want/need?
  - What can't you do without for: anytime, a week, a month, multiple months, years?
  - What is the load associated with these tasks?
  - What other support requirements are associated with these tasks (HVAC, conditioned space for operating staff, housing and supportive infrastructure for operating staff, etc.) for the associated outage duration"
- What is your "Plan B" if an outage occurs and stretches into days/weeks/months?
- What can you afford (in terms of cost, delay, disruption of operations, etc.)?

“Microgrid” Options: A Typology

- Emergency generator
- Remote generator
- Emergency grid (E-grid)
- Emergency grid plus (E-grid+)
- Islanded facility
- Energy security island (islanded region)

Emergency Generator

- Dedicated load with own power source and fuel supply.
- Common configuration operates in isolation from the commercial power grid during emergencies.
- Typically designed for limited period of operation without any reserve in case of failure (and without redundant fuel supplies).
- Example: Diesel generator

Remote Generator

- Like emergency generator but without grid connection.
- Fuel diversity can be provided by coupling with renewable power sources, typically mediated with battery storage.
- Example: Diesel generator with wind/solar hybrid, Skybuilt system

Emergency grid (E-grid)

- A configuration of emergency generators interconnected via a “microgrid” to serve multiple loads. Can be small or large.
- The microgrid may be isolated from the grid (remote site) or isolated during commercial grid outages (grid connected).
- Multiple generators and “microgrid” provides for generating reserves.
- May also have redundant fuel supply and energy management system of some sort.
- Examples: Campuses, industrial parks, amusement parks, National Parks, Alaska military bases.

E-grid + renewables

- The addition of renewable resources to an E-grid.
- Provides additional redundancy.
- Provides fuel diversity.
- Extends operating range (energy storage is the conventional generator's fuel tank).
- Coupled with demand management/Smart Grid technologies can operate multiple weeks/months, even with intermittent renewables.
- Requires energy management system of some sort (more sophisticated as complexity increases).

Island

- A configuration of resources networked together through a power grid with:
  - "Indigenous" fuel sources to allow multiple months of operation without refueling;
  - Generation in reserve for redundancy;
  - Real-time energy management to maintain power quality to industry standards.
- Can be small or large and may include multiple voltage levels and associated substations.
- Example: China Lake geothermal plants, Progress Energy feeds to Fort Bragg.

Energy Security Island

- A re-configuration of the existing power grid by the utility to ensure portions of the regional grid can be islanded in case of an interconnection-wide blackout and provide industry standard power and reliability to the bulk of customers in the island.
- Characterized by:
  - Multiple resources with indigenous fuel or substantial stockpiles
  - Redundant transmission infrastructure
  - Spares of critical materials
  - May include load curtailment of non-critical circuits/loads.
- A deliberate change in the operation of the utility's grid, with approval of regional reliability coordinator, transmission operator, and regulator.

What Does “it” Cost?

- No simple answer, especially for larger, more complex installations:
  - Least costly option: Dedicated generator/storage - usually diesel (typically $1,000 kW).
  - Most costly (to facility): E-grid + - But addition of renewables and demand response/Smart Grid functions may repay investment (in part). Potentially $10s of millions for a DOD installation depending on scale.
  - Most costly in total: Energy security island - This has greatest benefit to base and consumers so cost will be spread in rates and cost to facility should be minimal.

Hidden Costs

- Fuel storage and spill risk (fuel has to be “fresh” and there is a spill risk at each refueling and potential VOCs from venting)
- Staffing a management center/operating an EMS (potentially for 24/7 operations)
- Maintaining energy scheduling/trading desk (also potentially 24/7 operations)
- Maintenance of relays, switches, control systems, software, and other items.
- Protection against cyber threats

How to Value Cost/Benefit

- Dedicated generation: ~ $1,000 kW + on-going O&M and any fuel costs and environmental mitigation expenses.
- As "insurance policy"
  - Translate dedicated generation cost into an energy security "adder" to plus up power cost.
  - Using diesel back-up as a baseline, "insurance" value is ~ 1.13 cents/kWh.
- Other options at actual cost minus potential "lifetime" benefits from demand response, etc. – Can more than pay for cost of renewables in many cases and subsidize cost of e-grid.

Provocative Observation

- The nation's electrical grid is composed of over 3,000 independent distribution entities/systems.
- Many of these were isolated "islands" until the 1960s. Many in the West had origins in isolated (electrically and physically) "company towns."
- The NYC Blackout of 1965, declining cost of large plants, and high voltage and interstate transmission changed all that. (All of NYC was not blacked out in 1965. There were still islands of power within it.)
- Would we be better off if we went "Back to the Future" to recreate this network as energy security islands?

Q and A

Mike Warwick
Pacific Northwest National Laboratory
Portland, OR Office
Mike.warwick@pnl.gov
(503) 417-7555