Flexible CHP System with Low NOx, CO, and VOC Emissions

DE-EE0003779

Gas Technology Institute/ California Energy Commission/ Utilization Technology Development/ Sustaining Membership Program/ Integrated CHP Systems Corp./ Cannon Boiler Works

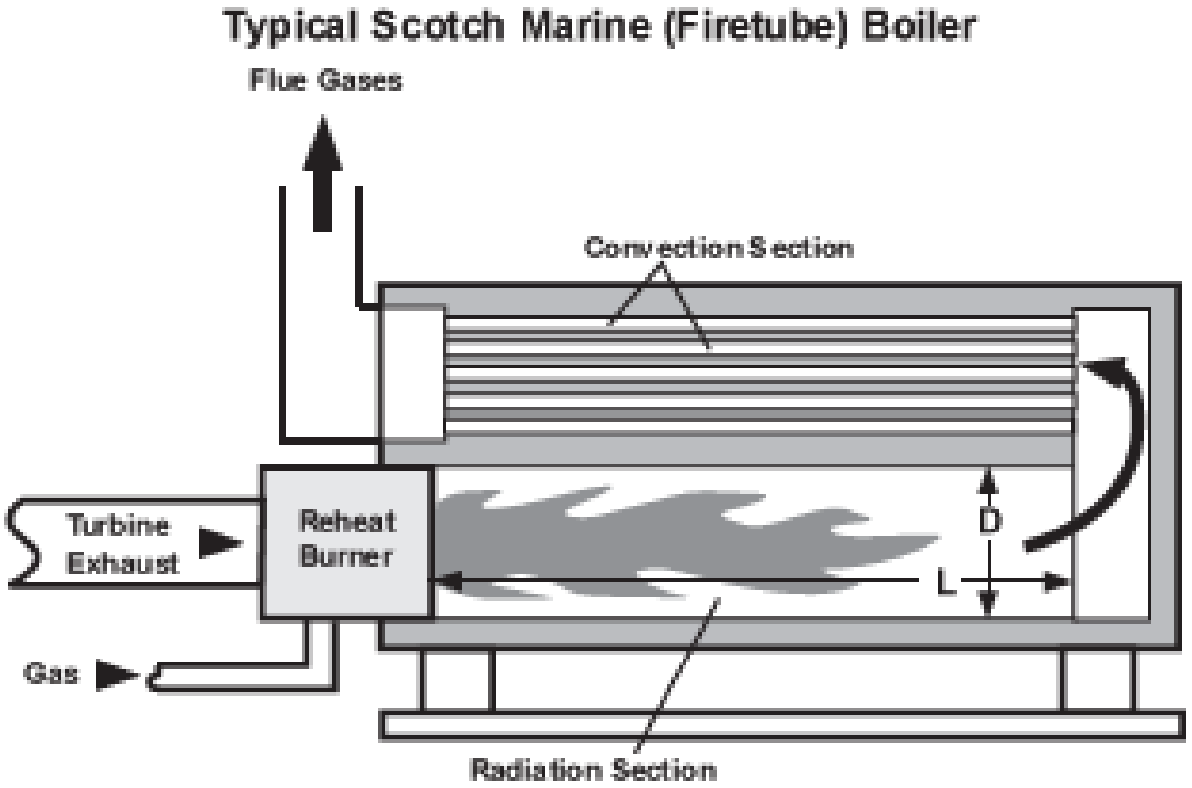
August 23, 2010 to September 1, 2011, Final Report November 30, 2013

David Cygan, Gas Technology Institute
David.Cygan@gastechnology.org, 847-768-0524

U.S. DOE Industrial Distributed Energy Portfolio Review Meeting
Washington, D.C.
June 1-2, 2011

Executive Summary

The objective of this Agreement is to deploy a Flexible Combined Heat and Power (FlexCHP) system to deliver power and steam while holding NOx, CO, and VOC emissions below the 2007 Fossil Fuel Emissions Standard targets for microturbines.



Project Objective

- Demonstrate a novel supplemental burner for conventional turbines and microturbine-based CHP applications
- Integrate the burner into a cost-effective CHP package
  - Achieve 84% (high heating value) system efficiency
  - Meet the 2007 Fossil Fuel Emissions Standard targets
  - Generate a pre-engineered cost-effective CHP package employing state-of-the-art design concepts
  - Validate the system in the GTI laboratory
  - Demonstrate the system at a California host site

State of the Art

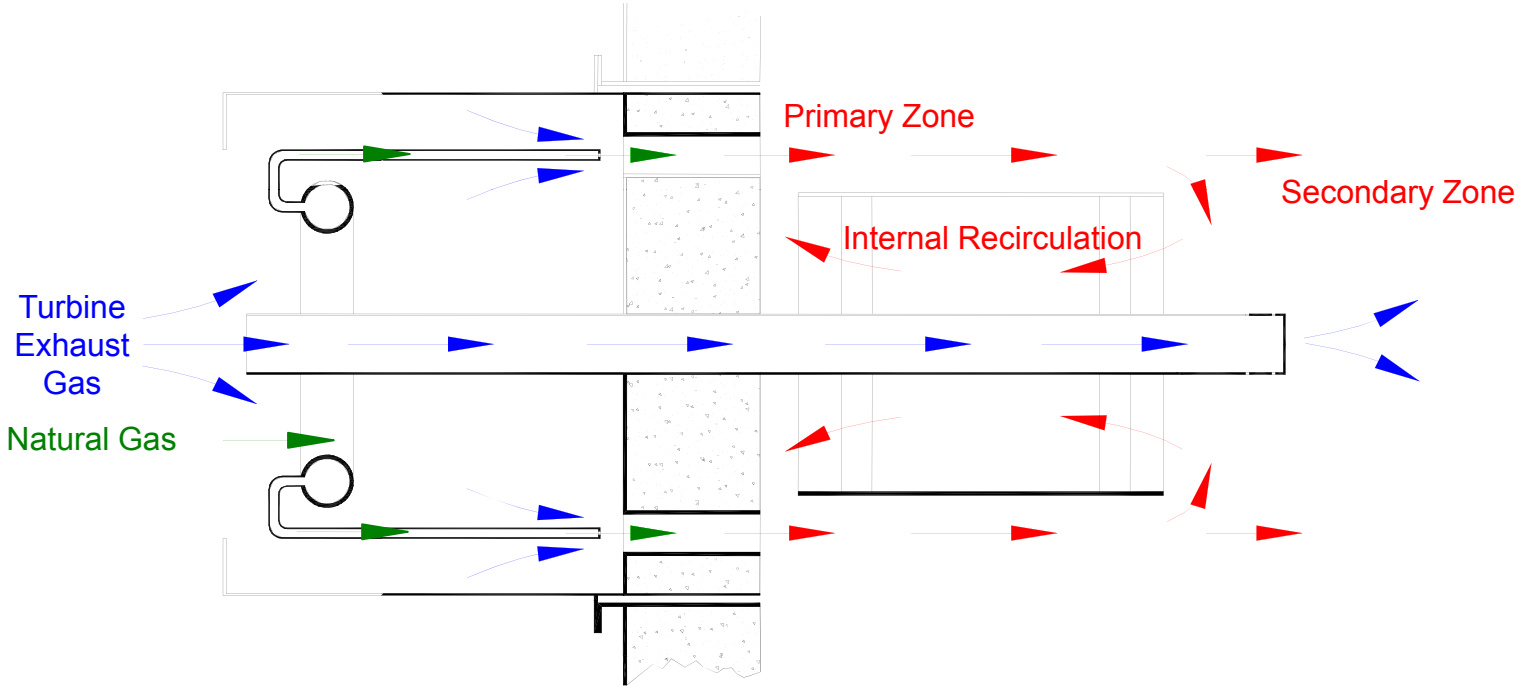
- Current supplemental burner technologies do not meet the 2007 Fossil Fuel Emissions Standard targets for microturbines.
  - less than 0.07 lb NOx/MWh,
  - 0.10 lb CO/MWh, and
  - 0.02 lb VOC/MWh

State of the Art

- Current large combustion turbine CHP technologies require costly additional exhaust treatment equipment to meet the target emissions standards
- Due to emissions restrictions in air districts that enforce California Air Resource Board 2007 standards, development of CHP systems has slowed due to difficulties and costs associated with meeting emissions standards

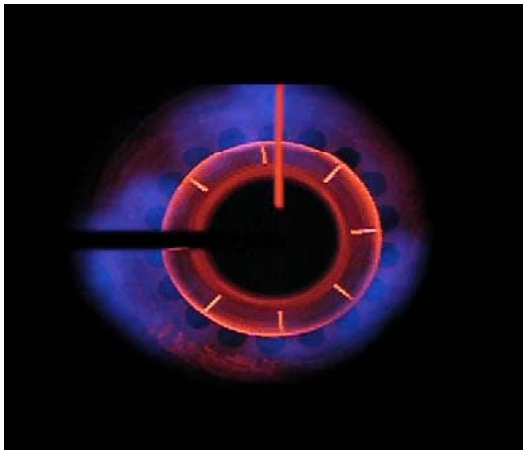
Technical Approach

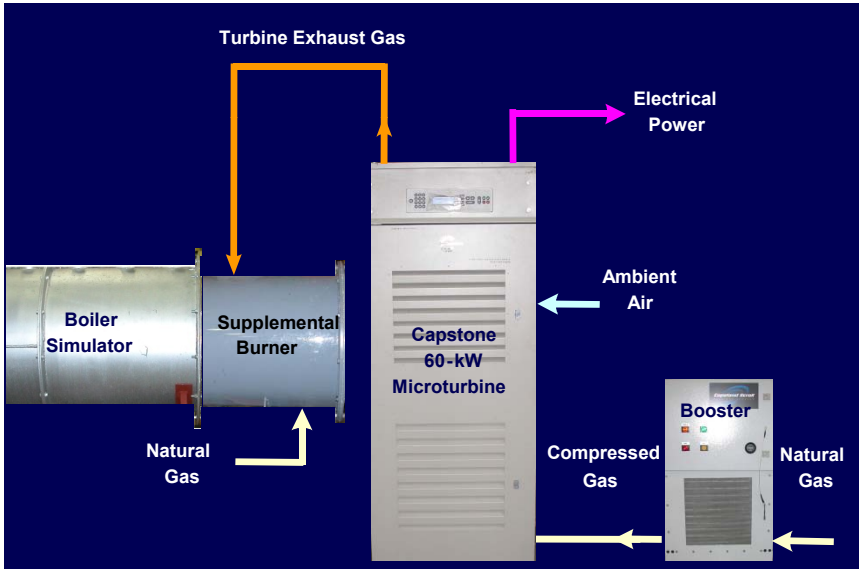
- At the heart of the FlexCHP system is the Ultra-Low-NOx supplemental burner
  - Based on Forced Internal Recirculation burner combustion method



Technical Approach

- Ultra-Low-NOx supplemental burner features
  - Less than three inches wc burner pressure drop
  - Targeted for boilers and absorption chillers
  - Significant thermal energy added to turbine exhaust gas
  - No blower required
  - No augmentation air requirement





Transition and Deployment

- Host Site Selection and Execution of Agreement with Host Site
  - Food Processing Site selected in Riverside, CA
- Design Engineering and Fabrication of CHP System
- Laboratory Validation of the FlexCHP-65 System
  - Fine tuning work that is site specific
- Field Unit Installation and Shakedown-Initial installation drawings started for layout
- FlexCHP-65 System Operation, Data Collection, Processing, and Analysis

Measure of Success

- The measurements used to determine technical success will be
  - Achieve 84% (HHV) system efficiency
  - Meet the 2007 Fossil Fuel Emissions Standard targets
- The measurement used to determine commercial success will be
  - Number of units deployed
  - Uptake of concept by equipment supplier community

Benefits

- The low cost integrated package will make the system attractive to customers
- The FlexCHP-65 can recover 10 to 14% of the boilers rated output. This is a comparable reduction in fuel and greenhouse gases
- Reduced load on the power grid by producing electrical power locally.
- The modular package approach will reduce installation schedule and costs
- The integrated system approach reduces technical risk

Commercialization Approach

- The system requires the development and field verification of a commercial prototype of the Ultra-Low-NOx burner
- A market outreach program will be engaged through both market channel partners as well as related industry associations including ASHRAE, ASME, PowerGen, etc.
- Cannon Boiler Works and Integrated CHP Systems will offer the integrated package to the market
- Three year transition period in assisting the market channel partners identify and qualify sales opportunities as well as assist in sales and applications

Project Management & Budget

Milestone Task	Decision Point Deliverable	Description	Performance Measure
1.0	Contract in Place	Work starts	Contract signed
2.0	Laboratory Validation of the FlexCHP-65 System Completed	System validation completed	All equipment and subsystems installed and operating. Performance objectives achieved.
3.0	Field Demonstration Performance Test Plan	A written test plan that describes the test plan, procedures, instrumentation used and instrumentation guidelines.	The finalized document presented to and accepted by DOE.
4.0	Field Demonstration of the FlexCHP-65 System Completed	Complete performance testing in accordance with the Field Demonstration Performance Test Plan	All equipment and subsystems installed and operating. Performance objectives achieved.
4.0	Stage-Gate Demonstration of FlexCHP-65 System at host site	Stage Gate host site demonstration of FlexCHP 65 completed in accordance with the Field Demonstration Performance Test Plan and objectives and goals are met.	Stage Gate has been achieved and approval has been given to move on.
4.0	Field Performance Test Report	A written report of the field host site demonstration.	The finalized document presented to and accepted by DOE.
5.0	Report for Production Units	Report that describes a series of pre-engineered Flex-CHP package designs for commercialization.	The finalized document presented to DOE.
1.2	Critical Briefings	Go/No Go Decision Point	Go/No Go Decision Criteria based on the project goals and objectives.
6.0	Draft Technology Transfer Plan	Provide a written Draft Technology Transfer Plan to make the knowledge gained, experimental results, and lessons learned available to key decision-makers	The draft document presented to DOE.
6.0	Final Technology Transfer Plan	Provide a written Final Technology Transfer Plan updated from recommendations made from the draft.	The finalized document presented to and accepted by DOE.
7.0	Draft Commercialization Readiness Plan	Provide a draft written Commercial Readiness Plan that outlines the steps that will lead to the manufacturing of the technology developed in this project or to the commercialization of the project's results	The draft document presented to DOE.
7.0	Final Commercialization Readiness Plan	Provide a written Commercial Readiness Plan updated from recommendations made from the draft.	The finalized document presented to and accepted by DOE.
1.4	Issue Final Project Report	Prepare a comprehensive written Final Report describing the original purpose, approach, results, and conclusions of the work performed	The finalized document presented to DOE.
1.2	Critical Briefings	Project Complete	All project Tasks complete and Final Report written

Project Management & Budget

Project Budget				
	FY11	**FY12**	**FY13**	**FY14**
DOE Investment	$315,018	$259,003	$26,109	-
Cost Share	$434,015	$146,297	$38,848	-
Project Total	$749,033	$405,300	$64,957	-

Results and Accomplishments-Major Tasks

- Transitioned to a new host site for installation of the FlexCHP-65 system
- The burner has achieved the emission target goals in the laboratory
  - Operation may be extended to lower loads based on site specifics
- Installed system control full commissioning will occur at site
- Site integration package design underway

Path Forward

- Installation drawings and permits for the site with approvals
- Installation of the FlexCHP system
- Shake down and testing of the system
- Long term monitoring of the system
- Report on the findings
- Work with commercialization partner

Questions?