330 kWe Packaged CHP System with Reduced Emissions

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Cummins Power Generation/Cummins Engine Business Unit of Cummins, Inc.

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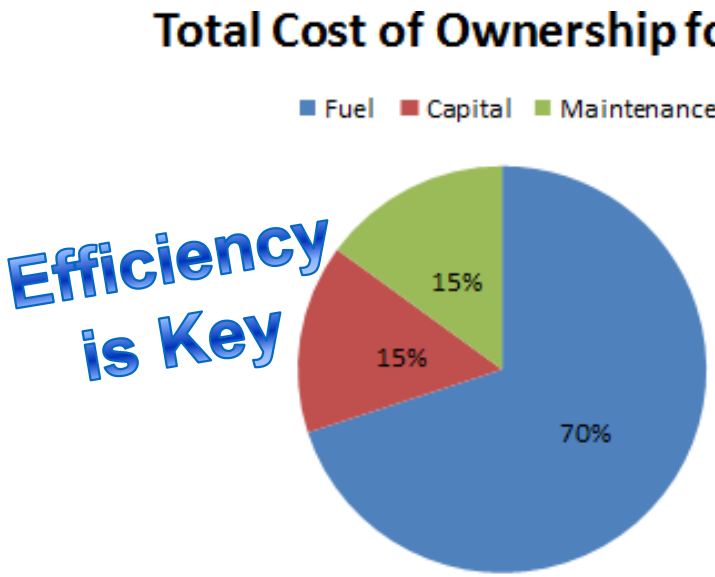
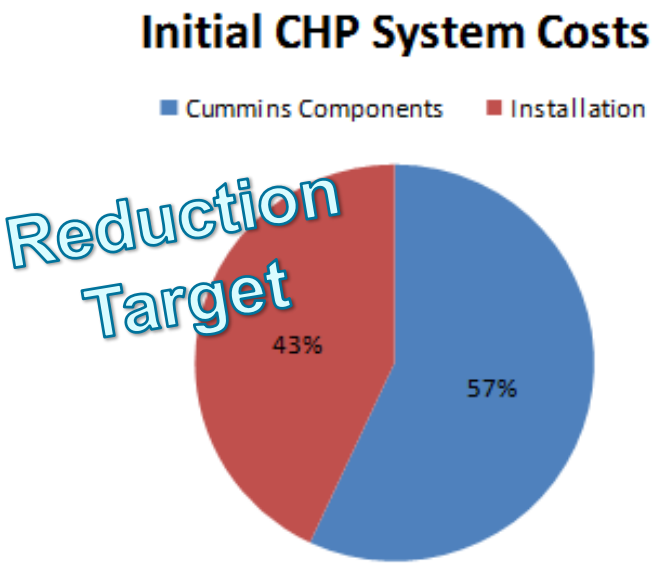
Project Objective

- Increase the adoption rate for high-efficiency small-scale Combined Heat and Power systems via development of a flexible, containerized 330 kWe unit.
  - Simplifies installation
  - Reduces total cost of ownership

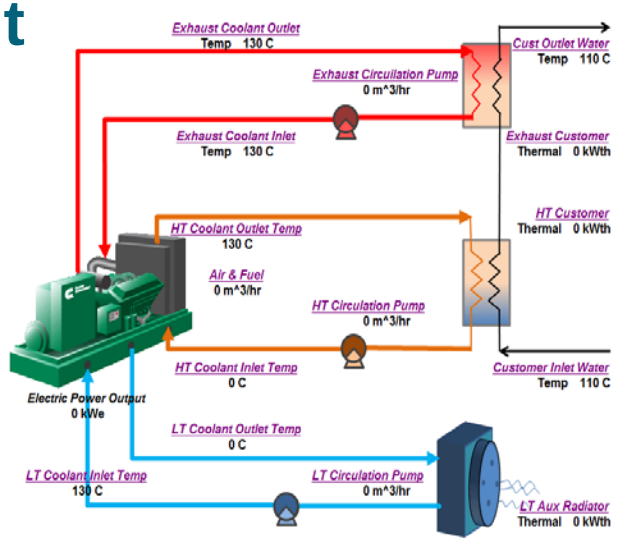


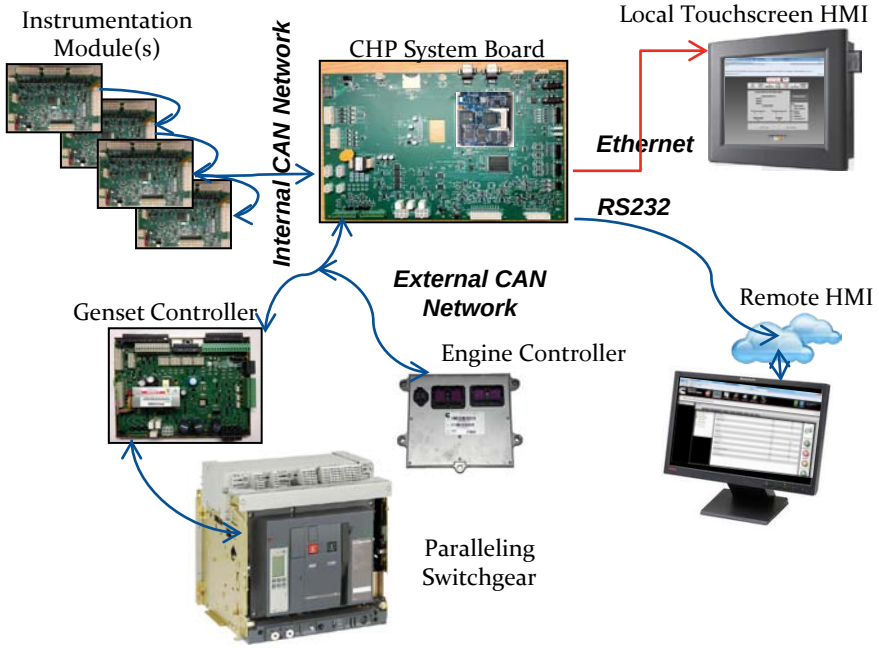


Technical Approach

Controls Development

- Dedicated control circuit board (eliminates costly PLC)
- Predictive service for components and consumables
- Dynamic total cost of ownership algorithms
- Custom maintenance schedules
- Remote monitoring and control
- High speed data logging

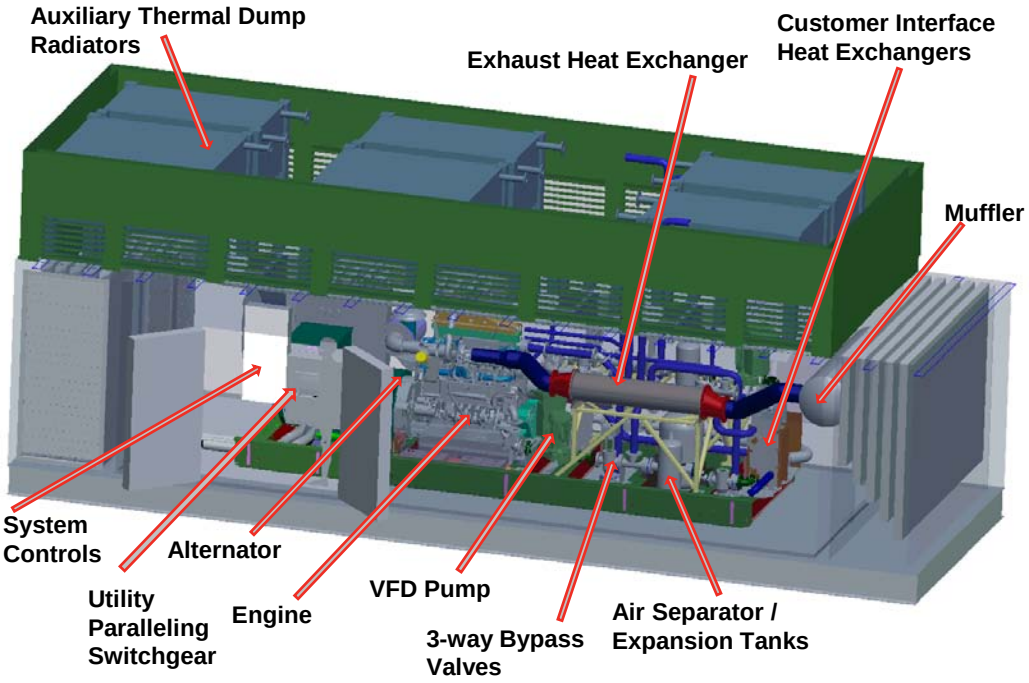




Technical Approach

Engine and Balance of Plant Development

- Leverage low cost, high volume components
- 2-Stage Charge Air Cooler
- Ultra-low noise enclosure with integrated hoist and 2.5’ walkway
- 5% BTE engine improvement



Transition and Deployment

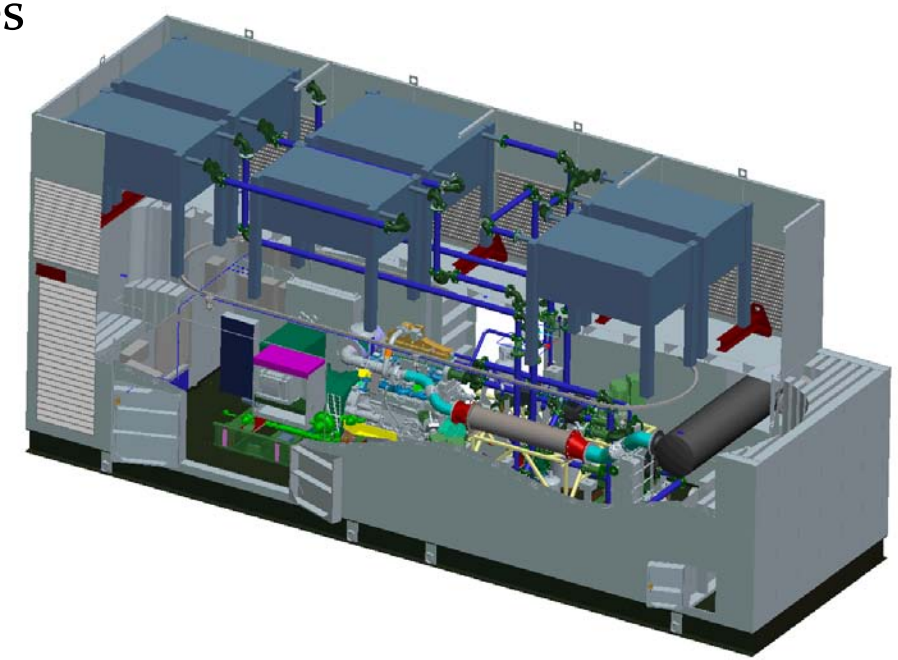
- Field Testing (Stage 4 Development & Verification)
  - System intent: “preheat” plant boiler, parallel to utility

- Commercialization
  - Utilize rigorous Cummins Value Package Introduction process (productization)
  - Implement cost reduction opportunities while maintaining flexible architecture
  - Leverage manufacturing efficiencies of scale
  - Dedicated support distribution system of 145 U.S. locations

Transition and Deployment

Target Markets:

- Institutional
  - Schools and Universities
- Commercial
  - Commercial Laundries
  - Hospitals and Nursing Homes
  - Hotels and Resorts
- Small Industrial
  - Chemical Production
  - Food Processing
  - Heat Molding / Plastics
- Gas & Electric Utilities

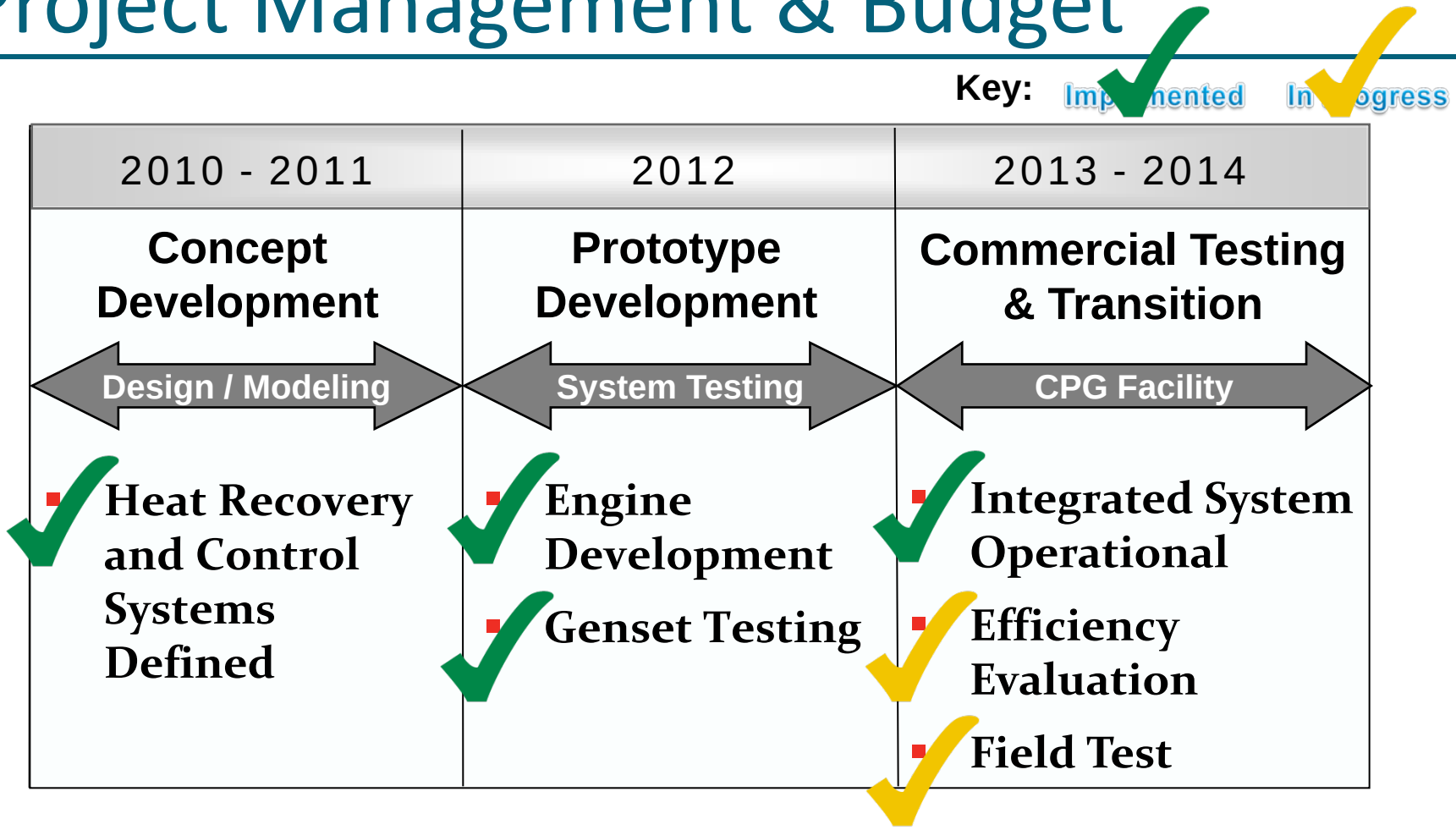


Measure of Success

- Energy and Emissions Reduction:
  - 36% less total fuel per kWh (compared to Cummins 19L)
  - 950 tons CO_2 estimated reduction per system (assuming 8000 hr/year, using National Grid Average Emissions)
- Transition DOE prototype to mass production
- Increase United States CHP system adoption rates
  - Reduce commercialization barriers at a State and Regional level (net metering, standby service tariffs)

Source: IEA 2007

Project Management & Budget



Total Project Budget	
DOE Investment	$ 6.02 M
Cost Share	$ 3.22 M
Project Total	$ 9.24 M

Results and Accomplishments

- Next Steps:
  - Evaluate cost reduction opportunities
  - Service, installation and manufacturing documentation
  - Identify changes for scalability to various power nodes
  - Evaluate impact of heat recovery architecture changes

Specification	Design target	Observed value
Electrical Power Output	330 kW_e	330 kW_e
Thermal Power Output	410 kW_{th}	418 kW_{th}
Brake Thermal Engine Efficiency	38%	38.3%
Emissions NOx	1 g/hp-hr	0.92 g/hp-hr
Overall System Efficiency (HHV)	70%	72.9%
System Noise Profile @ 6m	50 dB	46.5 dB
Customer Water Temperature Operating Range	5 – 95 C	12 – 95 C
Enclosure Size Equivalent	40’ ISO	37’ Custom