ABSTRACT

Title	Integrated CHP Using Ultra-Low-NOx Supplemental Firing
Contractor	Gas Technology Institute (GTI), CARB Grant Number: CAT 05-1
Project Manager	David Cygan
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Objective	The objective of this project is to deploy Gas Technology Institute's (GTI's) 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 for microturbines. The system appropriately designated a FlexCHP-65, will combine a Capstone C65 microturbine, a GTI-developed supplemental Ultra-Low-NOx (ULN) burner, and a 100 Horsepower (HP) heat recovery boiler by Johnston Boiler Company.
Technical Perspective	The supplemental ULN burner is an innovative combustion approach that promises industrial end-users a dramatic increase in energy efficiency and reduced air emissions. The efficiency of microturbine based distributed generation systems is a strong function of the ability of the system to recover and use the waste heat in the exhaust of the microturbine. The major advantages of a supplemental burner coupled with a microturbine are an increase in total system efficiency due to lowering exhaust oxygen levels from 17-18 vol.% to 3-5 vol.%, and an increase in quality of the heat produced from the microturbine exhaust. By employing auxiliary burners in the exhaust of the microturbine, the amount and temperature of the available heat will be decoupled from the amount of electricity produced. This advantage will enable more systems utilizing waste heat recovery from turbines to be designed, manufactured and sold. The developed supplemental burner has unmatched emission characteristics, which will provide a competitive edge over existing low-NOx systems in the fast developing area of CHP applications for installations where low emissions is a performance requirement.
Technical Approach	Combining the supplemental ULN burner technology with state-of-the-art gas turbines, meeting the 2007 Fossil Fuel Emissions Standard for CHP installations without the use of end-of-pipe cleanup technology such as selective catalytic reduction (SCR). The supplemental burner, designed by GTI to be installed between the gas turbine and heat recovery boiler or absorption chiller, combusts natural gas using the turbine exhaust gas (TEG) as oxidant, just as current duct burners do. Integrating the supplemental burner technology with a gas turbine creates the additional benefit of reduced NOx emissions from the combined system. NOx created in

the gas turbine is also present during the combustion process of the supplemental burner and results in an overall NOx concentration reduction compared to the two units operating separately. The additional fuel combustion adds very little NOx and effectively completes combustion, keeping CO at very low levels in spite of the suppression of thermal NOx, which generally is difficult to achieve without raising CO emissions.

Results The supplemental ULN burner has demonstrated increased energy efficiency while meeting the 2007 Fossil Fuel Emissions Standard without the use of catalytic exhaust gas treatment. The key to this breakthrough performance is a simple and reliable advanced burner design with engineered internal recirculation. The burner exposes NOx and NOx precursors to a low temperature zone, resulting in a lower NOx content per unit of heat input than that of the original TEG. Preliminary laboratory testing with a 2.2 million Btu/h supplemental burner firing the exhaust from a 60-kW Capstone microturbine proved the capability of the system to deliver final stack NOx below 0.07 lb/MWh. Additional testing showed that the burner can be successfully scaled up to 7.5 million Btu/h. This also indicates the possibility of integration with megawatt-scale engines such as the Solar Mercury 50. Evaluation of a 4 million Btu/h burner firing with exhaust gas from a 65-kW Capstone microturbine is following the path to reduce NOx formed in the turbine and deliver final NOx emissions in the stack at levels which have not been achieved without SCR. The resulting CHP packages promise to make CHP implementation more attractive, mitigate greenhouse gas emissions, improve the competitiveness of industry, and improve the reliability of electricity.

Project Implications The FlexCHP system will provide CHP users with a highly efficient source of on-site heat for use with boilers and absorption chillers. The technology is environmentally superior and cost-competitive compared to state-of-the-art duct burner technology available on the market. The developed technical approach can be expanded to other combustion applications using TEG or preheated air as combustion air in situations where low combustion emissions are required.