Understanding Energy Economics and Optimization Technology for the Strategic Development of Microgrids

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Viridity Energy - Recognized Leader in Smart Energy Technology

Key Company Facts

- Founded in 2008 by well known industry executives
- Experienced Team:
  - Experienced utility and power market executives
  - Technology innovators
  - Regulatory policy and affairs experts
- Recipient of multiple industry awards and grants

Unparalleled Solutions

- Integrated energy management from Demand Response to Dynamic Load Management and Microgrids
- Patent pending software platform
  - Optimizes and integrates energy assets such as controllable loads, cogeneration, renewables, and energy storage systems
- Network Operating Center
  - Supports customer participation in wholesale power markets

Types of Clients

- Commercial
- Industrial
- Institutional
- National Accounts
- Data Centers
- Utilities
- Military
- National Accounts
Clients and Partners

Sample Individual Customers:

Utilities:

Partners:
Identifying the critical DOD need:
  • Mission Assurance

Identifying the critical threats:
  • Over Consumption
  • Aging Infrastructure

MILITARY MICROGRIDS
The Challenge
How do we strengthen reliability? Now?

Our existing power infrastructure is struggling to keep up with grid needs
- Average generating station in U.S. is 42 years old, two years older than its expected lifespan (Source: DOE)
- $150 billion per year in grid-related power outages (Source: EPRI)

Electric Demand is quickly outpacing supply
- Peak demand projected to grow by 19% over the next decade, while capacity projected to grow by only 6% (Source: Brattle Group)

Electric Demand is quickly outpacing supply
2003 NE Blackout - Before
How do we strengthen reliability? Today?
2003 NE Blackout - During
How do we strengthen reliability? Today?
Strategic Deployment - - WHERE? WHY?

• Where to start and why?
• Areas of greatest risk and greatest opportunity

MILITARY MICROGRIDS
Strategic Deployment - National Security

- Where are the greatest reliability risks to our grid? Where are the most important locations to strengthen the grid?
At the weakest link - Most congested spots, with most critical missions

In August 2006, the U.S. Department of Energy (DOE) issued the 2006 National Electric Transmission Congestion Study. That study identified two Critical Congestion Areas (the Mid-Atlantic, extending from New York down into Virginia, and Southern California).
Microgrids provide needed virtual generation and load balancing to strengthen/protect the grid.
< 65 U.S. Military/Federal Installations in Demand Response
DOE Smart Grid Demonstration Grant with ConEdison, Viridity and City of New York

**GOAL:** To deploy smart grid technology within New York City and demonstrate its ability to integrate and optimize distributed energy resources to enhance efficiency, reliability and economic savings for the Utility and End Users alike.

- Viridity Energy’s Network Operations Center serves as the Microgrid Coordinator for ConEdison’s smart grid deployment
- As additional buildings and campuses are enrolled in the program, Viridity is the distributed resource management hub that ensures proper integration of demand and distribution
Strategic Development --- HOW?

- From Consumers to Pro-sumers
- Virtual Power Generation
- Virtual Power Plants: the strategic path to microgrids that can self fund

MILITARY MICROGRIDS
Evolve from Consumer to Pro-sumer

Definition of Pro-sumer:

“A load entity that takes an enlightened, proactive approach to its energy consumption, by:

a) Utilizing real-time internal and external information to manage energy consumption;

b) Strategically increasing/maximizing onsite generation/storage

c) Interfacing with the wholesale power markets and utilities on a continuous basis to provide virtual power;

d) Making its own energy choices rather than acting as a passive bill-payer.”
Evolve from Consumer to Pro-sumer

Prosumer: Demand Supply Optimization

Energy Efficiency

Demand Control
- Peak Load Management > Supply Savings

Demand Response
- Reactive: Emergency Capacity, Emergency Reliability
- Proactive: Energy Market, Ancillaries

Who benefits from Prosumers?
- Utilities, Grid Operators, FERC, US Citizens, Prosumers themselves
Grid needs new generation: Virtual/Clean Generation

Virtual Generation

The ability to curtail allocated electric load on demand to balance supply and demand on the grid via utility and grid programs.

- Negawatts vs Megawatt
- Renewables vs Dispatchable Generation
- Controllable Load

*Virtual generation created by pro-sumers improves grid reliability, energy security, while providing clean generation that enables further investment in strategic microgrid development. HOW?*
VPower™ takes every resource into account in the to develop reliable virtual generation from controllable load.

VPower™ brings reliability, economics and security together to build an optimal microgrid.

- Multiple resources aggregated
- Load and price forecast
- Resource optimized schedule
- Virtual power dispatch
- Integration with Wholesale Energy Markets

Load

Generation

Transmission and congestion zones

LMP prices

Distribution Infrastructure

Load

Virtual Power

™

VPower™™ takes every resource into account in the to develop reliable virtual generation from controllable load.
Through smart technology like VPower™’s PowerControl™ clients can maximize virtual generation with compromising mission objectives.

By modeling the unique building and/or equipment information and operational constraints, our customer’s load management strategy is customized to match their objectives.
By Considering All Opportunities Through Dynamic Load Management, Customers Gain Insight Into Market Opportunities
Affordable, safe storage that:

- Shifts peak usage to off peak times
- Enables renewable generation to be dispatchable
- Reduces reliance on fossil fueled generators
- Increases grid reliability by providing services such as frequency regulation

How does one overcome the first cost hurdle of storage?
SEPTA Regenerative Braking → Battery Storage → Electric grid via regulation

1. Train pulls into the station and releases heat/energy when it brakes.

2. Energy is stored in Lithium-Ion batteries installed on site.

3. Battery is integrated with the electric grid and will provide frequency regulation balancing services in exchange for revenue payments.

Interesting Fact: SEPTA is the nation’s sixth-largest public transportation system, and the fifth-largest electricity user in the Philadelphia, PA metro region.
Viridity launches a Regulation Services Product with Axion Power International, a battery manufacturer, and PJM.

Viridity and Axion communicate via Modbus over Internet Protocol. Regulation services provided to the grid on a second by second basis.
**Needed Solutions:**

**Generation, Storage, Infrastructure**

Viridity Energy enables the seamless integration of distributed resources, smart loads and microgrids as Virtual Power into real time power grid operations.

- Viridity’s VPower™ system integrates and optimizes customer distributed energy resources.
- The resources appear to the system operators as a “virtual generator” that is integrated into the dispatch.
- Enables energy systems within energy systems to have bi-directional communication and monitoring and islanding capabilities.
- Centralizes operations and enables automated control.
- Co – Optimizes Efficiency with Flexibility.
The Fort Meade installation has the fourth largest workforce of any army installation in the United States, and with over 42,000 personnel, is Maryland’s largest employer. Fort Meade has 85 tenant units, covers 5,067 acres and has 1,517 buildings.

Project Overview

- Site assessments for controllable load
- Identification critical vs non critical sites
- Maximize on site generation/storage
- PJM Market interface Evolution
- Microgrid Planning
- Demand Supply Optimization
Proposed Solar / Storage Microgrid Project: Fort Meade

Fort Meade - proposed location

<table>
<thead>
<tr>
<th></th>
<th>Gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>$102,282</td>
</tr>
<tr>
<td>Sync Reserve</td>
<td>$114,100</td>
</tr>
<tr>
<td>Regulation</td>
<td>$116,451</td>
</tr>
<tr>
<td>Economic</td>
<td>$26,977</td>
</tr>
<tr>
<td>Supply Savings</td>
<td>$36,135</td>
</tr>
<tr>
<td>Totals:</td>
<td>$395,945</td>
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</tbody>
</table>

- 2.5 MW diesel generator onsite; second 2.5 MW generator by June 2014
- 200 kW Solar Array
- 500 kW/285 kWh carbon lead acid battery
- Demand Response Inverter
- \( VPower^{TM} \) Optimization

The Simple Payback is 5.42 years.

“For the month of July 2011, Ft Meade had a 7% drop in kWh with a 17% drop in electric costs over July 2010, while cooling degree days were up by 13%. DR had something to do with this.” - Tony Karwoski, REM for Fort Meade
Financial Summary for PJM
Various benefits through the wholesale market

By taking advantage of existing and new onsite energy assets, military bases can earn new sources of revenues to reduce operating expense and/or reinvest in additional reliability infrastructure while strengthening energy security.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Wholesale Market Participation</th>
<th>Customer Benefit on a per-MW basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas Generator</td>
<td>Capacity, Economic, Synchronize Reserve</td>
<td>$107,073</td>
</tr>
<tr>
<td>Diesel Generator</td>
<td>Capacity, Sync Reserve</td>
<td>$67,160</td>
</tr>
<tr>
<td>HVAC Load Optimization through VPower™ (500kW)</td>
<td>Economic</td>
<td>$64,013</td>
</tr>
<tr>
<td>Large Format Storage</td>
<td>Regulation</td>
<td>$93,402</td>
</tr>
</tbody>
</table>
**HVAC Optimization**

500kW of load reduction by adjusting temp. set points

**Proposition:** Using the VPower™ platform, raise temperature of data center by 1-2⁰ during high-priced hours. No more than 3 or 4 hours of elevated temperature per day.

**Risk to customer:** Minimal. Each site will be custom parameterized for maximum reliability.

<table>
<thead>
<tr>
<th>Market Opportunity</th>
<th>Gross Revs/Benefits</th>
<th>Notes &amp; Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting June 1, 2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>$39,013</td>
<td>500 hours of participation in Economic Load Response Program</td>
</tr>
<tr>
<td>Retail Electricity Savings</td>
<td>$25,000</td>
<td>250 MWh of load reduction annually at an assumed rate of $100/MWh</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$64,013</strong></td>
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</tbody>
</table>

**Additional Notes:**

1. Economic revenues are based on 2010 historical Pepco (DC Metro area) zonal prices for 500 hours of Economic Load Response participation. The top 500 hours in Pepco zone averaged $130.04/MWh.
2. All figures are net of Viridity fees (40% on Economic and Sync Reserve; 10% on Capacity).
Military Microgrid Development and Deployment

MISSION ASSURANCE

Source: automationfederation.org

PROSUMER
- Generation
- Storage
- Smart infrastructure

POWER GRID

MICROGRID
QUESTIONS?

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