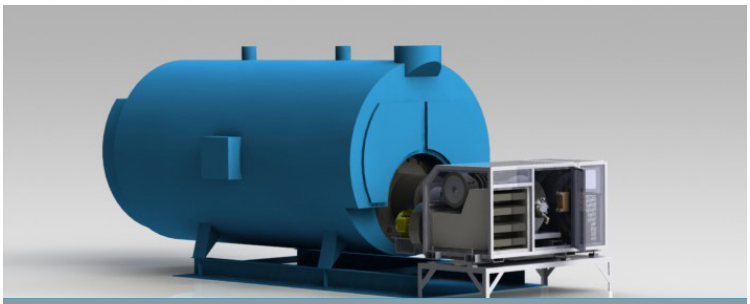
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy
ADVANCED MANUFACTURING OFFICE

Combined Heat and Power Integrated with Burners for Packaged Boilers

Providing Clean, Low-Cost, Onsite Distributed Generation at Very High Fuel Efficiency

This project integrated a gas-fired, simple-cycle 100 kilowatt (kW) microturbine (SCMT) with a new ultra-low nitrogen oxide (NO_x) gas-fired burner (ULNB) to develop a combined heat and power (CHP) assembly called the Boiler Burner Energy System Technology (BBEST).



Boiler Burner Electrical System Technology (BBEST) for packaged boilers. *Photo courtesy of CMCE, Inc.*

Introduction

CHP systems can achieve significant gains in fuel efficiency for power generation and reductions in greenhouse gas emissions. While large CHP systems have been installed and used for many years, small CHP systems (especially less than 250 kW in generating capacity) have seen limited market acceptance. However, the number of potential host sites for large, multi-MW CHP installations is limited by the need for significant thermal loads to fully exploit the benefits of CHP. Small CHP installations, in contrast, have a much greater potential market.

This project developed the BBEST, a CHP assembly of a gas-fired, 100 kW SCMT and a new ULNB, to increase acceptance of small CHP systems. This technology will improve reliability while reducing costs and the need for maintenance.

The project's BBEST system will achieve an overall CHP fuel efficiency of > 80% and a power conversion efficiency of 3,800 British thermal units (Btu)/kilowatt hour. The CHP product will be used in new installations and as a retrofit for existing industrial and commercial boilers in place of conventional burners.

Benefits for Our Industry and Our Nation

If a low-cost domestic microturbine can be procured, the incremental cost for power generation can be as low as $700/kW, compared to as much as $2,000/kW for conventional CHP. Maximum system efficiency is expected to be > 80%, compared to 70% for conventional systems.

Increased efficiency will benefit industry through energy savings and associated cost reductions, as well as decreased greenhouse gas emissions. The system will also reduce NO_x emissions to meet stringent air quality regulations.

The developed BBEST system offers a new, cost-effective CHP alternative for industrial plants and other facilities with smaller thermal loads. This greatly increases the number of potential CHP sites. It is estimated that each 100 kW BBEST system installation will result in over $100,000 in annual energy savings (based on boiler load factor of 66% and a spark spread defined by $0.16/kWh for price of electricity and $5/MMBtu for natural gas). These savings allow for a simple payback of 2.5 years without incentives. The hotel where the demonstration system was installed is realizing annual energy savings of $117,000 in electricity costs based on 4,250 Btu/kWh microturbine heat rate, a natural gas cost of $6/MMBtu, and an electricity rate of $0.16/kWh.

Applications in Our Nation's Industry

This project will target a large retrofit CHP market consisting of about 130,000 industrial and commercial boilers operating in the United States, each with heat input design capacities of <100 million Btu/hour. The BBEST CHP assembly will be applicable to all major packaged boiler designs (A-Type Watertube, D-Type Watertube, O-Type Watertube, and Firetube). Sectors that will most likely benefit are small industrial plants, schools, and health care facilities.

Project Description

This project engineered, designed, and fabricated the BBEST CHP assembly that integrates a low-cost, clean-burning, gas-fired 100 kW SCMT with a new ULNB. The compact BBEST CHP product can be used in new installations or in retrofits of existing industrial and commercial boilers.

The first part of the project included hardware development, assembly, and preliminary testing. Each key CHP system component (ULNB, SCMT, assembly BBEST CHP package, and integrated controls) was engineered, designed, fabricated, tested, and optimized.

The second part of this project included field installation and demonstration testing at a California hotel. The field verification tests documented performance of the BBEST CHP technology and its attainment of energy and emission targets, and objectives under parametric and normal boiler operation.

Barriers

- Developing a new ULNB that considers the optimum integration of the SCMT equipment and exhaust gas properties
- Improving the SCMT premix combustor to provide greater CHP operational flexibility
- Creating an integrated, user-friendly control assembly for electronics and software
- Fabricating the CHP assembly in a compact, small-footprint package applicable to a broad range of packaged boiler designs
- Increasing market acceptance of small CHP systems

Pathways

CMCE, Inc. (CMCE) and its subcontractor, Altex Technologies Corporation (ATC), were the key partners for this project. CMCE purchased all necessary equipment, led the SCMT optimization, integrated controls installation, and field testing. ATC led the ULNB development, assembly design, and preliminary testing of individual components, as well as supported the field testing.

The initial steps of this project were to develop the ULNB and SCMT; the chosen micro-turbine was a Turbec T-100. Once these were complete, they were assembled into an integrated BBEST CHP package. A burner management system (BMS) was designed and fabricated for the ULNB. The BMS control was integrated with the SCMT power electronics.

After preliminary testing was completed in the ATC combustion laboratory, CMCE outsourced the field installation of the system to a local burner/boiler retrofit company. The BBEST CHP technology demonstration was installed at the Westin Hotel in Costa Mesa, California and tested for its performance.

Milestones

- Development of a new ULNB
- Development of a new SCMT
- Assembly of the ULNB and SCMT into an integrated BBEST CHP package
- Integration of the BMS control with the SCMT power electronics
- Completion of preliminary testing
- Completion of field installation and performance test

Commercialization

Since August 2008, CMCE and ATC have had an agreement in place to develop and commercialize BBEST integrated CHP products for packaged boilers. The BBEST technology is being commercialized under the Leva Energy brand name “Power Burner”.

Approximately 40,000 units of the target industrial and commercial boiler population are located in strict air permit areas of the country. These units require burner upgrades for emission compliance. CMCE and ATC recognize this as a near-term opportunity for the BBEST CHP technology.

The team aims to grow installations exponentially, with the goal of 3,500 BBEST CHP units installed in year 7 of sales and 15,000 units in year 10. An estimated cumulative 39,000 units (nearly one-third of the available industrial and commercial boiler population in the United States) could be installed in the first 10 years of commercialization. The successful commercialization of the developed technology will require significant investments in order to secure key suppliers and build the needed infrastructure to support installations and maintenance of field operating systems.

Project Partners

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Project final report available at
www.osti.gov/scitech: *OSTI Identifier 1111427* ■