2012 Smart Grid Program Peer Review Meeting

Integrated, Automated DG Technologies Demonstration

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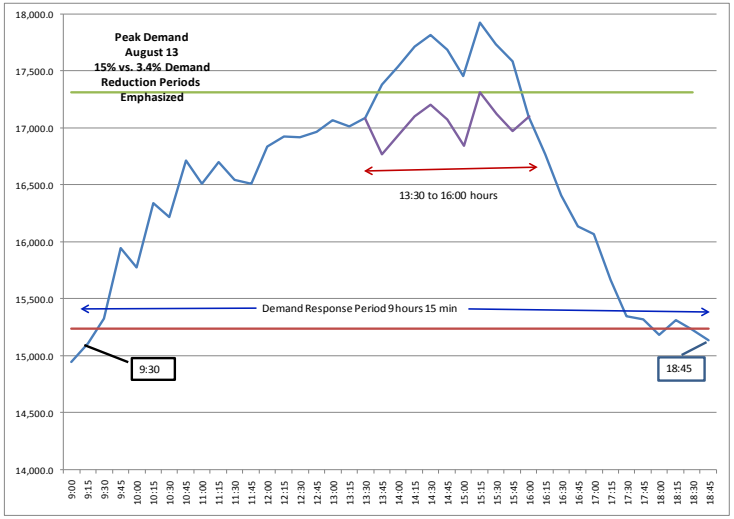
ATK Launch Systems

June 7- 8, 2012

Integrated, Automated DG Technologies Demonstration

Objective

Automated Substation Demand Reduction using Renewable/Distributed Generation



Life-cycle Funding

$2,685K, DOE $2,148K

’08 – ’10: Phase I $879K – DOE $703K
’11-’13: Phase IE Total $1,806K – DOE $1,445

Technical Scope

Phase 1E

Install a mix of distributed generation (including renewables) with automated controls and two-way communication with the utility and achieve a 3.4% reduction in peak demand.

Project Targets – Phase IE

Target	Approach
- Renewable generation integration	- Use of Energy Storage
- Renewable generation for demand control	- Dispatch of energy storage
- Automated controls for demand response	- Technology to capture and dispatch
- Harvesting waste energy streams	- New ORC technology for boiler flue gas heat recovery
- Advancing energy storage technologies	- New Flywheel storage technology

- Total Cost - $1,806K
  - 100 kW of Wind, 100 kW of waste heat generation, 2500 kWHrs flywheel storage
- Demand Reduction – 3.4%

- Electric Costs: (Projected to increase about 10% per year)
  - Peak energy - $0.040588/kWh,
  - Off peak energy - $.02488/kWh,
  - Demand - $1.94 + 12.18 = $14.12/kW

Technical Approach (1 of 2)

- Storage is a critical element, Both micro-hydro and compressed air generation storage had technical and application issues:

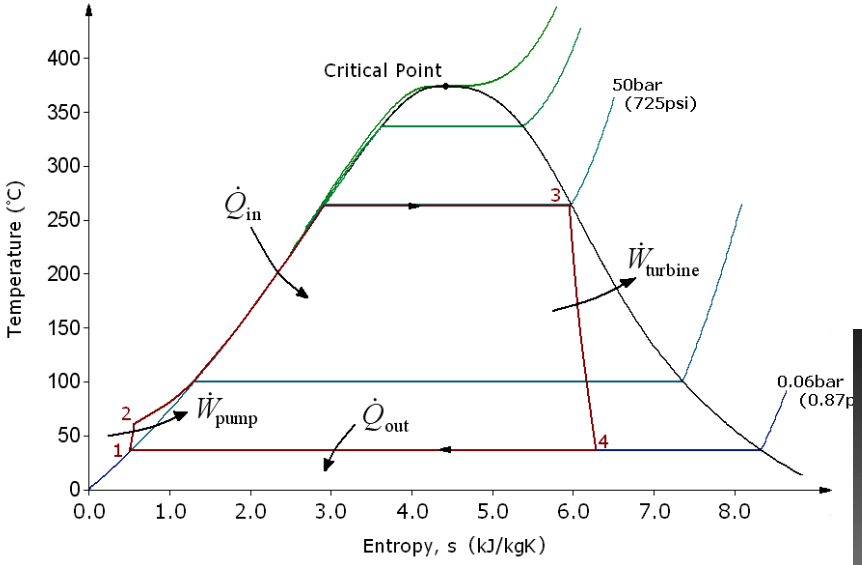
- Overall efficiency of compressed air storage – access to a compressed air stream that was 100% waste compressed air.

- Sites available for micro-hydro - no run of pipe, needed storage on both sides, only one site.

- Non-commercial grade wind – identify on-site microclimates
- Non-viable waste heat sources – new ORC technology
  - Could not find any ORC equipment to meet our waste heat parameters
- Efficient and cost effective storage – new Flywheel storage technology
  - Extremely high cycle efficiency: 90+ percent

- Store energy when less valued (or available from wind/waste heat resources), dispatch when highest value (peak energy and demand periods.)

Technical Approach (2 of 2)

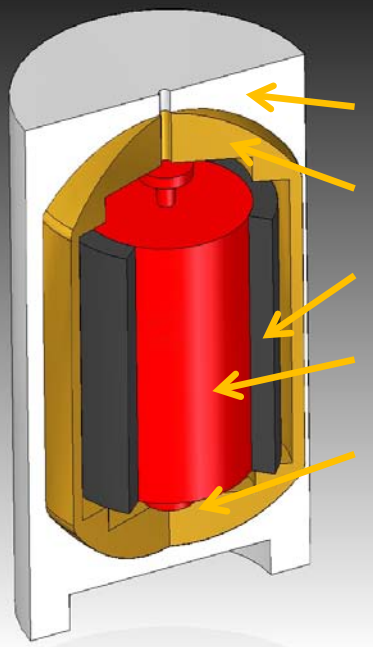


Rankine Cycle

New Organic Cycle uses blend of refrigerant(s) for lower operating temperature requirements.

New Flywheel Technology

- *No moving parts come into contact*
- *No friction losses/ no heat produced that will require cooling*
- *Negligible electrical losses*
- *No maintenance required within sealed vessel*
- *20+ year expected life*



12.5 kVAC ***250 kWh @ 250 KW***

Technical Accomplishments (1 of 3)

1. FY09 & FY10 –

- Wind, Micro-hydro generation storage, compressed air storage generation, single board PC monitoring and control – std database storage, investigated alternative available waste energy sources (heat from compressors, boilers) and viable technologies to extract.

2. FY12 -

- Windmill and Waste Heat Generator (WHG) ordered – Aug ‘11
- Site preparation work for both windmill and WHG completed – Mar ‘12
- Fabrication and testing of 25 kW PMG - Jul ’12 (Size and configuration for portable and DOD applications.)

Technical Accomplishments (2 of 3)

2. FY12 – (cont'd)
   - Re-start process of ordering a re-furbished windmill (original vendor was un-able to secure and provide a unit at the original contract price.) Jun '12
   - Waste heat generation unit currently under detailed design - fabrication begins Jul '12,
3. FY '13
   - Complete fabrication and testing of 250 kW flywheel storage units initially with Permanent Magnet Generators (PMG) and then Electrostatic Generators (ESG.) – Nov '12
   - Complete fabrication of new waste heat generation unit – Dec '12
   - Complete installation of WHG, WG, and Flywheel Storage Array – Mar '13

Technical Accomplishments (3 of 3)

3. FY13 – (cont'd)
   - Full operation and documenting of 3.4% demand reduction – Sep '13
   - Next Phase – Larger utility scale storage array?

Storage Technical Parameters

Utility/Grid

1. Electric Energy Time-shift
2. Electric Supply Capacity
3. Load Following
4. Area Regulation
5. Reserve Capacity
6. Voltage Support
7. Transmission Support
8. Transmission Congestion Relief
9. Transmission & Distribution (T&D) Upgrade Deferral
10. Substation On-site Power

End User/Utility Customer

11. Time-of-use (TOU) Energy Cost Management
12. Demand Charge Management
13. Electric Service Reliability
14. Electric Service Power Quality

Renewable Integration

15. Renewable Energy Time-shift
16. Renewable Capacity Firming
17. Wind Generation Grid Integration

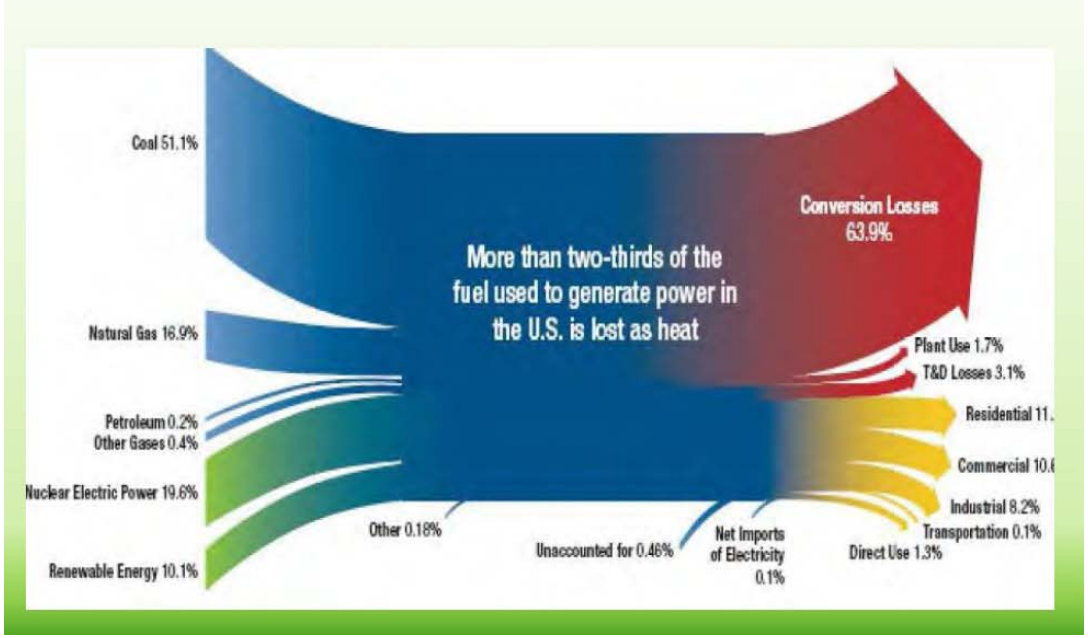
Project Significance and Impact (1 of 1)

- **Storage with Renewables Integration** – dispatch when needed – for both customer and grid
- **Waste Heat Generation** – Thousands of waste heat steams that can be harnessed – improved reliability, reduced need for centralized/remote utility generation and transmission – energy generated at loads – useable energy from current waste streams

- **Storage –**

1. Energy Time-shift
2. Peak Capacity
3. Load Following
4. Area Regulation
5. Reserves Capacity
6. Voltage/VAR Support
7. Transmission Support
8. Transmission Congestion Relief
9. Transmission & Distribution (T&D) Upgrade Deferral

- **Harvesting Waste Heat Streams**



Interactions & Collaborations (1 of 1)

DOE – funding and support in ever changing energy world.

ATK – Employees are excited to be involved in energy project advancing technologies, improving reliability and reducing carbon footprint. Sharing of project progress with enterprise-wide energy team.

TransPacific Energy – ORC System – newly patented pushing envelope of applications. Others doing the same ElectraTherm.

EMB Energy – Newly patented flywheel storage system. Build on what others have done, LLNL, Beacon Energy, High cycle efficiency, unique approach.

PacifiCorp/Rocky Mountain Power – Actively involved; our storage array, if successful, may be scaled up to utility size, controls compatible and integrated with current utility systems.

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