

Deployment of FlexCHP System

DE-EE0003779

Gas Technology Institute/Integrated CHP Systems Corporation/
Cannon Boiler Works/Inland Empire Foods
September 2, 2010 to December 31, 2014

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U.S. DOE Advanced Manufacturing Office Peer Review Meeting
Washington, D.C.
May 6-7, 2014

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Project Objective

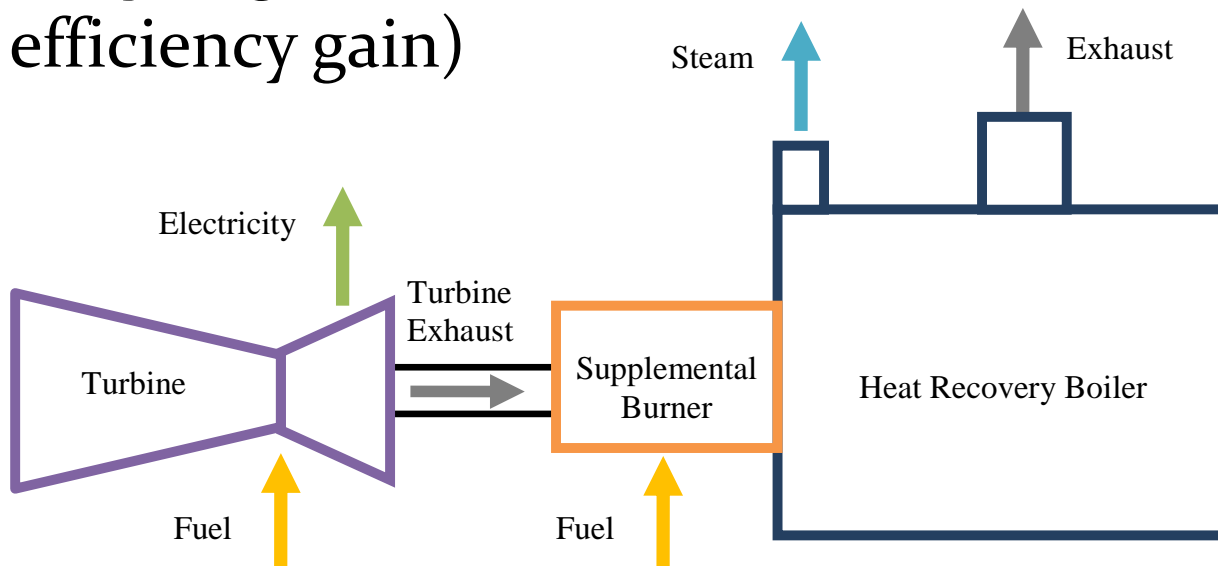
- Goal
 - Develop a cost-effective gas turbine based CHP system that improves overall efficiency and meets California Air Resources Board (CARB) 2007 emission standards without catalytic exhaust gas treatment – on target
- Objectives
 - Achieve 84% (high heating value) system efficiency ✓
 - Generate 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 ✓
 - Commercialize product – on target

Project Team

- Performing organizations
 - Gas Technology Institute – overall Project Management, combustion technology, laboratory development
 - Cannon Boiler Works – commercialization partner, burner manufacturer, and boiler integrated CHP system supplier
 - Integrated CHP Systems Corporation – commercialization partner, CHP system field integration, design and installation
 - Inland Empire Foods – host site
- Sponsors
 - U.S. Department of Energy
 - California Energy Commission
 - California Air Resources Board
 - Utilization Technology Development

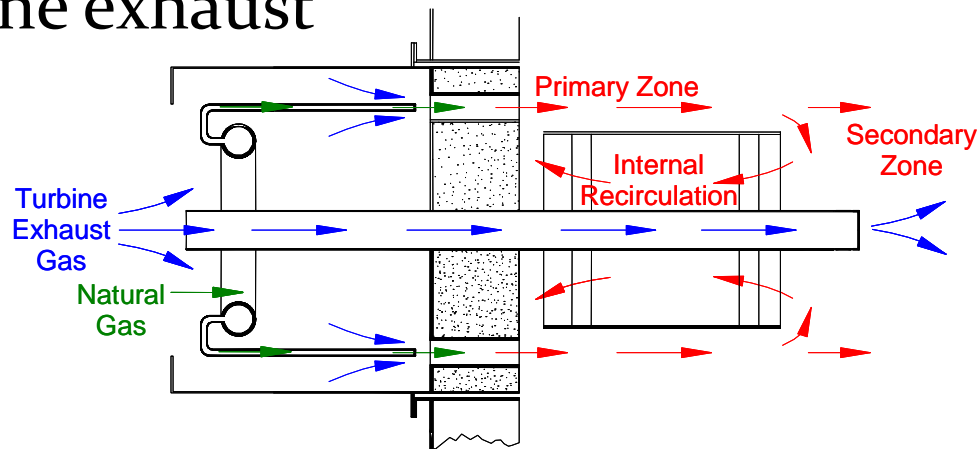
Technology Overview

- Turbines are commonly employed in CHP applications; however, they operate with significant excess air, causing efficiency penalties
- Supplemental duct burners fire additional fuel with turbine exhaust in a boiler to recover heat and improve efficiency (e.g. excess air reduced from 355% to 15% → 29% efficiency gain)



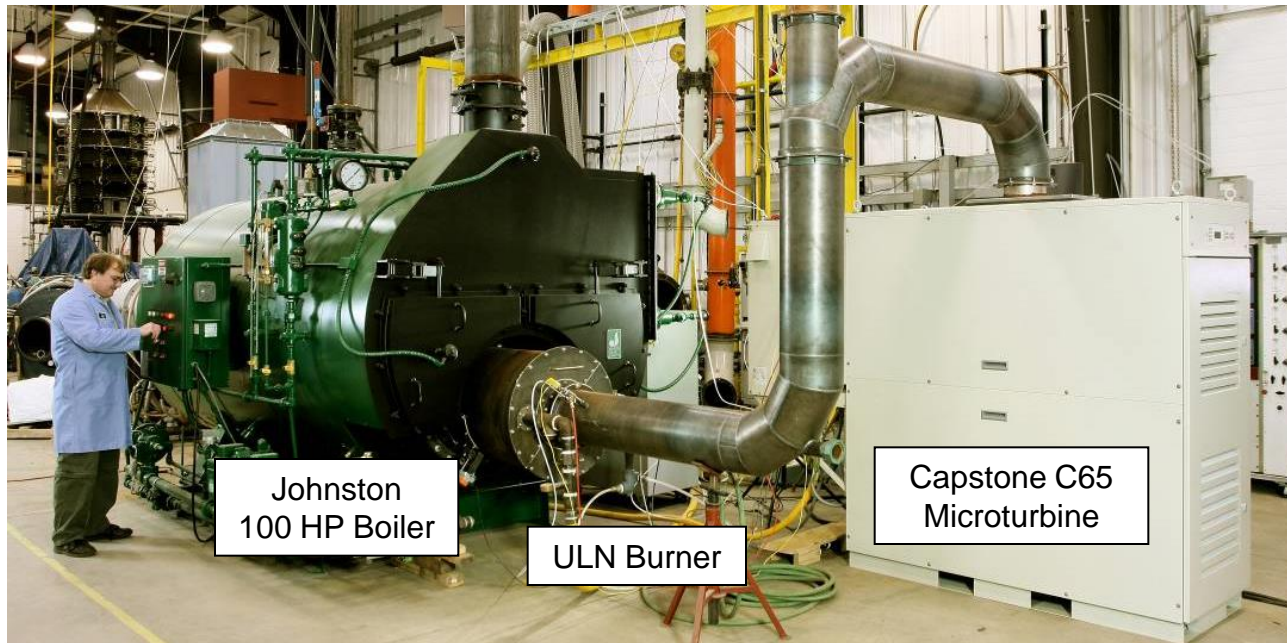
Market Barrier - Emissions

- CHP technologies have struggled to meet 2007 California Air Resource Board (CARB) emissions criteria ($\text{NO}_x < 0.07 \text{ lb/MWh}$, $\text{CO} < 0.10 \text{ lb/MWh}$)
- Post combustion cleanup methods, such as SCR, add significant cost
- GTI has developed a low-cost, Ultra Low NO_x (ULN) burner technology suitable for supplemental firing with turbine exhaust



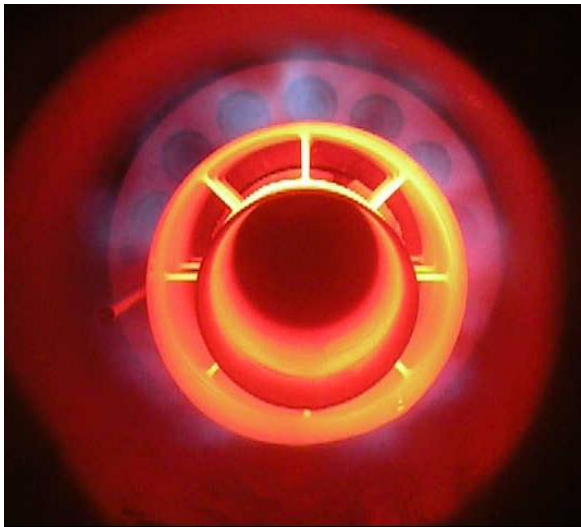
Market Barrier – Installed Cost

- High installed costs of CHP has limited deployment; especially for smaller generation facilities
- Developed a cost-competitive packaged CHP system (FlexCHP-65) with integrated controls



FlexCHP Technology Demonstration

- FlexCHP installed at a food processing facility
- Fully instrumented to assess system performance (ASERTTI protocol)



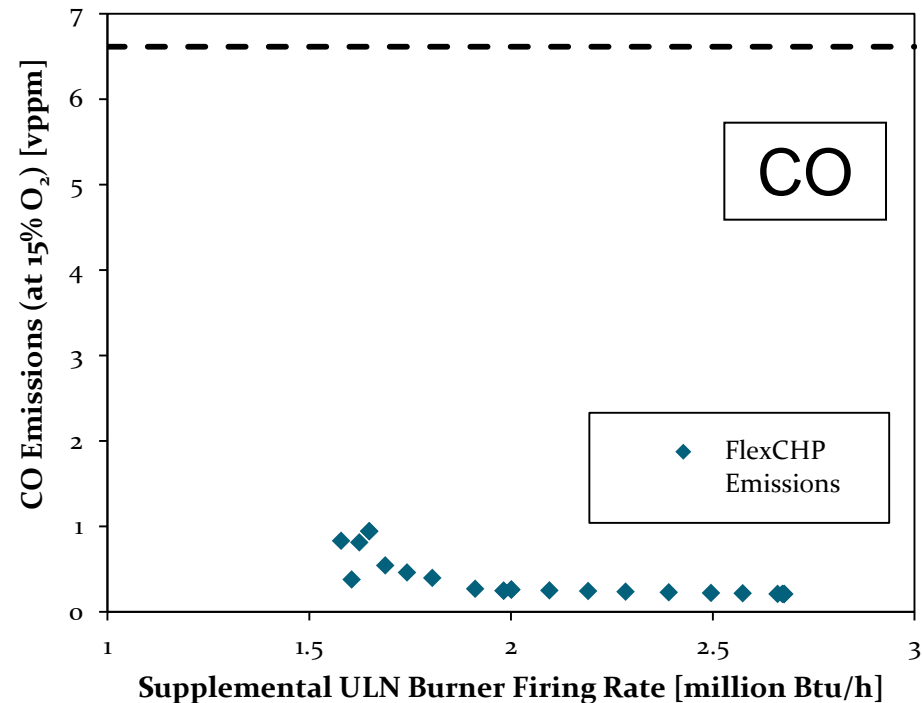
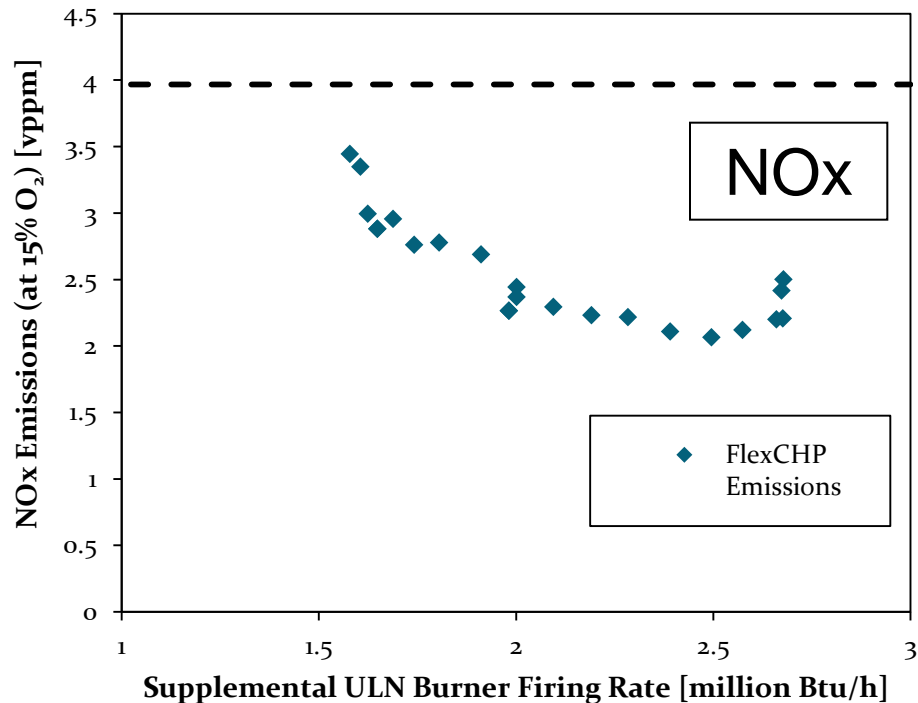
Supplemental Burner at 3 million Btu/h



FlexCHP-65 System

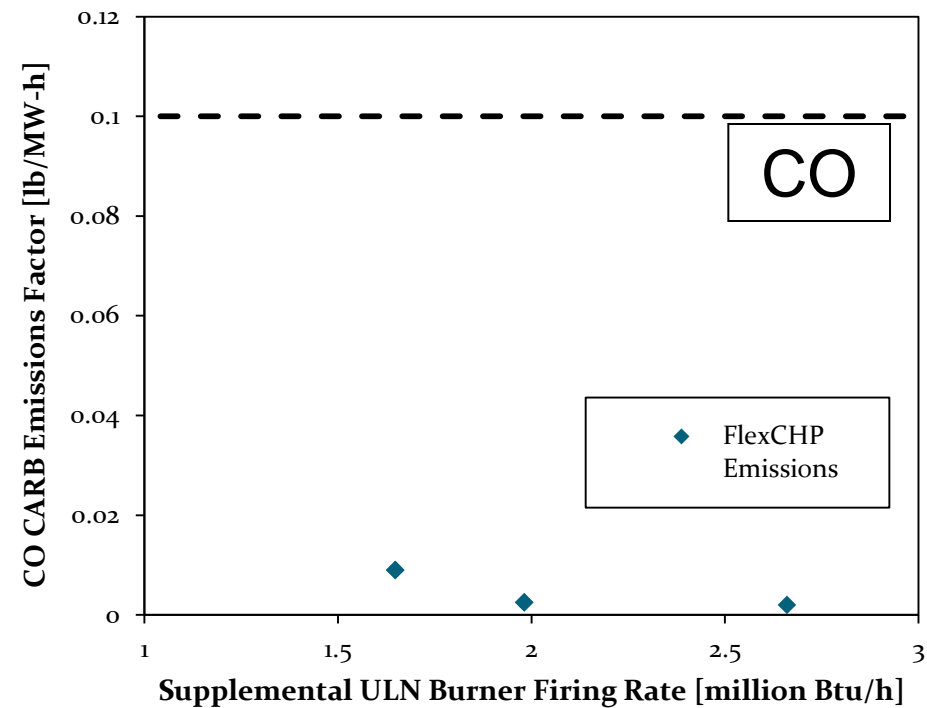
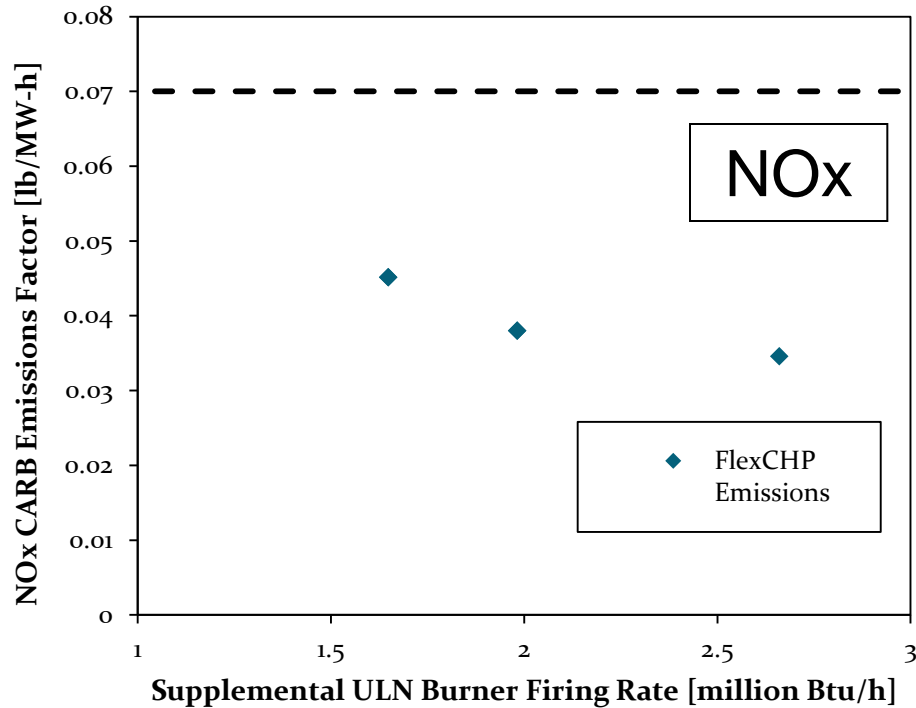
FlexCHP Emissions vs. Microturbine

- NO_x and CO much lower than microturbine
- VOC near zero (< 0.5 ppm uncorrected)



FlexCHP Emissions vs. CARB 2007

- NO_x and CO far exceed 2007 CARB criteria
- VOC near zero (< 0.5 ppm uncorrected)



Transition and Deployment

- FlexCHP will be of value to industrial, commercial and institutional facilities; government energy, environmental and economic development agencies; gas and electric utilities; project developers and financiers
- Best suited for facilities with 1 – 200 tons/h steam demand
- Steam and electricity produced will generally be used onsite with any excess electricity sold
- ULN burner can be retrofit to an existing boiler or a fully integrated packaged system can be installed
- Helps end users meet energy/environmental goals

Transition and Deployment

- Target initial commercialization at regions with high electricity costs and/or strict emissions limits
- License technology to the primary commercializer
- Identify and address technical (increase turndown and allow variable turbine exhaust and full air firing) and resource gaps (technical lead, facilities for larger scale tests, and deployment funds)
- Expand technology operating flexibility and market
- Value engineer to reduce system and installation costs
- Take advantage of available local incentives

Measure of Success

- End users are able to cost effectively meet regulations and continue and/or expand operations
- Energy intensity is reduced, significant electricity is generated onsite and new jobs are created
- Sales levels are consistent with projections, design is stable and commercialization partner is able to meet market demand
- In year 10, cumulative sales equal about 500 units (600 kW equivalent) resulting in annual savings of 5.1 bcf natural gas, 710 tons NO_x and 6.5 million tons CO₂

Project Management & Budget

- 42 months
- Completed laboratory verification of integrated system with prototype ULN burner, turbine and boiler
- Successfully demonstrated FlexCHP package in the field, meeting energy savings and emissions goals
- Validated results, independent third party source test
- Initiated technology transfer
 - Market outreach, expansion of operating flexibility and address resource needs

Total Project Budget	
DOE Investment	\$695,130
Cost Share	\$754,726
Project Total	\$1,449,856

Results and Accomplishments

- Laboratory tests demonstrated ability to exceed CARB 2007 emissions criteria for NO_x, CO and VOC across full turndown
- Field tests at Inland Empire Foods, Inc. in California demonstrated increased efficiency from 23.6% for turbine alone to 84.2% for integrated system and achieved NO_x levels that were 50% below and CO and VOC levels that were far below CARB 2007 limits
- Remaining work consists of data collection/monitoring and communication of successful results
- Formulate a scale up approach that will allow for a range of packaged CHP systems to meet customer needs