Intelligent Energy Management and Energy Storage
Our Company

Products
- Energy Router™ Energy Optimizer
  - Intelligent management of all energy sources and loads (uses)
  - Manage different sources and loads regardless of voltage
- Multi-Flex™ Energy Converter
  - Conversion of DC and AC energy
  - Physical allocation of energy
- RAIB™ Cost Effective Battery Storage
  - Meet Cost/Performance target by blending different batteries

Technology
- Energy Management Software and Firmware including Communication
- Bi-Directional Inverter & DC-DC Converter
- 3 Patents granted, 3 Patents pending

Product Status
- 2+ years product history

Founded 2007
Indianapolis, IN
Why Storage is Needed

Utilities Cannot Meet Peaks in Demand
- Summer cooling needs exceed generating capacity
- Rolling brownouts and blackouts
- San Onofre plant shut down – 1.5GW decommissioned
- Transmission lines reach capacity
- Storage near loads relieves peak capacity

Peaker Plants Take Time To Become Operational
- Gas turbines can take 10 minutes or more to spin-up
  - Demand is instantaneous
- Spinning reserves are expensive and a waste of energy

Utilities Cannot Control Distributed Generation
- Solar production ebbs and flows with sunshine and cloud passage
- Voltage range limits cannot be maintained
U.S. Energy Department’s Energy Storage Report

The Need For Energy Storage
- Smooth Alternative Energy Production
- Provide Uninterrupted Power for grid failures due to extreme weather
- Manage Vehicle-to-Grid

Challenges for Storage Acceptance
- Cost
  - Battery storage can be expensive
  - There is no single best battery chemistry
    - Each has a different cost/performance characteristic
- Reliability and Safety
  - Existing Technology is relatively new and has not been time-tested
  - Multiple fires with Li-ion, Advanced Lead-Acid, and Sodium systems
- Regulatory Environment
  - Regulations has not caught up with the need (hurdles should be eliminated)
- Industry acceptance
  - Utilities are slow to change
Storage Opportunity — (Multi-day view)

- AC still largest peak load
- Reinforces Peak Demand Storage Opportunity

60% of Peak Load is A/C
Excess Generation Capacity Exists (Day view)

- Base generation is lowest-cost electricity
- Air Conditioning is largest peak load
- Solar can off-set but solar is variable

Peak can be met with stored energy

Store energy in “off-peak”

Source: UC Davis
The Variability of Solar Energy

Maximum AB Voltage

- Upper ANSI range
- Nominal Voltage

10 minute Range Blow-up

Voltage

Time

9:36:00 AM 10:19:12 AM 11:02:24 AM 11:45:36 AM 12:28:48 PM 1:12:00 AM 1:55:12 PM

12,000 12,200 12,400 12,600 12,800 13,000 13,200

Nominal Voltage

Upper ANSI range

12,000 12,200 12,400 12,600 12,800 13,000

Time

Energy Storage Market

For Producers
- Supplement Production
- Improve Quality/Meet Targets

For End-Users
- Reduce Bills
- Improve Quality

Functionality Needed
- Intelligent control & allocation
- Communications
- Hardware to physically manage energy

10 Year Storage Value Forecast

- Utility Company
  - $63.6B
- End User & Microgrid
  - $109.7B
- Renewables
  - $51.2B

Source: Sandia Reports Feb 2010
Redundant Array of Inexpensive Batteries RAIB™

Cost Effective Energy Storage

- Used “Starter” Batteries
  - Group 31 lead-Acid: 75% of the capacity for 33% of the cost of new

- Secondary Use Hybrid Vehicle Batteries
  - Contract with Hybrid Vehicle Mfg.

- Mix new and used batteries
  - Target Price/Performance

- Modular and Scalable
  - 50kW to 50MW

- Battery agnostic
  - Ability to integrate any battery

One MWh RAIB™ Storage
Returned Battery Distribution Curve

Target: 75% original storage capacity or greater

- Sort and group by similar capacity
- Manage groups individually to optimize energy (charge and discharge cycles)
**Energy Router™**

**Energy Optimization Software**

**Modular and Scalable Platform**
- Intelligent management of any number of sources of energy and energy loads
- Web access to management and reporting

**Functions**
- Uninterruptable Power Supply (UPS)
- Clean and smooth power
- Energy storage
- Solar MPPT (Maximum Peak Power Tracking)
- Manage generators
- Building management
Multi-Flex™ Hardware

The Precise Transfer and Allocation of Energy

- Scalable from <1kW to >1MW
- Modular
- In Production
  - Operating in the field for 2 years
- Next Generation Inverter
  - Individual phase control
Microgrid Management Example

Communications:

- Energy Router™
Grid Balancing Example

Multi-Flex™
- Voltage Regulation
- Frequency Regulation
- Peak Demand
- Phase Balancing
  - Unique function - first to market
- Generation Savings
  - 45KVA vs 55KVA
- Aggregation
- Tie together with others to meet larger Grid needs

Utility Generation:
- 45kVA Phase 1
- 45kVA Phase 2
- 45kVA Phase 3

Actual Use:
- 55kVA Phase 1
- 40kVA Phase 2
- 43kVA Phase 3

10kVA Neighborhood Phase 1
(+/- 5kW PV)

2kVA Neighborhood Phase 2

15kVA Phase 1
8kVA Phase 2
13kVA Phase 3
(+/- 10kW PV)

30kVA Phase 1
30kVA Phase 2
30kVA Phase 3

Multi-Flex™ 4Q Inverter

Required:
- -2kVA Phase 3
- -5kVA Phase 2
- +10kVA Phase 1
  (+/- 15kW/Phase)

Battery Storage
3kW DC Discharge
Thank You

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