Ultra Clean 1.1 MW High Efficiency Natural Gas Engine Powered CHP System

Contract: DE-EE0004016

GE Energy, Dresser Inc.

10/2010 – 9/2014

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U.S. DOE Industrial Distributed Energy Portfolio Review Meeting

Washington, D.C.

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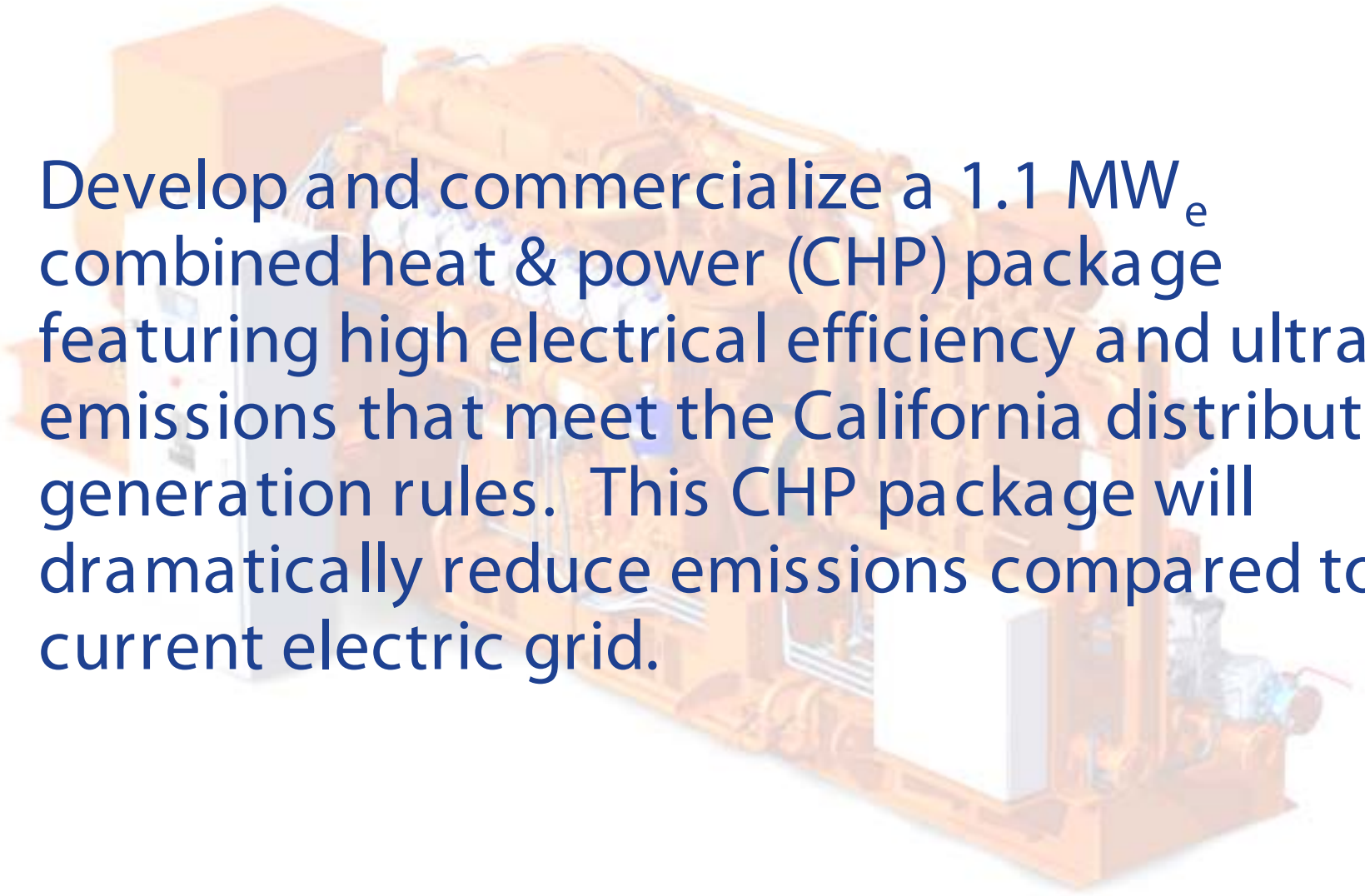
Project Overview



Develop and commercialize a 1.1 MW_e combined heat & power (CHP) package featuring high electrical efficiency and ultra low emissions that meet the California distributed generation rules. This CHP package will dramatically reduce emissions compared to the current electric grid.

Project Objective

- Develop & commercialize a 1.1 MW_e CHP package
- Key technical challenge is the emissions requirement
- Key business challenge is to broadly popularize CHP

Current state-of-the-art

- >20 MW CHP well accepted in the US
- 1-5 MW scale CHP well accepted in Europe
- Engine manufacturers supply just engines
- Developers specify engine, generator and the remaining CHP components
- Installers build and install the system on a one-off basis

Current state-of-the-art

- No design feedback to improve reliability, cost and performance
- Current reciprocating engines not ideal for steam production
- Current engine NO_x emissions similar to existing grid

Technical/commercial approach

- New (ARES) combustion concept maintains current lean burn advantages while dramatically lowering emissions
- New combustion concept yields higher exhaust temperature – better for steam
- ARES technology increases electrical efficiency w/o hurting CHP potential
- Most risk retirement accomplished under ARES program
- Package system yields synergies

Technical/commercial approach

- Waukesha gas engine fleet experience
- GE leverage
  - Large supplier to utilities
  - Full range portfolio
  - Ability to open markets

Transition and deployment

- Focus on "top five" states
- Target industries with coincidence of electrical & heat demand
  - Hospitals, industrial facilities, commercial real estate, green houses
  - 1-6 MW_e demand with a similar heat demand
  - Facilities concerned about energy costs and power security
- Utilities
  - Demand-side management
  - Grid congestion

Transition and deployment

- Technology deployable across entire product portfolio
  - GE gas engine product portfolio spans 500 – 9,500 kW
- Potential to license IP for < 500 kW sized engines

Measure of success

- CHP fastest, cheapest way of reducing energy usage and Green House Gases
- Denmark gets 50% of it's electricity from CHP, and half of that is from gas engines

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Benefits

- CHP cleaner than existing grid
- Technical potential of 12.85 GW new CHP identified
- Assuming 75% utilization would eliminate 78,900 tons NO_x and 10 million tons CO_2/year by 2030

	Grid (lb/MW-hr)	CHP (lb/MW-hr)
NO_x	1.94	0.07 w/o heat
CO_2	1329	1077 w/o heat
SO_2	5.26	0
Hg	2.7E-5	0
N_2O	0.026	trace

Benefits

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

Commercialization approach

- Focus on "top five" states first
- With success, propagate to other states
- Explore alternative business models
  - Leverage GE Capital
  - Maintenance contracts
  - Bring electric utilities into the tent

Project management & budget

Expected Project Duration: 4 years

Projected DOE Funding: $6,641,565

Total Project Cost: $11,473,068

Project Budget				
	FY11	**FY12**	**FY13**	**FY14**
DOE Investment	$1,462,664	$2,074,500	$1,727,111	$1,377,290
Cost Share	$1,389,392	$889,072	$1,176,014	$1,377,025
Project Total	$2,852,056	$2,963,572	$2,903,125	$2,754,315

Project management & budget

Phase	Milestone	Target Date	Actual Date
1	M/S 1 - Market Opportunity Defined	Feb-2011	Jun-2011
1	M/S 2 - Prelim. Technical System Evaluations Complete	Feb-2011	Mar-2011
2	M/S 3 - Design / Dev Concepts Determined	Jul-2011	
3	M/S 4 - Technical Solution Ultra-low Emissions Confirmed	Aug-2012	
3	M/S 5 - Technical Solution CHP Application Confirmed	Feb-2013	
4	M/S 6 - Field Test Location Solidified	May-2013	
4	M/S 7 - Release for Pilot Build	Jul-2013	
4	M/S 8 - Start Field Site Installation	Feb-2014	
4	M/S 9 - System Performance Requirements Achieved	Jul-2014	
5	M/S 10 - Product & process validation complete	Aug-2014	
5	M/S 11 - Project closure	Nov-2014	

Tollgate process utilized with management and DOE approval

Results and accomplishments

1st Phase One Milestone Complete

- Preliminary Technical Systems Evaluations

2nd Phase One Milestone ~80% Complete

- Market Study / VOC Activities
- Market Opportunity Defined

Expecting to exit Phase 1 in June

Path forward

- Continue following the project plan
- Early endurance testing to retire the last risks
  - >2500 hours on engine


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