Advanced Natural Gas Reciprocating Engines (ARES)
Contract: DE-FC26-01CH11080
GE Energy, Dresser Inc.
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Project Overview

Develop a reciprocating natural gas engine with 50% Brake Thermal Efficiency (BTE) while:

- producing 0.1 g/bhp-hr NO_x
- reducing the cost of electricity by 10% and,
- with no change in reliability, durability, or maintenance costs

Project Objective

- Develop cost-effective technologies to improve efficiency
- New technologies needed

Current state-of-the-art

- BTE in the 42-44% range depending on engine size – up from 37%
- Brake Mean Effective Pressure (BMEP) in the 16 – 17 bar range – up from 12 bar
- NO_x 0.5 g/bhp-hr – down from 1.25 g/bhp-hr

Technical approach

- Full optimization of engine sub-systems
  - Design of Experiments approach
  - Intensive computational simulation
- Looking for system synergies
- Not neglecting customer focus
  - Secondary benefits of new technologies reduce total cost of ownership

Technical approach

- Increase BMEP to drive initial cost down and efficiency up
  - Brings new technical challenges with
    - Spark plug life
    - Structural integrity
    - Turbocharger limitations
    - Knock margin

Transition and deployment

- Developed technologies are generic and applicable to our complete engine portfolio
- Technologies work with straight PowerGen or CHP

Transition and deployment

- Reciprocating engines have the highest efficiency of any technology less than 100 MW
- Recips offer low 1st cost, fast start, excellent cycling, and high efficiency at part load
- New market of peaking power – backup for renewables

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Measure of success

- 47% BTE demonstrated without exhaust energy recovery, preserving the heat for CHP use
- Initial cost increase minimal

Benefits

- Further improves CHP economics by increasing electric/thermal ratio while preserving exhaust energy
- Secondary benefits add as much value for the customer as fuel savings

Benefits

- Additional benefits by avoidance of electric grid losses
- Low water usage, no combustion residuals
- Energy security with on-site generation

Commercialization approach

- Commercializing ARES II technologies

Project management & budget

Expected Project Duration: 3.25 years

Projected DOE Funding: $7,538,127

Total Project Cost: $16,038,826

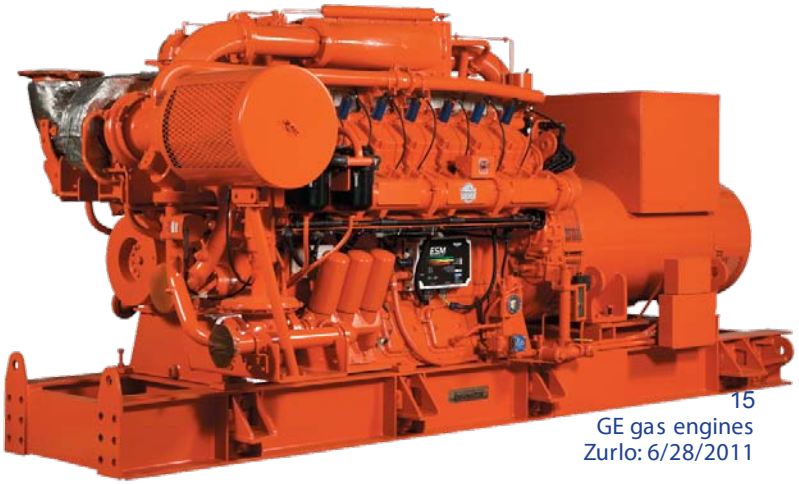
Project Budget				
	FY11	**FY12**	**FY13**	**FY14**
DOE Investment	$1,609,408	$2,640,272	$2,644,053	$644,754
Cost Share	$2,571,621	$ 2,640,271	$2,644,053	$644,754
Project Total	$4,180,669	$5,280,543	$5,288,106	$1,289,508

Project management & budget

Task/ Milestone Number	Title or Brief Description	Task/Milestone Completion Date			Progress Notes
		Original Planned	Actual	Percent Complete	
1	Power Cylinder Optimization Confirmed Version 1	Mar-11	Jul-11	60%	Testing in progress
2	Update Test Engine	Jul-11	Sep-11	30%	Components available, updates to start occurring during 3nd quarter
3	Valve Event Analysis Complete	Nov-11			
4	Engine Installation / Baselined	Mar-12			
5	Pmax Study - Phase 1 Complete	Mar-12			
6	Flow Loss Analysis Complete	Apr-12			
7	Ignition / Combustion options tested	May-12			
8	Power Cylinder Optimization Confirmed Version 2	Oct-12			
9	Friction Reduction options evaluated	Dec-12			
10	Exhaust Energy Recovery Systems Evaluated	Jan-13			
11	Engine Updated with Select Efficiency Options / Testing	Jun-13			
12	50%BTE Demonstration	Nov-13			

Results and accomplishments

- ARES Phase I completed and commercial product released in 2006
- Commercially successful product with strong export sales
- 6 patents, 6 ASME technical papers, numerous trade publication articles



Results and accomplishments

- ARES Phase II completed with 47% BTE lab demonstration – commercialization activities continuing
- 4 patents, one pending
- Ultra low emissions combustion technology transferred to DOE CHP project
- Many of the developed technologies have no or low initial cost increase
  - 25% lower engine friction
  - Wear rates down dramatically
  - Oil consumption cut in half

Results and accomplishments

- ARES Phase III started October, 2010
- Additional efficiency improvement technologies identified – testing in process

Path forward

- Validation of ARES II technologies in process
- Moving to production release of selected ARES II technologies
- Continuing to investigate new technologies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