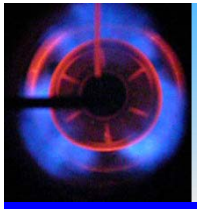
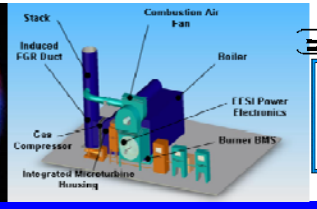

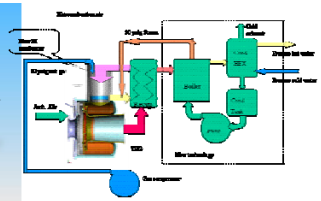

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OVERCOMING CHP BARRIERS THROUGH INNOVATIONS:
OVERVIEW OF CHP R&D

2012 IEPR Workshop on Combined Heat and Power in California
February 16, 2012
1516 Ninth Street, Sacramento, CA

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Energy Research and Development Division
California Energy Commission

Policy Drivers

SB 1250 (Perata), Chapter 512, Statutes of 2006

- Advanced electricity generation technologies that exceed applicable standards to increase reductions in greenhouse gas emissions from electricity generation, and that benefit electric utility customers

AB 32, the California Global Warming Solutions Act of 2006

- Reduce GHG emissions to 1990 levels (~25% reduction from BAU) (2020)
- All emissions from new baseload generation must be at or below emissions from a natural gas combined cycle plant (2020)

Governor Brown's Clean Energy Jobs Plan

- 6,500 MW Additional CHP Capacity (2030)

Senate Bill X1-2 (Simitian, 2011), Renewable Portfolio Standard

- 20 percent of retails sales from renewables by the end of 2013, 25 percent by the end of 2016, and the 33 percent requirement being met by the end of 2020

AB 1613 (Blakesley, Statutes of 2007), the Waste Heat and Carbon Emissions Reduction Act

- require an electrical corporation to purchase excess electricity delivered by a CHP system that complies with certain sizing, energy efficiency and air pollution control requirements.

Goals and Strategies

Overall Goal

- Advance the science and technology, reduce barriers and increase market penetration of combined heat and power (CHP)/combined cooling, heating and power (CCHP)

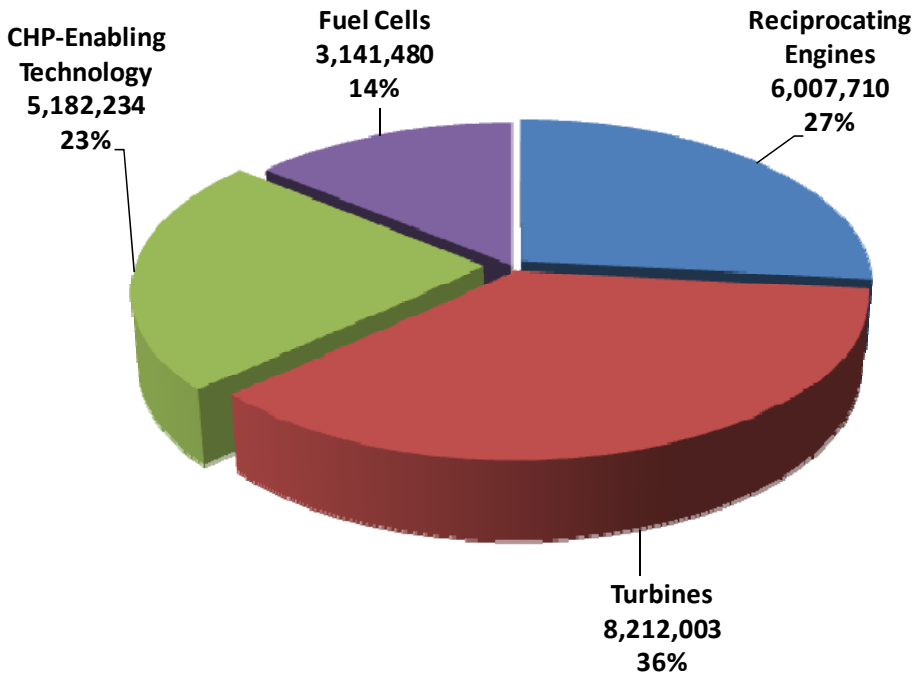
Strategies:

- Expand CHP/CCHP while developing innovative energy supply based on reliability, affordability and environmental attributes
  - CHP as the most efficient form of DG and qualifies as first in the loading order
  - Minimize pollutant formation during combustion processes
  - Maximize heat utilization and waste heat recovery (i.e., increase energy efficiency)
  - Upgrade the thermodynamic quality of fuels
- Develop hybrid generation, fuel-flexible systems and other energy efficient and low emission CHP technologies
- Develop and demonstrate diversified applications that use renewable resources

Portfolio of PIER CHP Technologies

CHP Projects by Technology Type

(Active and Recently Completed)

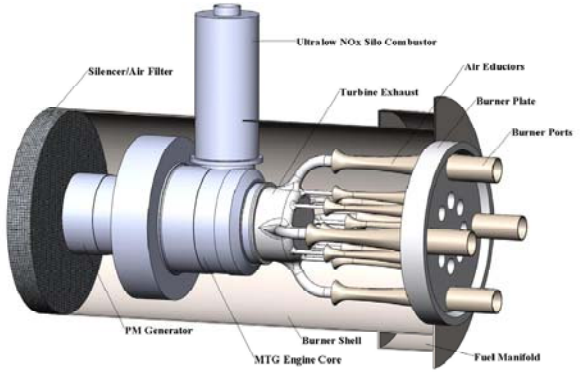


Common Emphasis and Goals

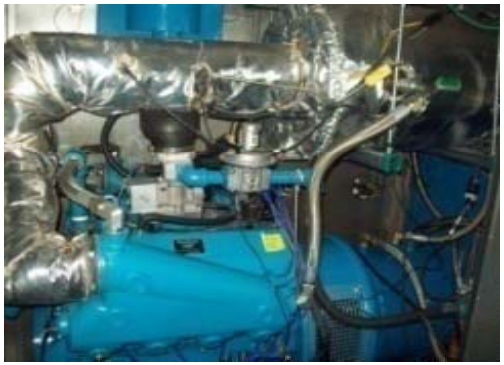
- Reduce cost and simplify CHP system operation (acceptable capital and maintenance costs)
- CHP/CCHP system development and demonstration in California
- High efficiency – Low CO_2
- Low emissions
- Reliability, availability, maintainability, and durability
- Apply standardized performance testing and reporting protocols

Example Projects

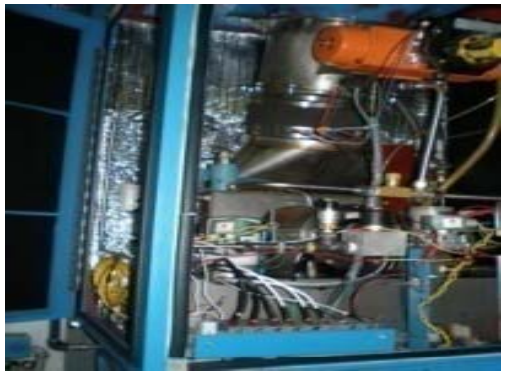
100 kW Engine-Based Premium Power CHP System inverter technology providing grid parallel and grid-independent operation.
Contractor: Tecogen, Inc.



Industrial CHP boiler burner energy system technology (BBEST) to reduce emissions and incremental cost and achieve high efficiency.
Contractor: Altex Technologies Corporation



Compact exhaust heat exchanger and emissions control in a 100 kW CHP system
Contractor: DE Solutions, Inc. / Tecogen, Inc.

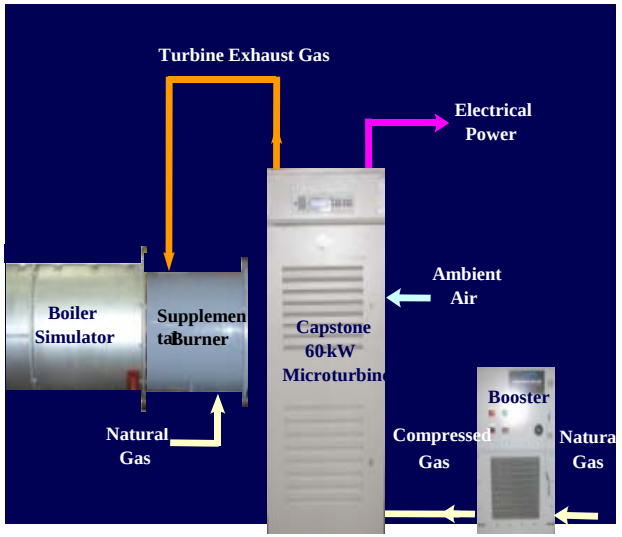


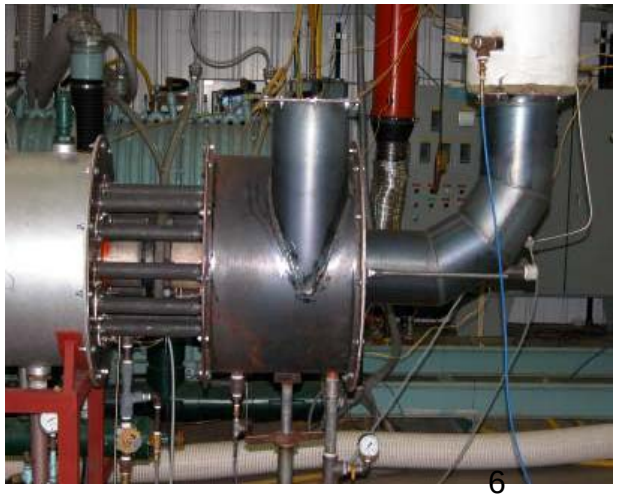
Thermal oxidizer for VOC destruction in a 100 kW Microturbine based CHP
Contractor: CMC Engineering

Example Projects

Integrated CHP Using Ultra-Low-NOx Supplemental Firing

- **Goal**: Develop a cost effective, highly efficient, ultra-low NOx, packaged CHP system with a small to medium sized gas turbine and boiler and an innovative natural gas-fired supplemental burner, to meet 2007 CARB standards without catalytic exhaust gas treatment.
- **Contractor/Partners**: Gas Technology Institute; CARB, Utilization Technology Development; Gas Research Institute, Accuchem Corp.
- **Status**: Design completed; on-going system refinement
- **Next steps**: Field demonstration in Riverside County
- **Benefits**: 10 to 25% reduction in capital cost of small DG/CHP systems, making them more cost effective for 10 MW or less applications.





Example Projects

Production and Conditioning of High Sulfur Biogas for Fuel Cell Combined Heat and Power Generation

- **Project Description**: Converted onion process wastes to biogas; demonstrated biogas cleaning and conditioning to fuel cell gas quality levels and generate CHP from fuel cells
- **Contractor/Partner:** Gas Technology Institute/Gills Onions
- **Rate payer benefits:** Energy and cost savings and GHG reduction:
  - Reduce natural gas use: 112,000 scf/day
  - Reduce GHG emissions: 14,500 metric tons/yr
  - Model for California food processing industry: ~40 mil. tons/yr of ag. waste could replace 26 billion scf of natural gas

Current Major Initiatives

Name of Initiative	Description	Status
1. Combined heat and power and distributed energy resources technologies	Develop and demonstrate innovative, efficient and cost-effective CHP technology Develop low-emissions technology CHP applications Utilize alternative fuels with low carbon intensity such as biogas, flared gas and natural gas	Several recently completed and on-going projects at different stages, e.g. near completion of emission control and biogas for fuel cell; completed designs and conducting field tests
2. Hybrid generation and fuel flexible DG/CHP/CCHP	Integrate emerging multiple DG/CHP/CCHP technologies and fuel flexibility, in diversified applications	Solicitation released in Jan. 6; proposals due on Feb. 29th

Looking Forward (Potential R&D Focus)

Localized Efficient and Advanced Power and Heat Systems (LEAPS)

- Accelerate deployment of advanced CHP systems in industrial, commercial, institutional and other new areas
  - Advanced CHP/CCHP in industrial, commercial and institutional applications, such as food processing, manufacturing , retail, hotels and hospitals
  - Local renewable resources to augment NG fired heating and power systems, such as wastewater from processing industry or local waste treatment facilities
  - CHP for waste heat and gas from industrial sources
  - CHP applications for associated gas – such as those produced from oil and gas fields in LA basin--- and other low-BTU gas

Innovations to further refine and improve CHP/CCHP

- Improve integration of CHP/CCHP systems with buildings and industrial processes
- Develop and demonstrate Smart Grid readiness
- Address renewable intermittency, example is through hybrid generation systems
- Improve efficiency and reduce emissions through advanced technologies

Questions

- Which technologies, systems, or components should R&D prioritize to address some of the barriers to the deployment of CHP?
- What are some emerging technologies that may be able to address the cost issues associated with CHP?
- Should RD&D be focused on renewable and fuel-flexible CHP to better help achieve the climate change and renewable portfolio standard goals?
- What issues, if any, impede the deployment of CHP into utility territories and how can RD&D help to make CHP beneficial to both the utilities and customers?
- What other future research direction, strategies or initiatives may be recommended so that RD&D can better help accelerate CHP market deployment?