“Biomass CHP – How To” – An Introduction

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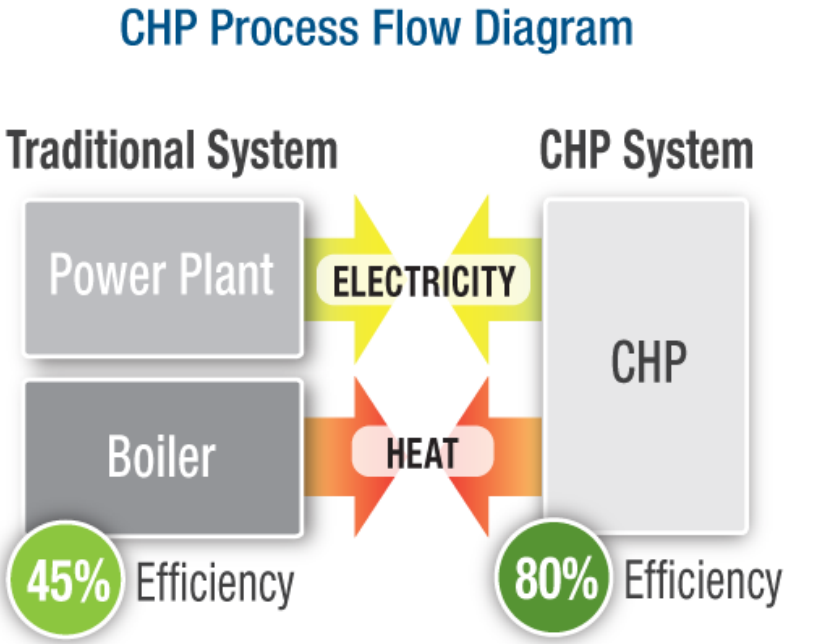
U.S. Department of Energy
Clean Energy Application Centers

What is Combined Heat and Power?

CHP is an *integrated energy system* that:

- **Is located at or near a factory or building**
- **Generates electrical and/or mechanical power**
- **Recovers waste heat for**
  - **Heating**
  - **Cooling**
  - **Dehumidification**
  - **Process thermal needs**
- **Can utilize a variety of technologies and fuels**



CHP is a proven high-efficient alternative to separate power and thermal energy production

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Overview

- **Biomass feedstocks**
- **Different feedstocks require different CHP technologies**
  - **Woody biomass – steam turbine generators and gasifiers**
  - **Anaerobic digestion – biogas gensets, fuel cells**
- **Both CHP technology pathways use organic materials more efficiently than electricity generation alone**
- **Lessons learned from each technology pathway include environmental, economic development, emerging commercialization, and technology applications**

Feedstock Perspectives

- **Think creatively – What is available locally and where does it go?**
  - **Clean urban wood waste**
  - **Food waste**
  - **Avoid organic materials going to the landfill – Beyond Waste**
- **All biomass is local – Transportation costs can kill a project.**

  50-mile radius (rule of thumb maximum distance)
- **Biomass feedstocks – How reliable is the source? Price?**

  Due diligence is needed for a long-term supply contract.

  Do a biomass availability assessment.

Feedstock Perspectives (continued)

- **What if we lost the supply? How do we manage seasonal variation? Have alternatives.**
- **Feedstock competition is coming as bioenergy technology advances.**
- **What is the moisture content? It makes a difference in system design.**
- **What is the quality of the feedstock? Wood chips by hammermill or knife – avoid clogging of auger.**

Environmental Considerations

- **Think environmental concerns through early and deeply – there are a wide variety of concerns.**
  - **Examples: The Evergreen State College and Thurston County**
- **Compared to what? This is a basis for showing improvements.**
  - **Example: Nippon Paper**
- **Air emissions – biomass portion of boiler MACT**
- **Nutrient overloading of digestate liquid**

Environmental Considerations (continued)

- **Preserving soil health – do not over-harvest the biomass**
- **Solid waste avoidance – uses for the ash. What are the nutrients?**
- **Carbon footprint and greenhouse gas reductions**
  - **Biogenic carbon**
- **Water use and quality impacts**
- **Have very good factsheets to tell the story and lessons learned**

Technology: What Makes a Great Project?

A great wood waste CHP/district energy project has:

- **Proper sizing**
- **High energy efficiency**
- **Covered storage area for the feedstock**
- **Quality requirements for the feedstock**
- **Strong moisture reduction system**
- **Strong environmental controls and well-understood environmental improvements**
- **Effective heating and cooling**

Fuel Drying – Why?

- **Significantly improves the efficiency of the boiler or gasifier.**
- **For boiler:**
  - **5% to 15% improvements in efficiency**

    (Boiler is not an efficient dryer, so dry fuel before it goes to the boiler.)
  - **50% to 60% more steam production**
- **Improves combustion**
- **Reduces air emissions**
- **See *Biomass Drying and Dewatering for Clean Heat & Power*, 2008, available from www.northwestcleanenergy.org (documents→CHP technology)**

Waste Heat Recovery for Drying Wood Waste

Heat recovery is key to a cost-effective dryer project.

- **Recover flue gas of power boiler or gasifier**
- **Recover heat from other waste heat sources**
- **Recover heat from dryer exhaust**

Design a complete CHP system, including:

- **Feedstock drying**
- **Waste heat recovery**

What Makes a Great Anaerobic Digestion CHP Project?

- **Maximizes revenue streams**
- **Uses co-digestion: It can flip the economics positive**

  Some co-digestion feedstocks are amazing producers of biogas
- **Has a proper design for the climate zone and solids content of the feedstock – good emerging technology**
- **Scrubs the biogas – major importance**
- **Strong O&M support**

Anaerobic Digestion Economics

A moving target – maximize co-products

Dairy example – 10 potential revenue streams

- **Power**
- **Green/renewable power adder (RECs)**
- **Carbon credit due to lagoon shutdown (methane reduction pathway)**
- **Digested fiber with proper pH balance and nutrients (peat moss alternative)**
- **Nitrogen fertilizer**
- **Phosphorous fertilizer**
- **Remaining liquid is excellent fertilizer**
- **Tipping fee for food processor waste**
- **Co-digestion increases biogas production**
- **Waste heat for greenhouses**

Biogas Scrubbing

Wide variety of biogas mixtures – methane content, chemicals and water:

- **Siloxanes – very hard on engines**
  - **Landfill gas and WWTF biogas**
- **Hydrogen sulfide – can the sulfur be used elsewhere in the system?**
- **Know your biogas**

Conclusion

- **Economic advantage – make your own power for on-site use or sell it/wheel it**
- **Long-term feedstock supply is crucial**
- **A long-term power purchase agreement is helpful**
- **Quality design is essential**
- **Use the feedstock efficiently**
- **BIOMASS CHP – A WINNER!**

Biomass/Biogas CHP Project Profiles

PROJECT PROFILE

Cooley Dickinson

500 KW BIOMASS CHP Plant

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Site Description

Cooley Dickinson Hospital in Northampton, MA is a 600,000 square-foot hospital with 140 in-patient beds that has been in operation for 125 years. The facility has a central energy plant which provides electricity, heat and cooling for the hospital campus. The hospital facility has a 12 month consistent heat load for heating, absorption chilled water, food preparation and centralized sterilization. Cooley Dickinson has operated a Zurn - 550 HP biomass boiler with wet scrubber emissions control since 1984. In 2006, an AFS - 600 HP Water/Fire Tube high pressure boiler was installed. To take advantage of the higher pressure steam supply, two 250KW Carrier Energent Micro Steam Turbines and a 680 Ton Absorption Chiller were added to the energy plant in 2009. One of the turbines reduces the steam pressure from 250 psig to 75 psig for distribution thought the hospital. The second turbine reduces the steam pressure from 75 psig to 15 psig for use in the absorption chiller.

Quick Facts

LOCATION: Northampton, MA
FUEL: Virgin Wood Chips
MAX CAPACITY: 500 KW
POLLUTION CONTROL: Multiclone separator and Baghouse
ENVIRONMENTAL BENEFITS: 99.5% particulate removal
AVERAGE CAPACITY FACTOR: 90 %
IN OPERATION SINCE: 2006
EQUIPMENT: AFS – 600 HP Water/Fire Tube Boiler with 2, 250KW Carrier Energent Micro Steam Turbines
USE OF ELECTRICAL ENERGY: Displaces loads previously supplied by the local utility

Reasons for Installing CHP

The motivation for installing the second Wood Chip plant in 2006 was a 120,000 sq ft hospital expansion project and to improve reliability and add redundancy to the existing 20 year old wood boiler. The second wood boiler also eliminated the need to burn oil during the 1-2 months of maintenance downtime each year. In 2009, The hospital implemented a formal energy conservation program which included the installation of the turbines to lower their operating costs The CHP plant is equipped with emissions controls meeting state requirements in accordance with the issued Air Permit. The Two micro-steam turbines reduce the hospitals 2,000 KW peak load by 350 KW (17.5%) and produce approximately 2,000,000 KWH of electricity per year (12.5%). The plant has a utility approved electrical interconnect allowing power generation in parallel with the electrical grid.

New 600HP AFS Boiler

Loading and Screening Equipment

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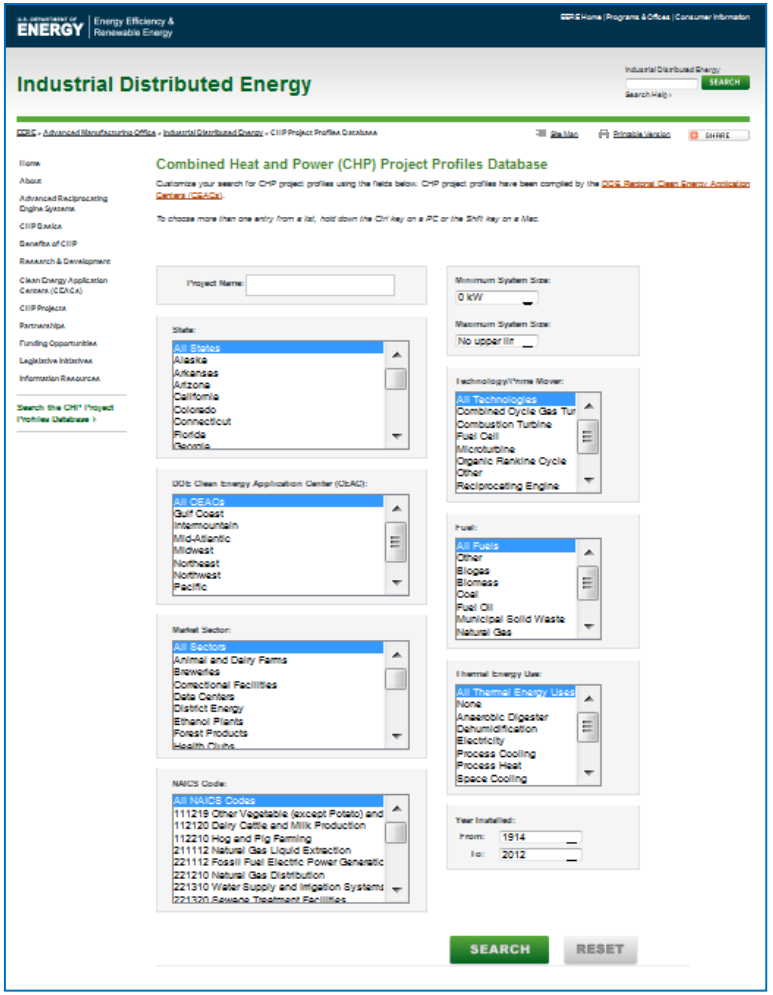
CEACs compile select CHP Project Profiles to inform and connect



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Search the CHP Project Profiles Database

Combined Heat and Power (CHP) Project Profiles Database

Customize your search for CHP project profiles using the fields below. CHP project profiles have been compiled by the DOE Regional Clean Energy Application Centers (CEACs).

To choose more than one entry from a list, hold down the Ctrl key on a PC or the Shift key on a Mac.

Project Name:

States: All States, Alaska, Arkansas, Arizona, California, Colorado, Connecticut, Florida, Georgia

DOE Clean Energy Application Center (CEAC): All CEACs, Gulf Coast, Intermountain, Mid-Atlantic, Midwest, Northeast, Northwest, Pacific

Market Sector: All Sectors, Animal and Dairy Farms, Breweries, Correctional Facilities, Data Centers, District Energy, Ethanol Plants, Forest Products, Health Clubs

NAICS Code: All NAICS Codes, 111219 Other Vegetable (except Potato) and, 112120 Dairy Cattle and Milk Production, 112210 Hog and Pig Farming, 211112 Natural Gas Liquid Extraction, 221112 Fossil Fuel Electric Power Generatic, 221210 Natural Gas Distribution, 221310 Water Supply and Irrigation Systems, 221320 Sewage Treatment Facilities

Minimum System Size: 0 kW
Maximum System Size: No upper lir

Technology/Prime Mover: All Technologies, Combined Cycle Gas Tur, Combustion Turbine, Fuel Cell, Microturbine, Organic Rankine Cycle, Other, Reciprocating Engine

Fuel: All Fuels, Other, Biogas, Biomass, Coal, Fuel Oil, Municipal Solid Waste, Natural Gas

Thermal Energy Use: All Thermal Energy Uses, None, Anaerobic Digester, Dehumidification, Electricity, Process Cooling, Process Heat, Space Cooling

Year Installed: From: 1914 To: 2012

SEARCH RESET

National Database on DOE AMO site

http://www1.eere.energy.gov/manufacturing/distributedenergy/chp_projects.html

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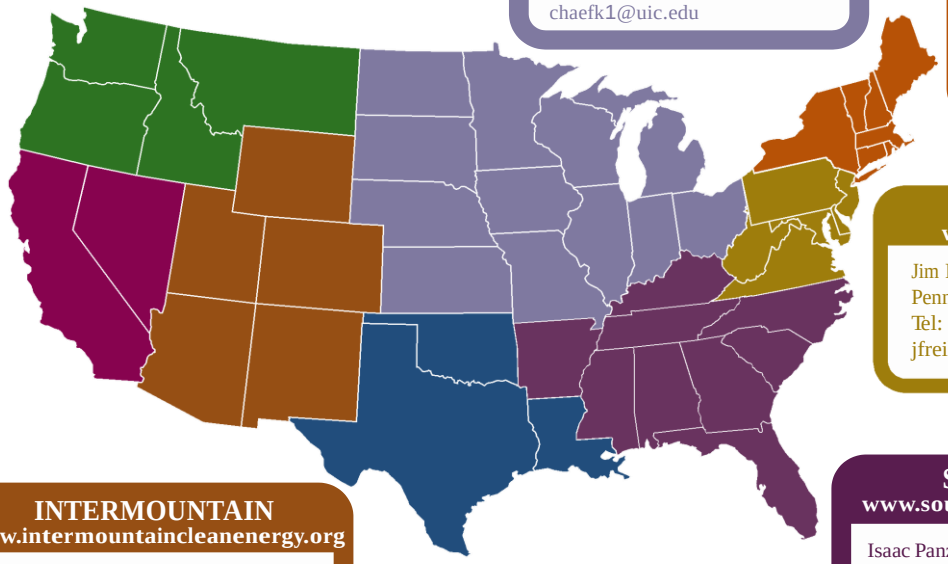

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