CHP in the United States

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US EPA Combined Heat and Power Partnership

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Presentation Overview

- EPA and Clean Energy
- CHP Capacity – Existing and Potential
  - District Energy and CHP
- Market Incentives and Challenges
- Case Studies

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EPA & Clean Energy

- EPA's regulatory & non-regulatory efforts are helping transform markets for cleaner sources of energy
- EPA is using flexibility in the regulatory process to support the use of clean energy options as part of an overall GHG reduction strategy
- EPA has many active programs supporting clean energy
  - CHP Partnership
  - Green Power Partnership
  - ENERGY STAR Program
  - State and Local Climate Energy Program
  - Re-Powering America's Lands
  - Global Methane Initiative

EPA & CHP

- CHP's unique role in:
  - Protecting public health and welfare
  - Addressing climate change
- CHP is a key supply-side energy efficiency resource
- Advances will help address key challenges:
  - Lowering the cost of reducing GHG emissions and other air pollutants
  - Increasing clean energy generation
  - Improving electricity system reliability

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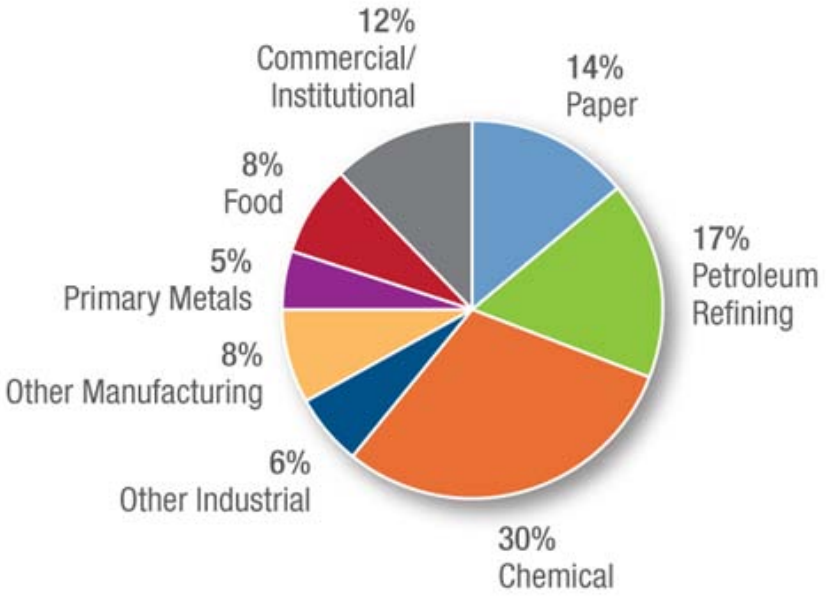
CHP is an Important Domestic Resource



Source: ICF CHP Installation Database, 2011

- 82 GW of installed CHP at almost 4,000 industrial and commercial facilities (2011)
- Avoids more than **1.8 quadrillion Btus** of fuel consumption annually
- Avoids **241 million metric tons of CO_2** as compared to traditional separate production
- CO_2 reduction equivalent to eliminating **forty 1,000 MW coal power plants**

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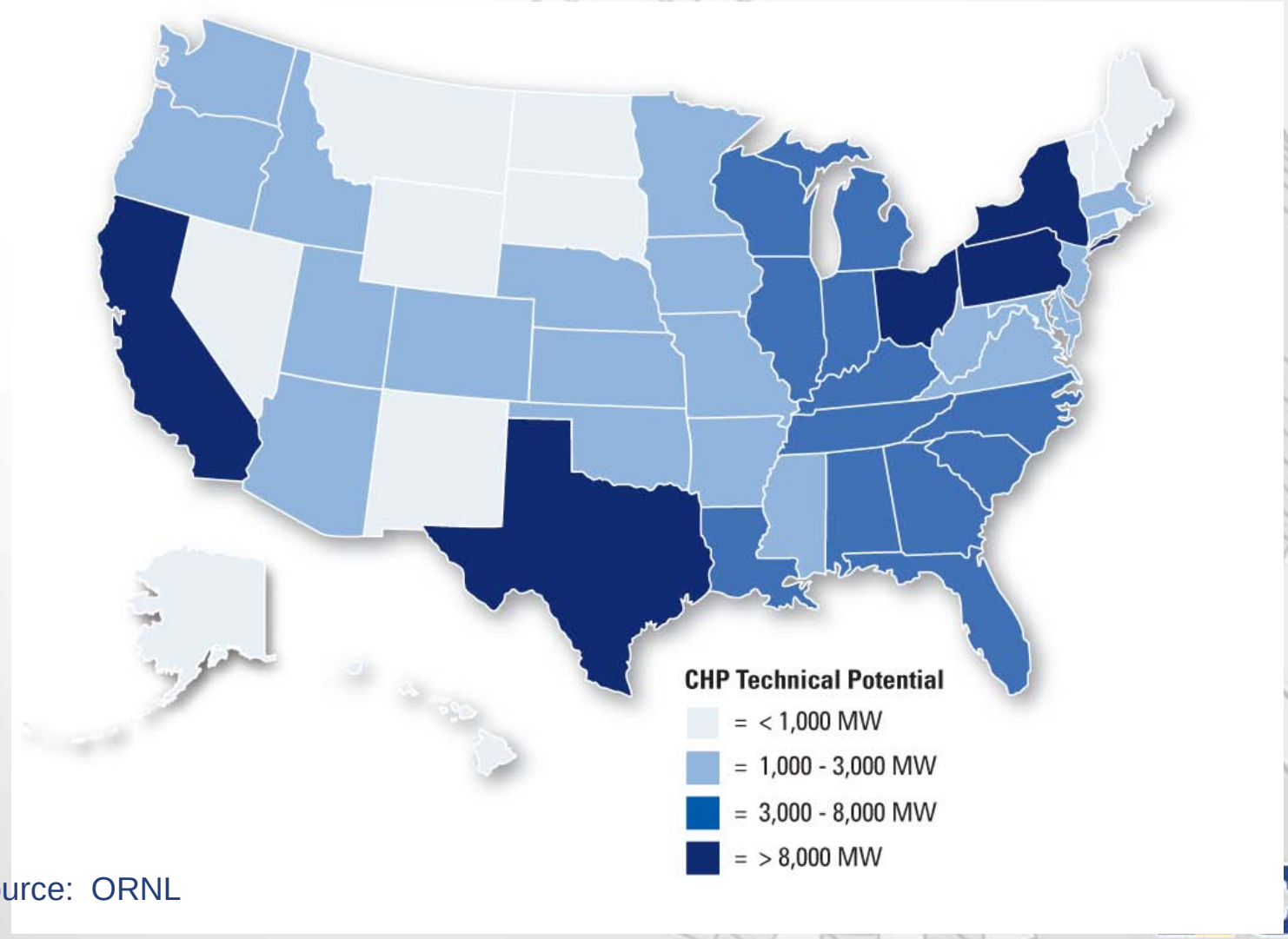
Potential for Additional CHP Is Nationwide



Source: ORNL

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CHP Technical Potential

- LBNL (2005): 95 GW
  (unconventional CHP)
- EEA (2006): 135 GW
- HR Report 110-304 (2007): 60 – 90 GW
- McKinsey (2007): 175 - 200 GW
- DOE/ORNL (2008) 170 – 250 GW

Source: EEA/ICF International

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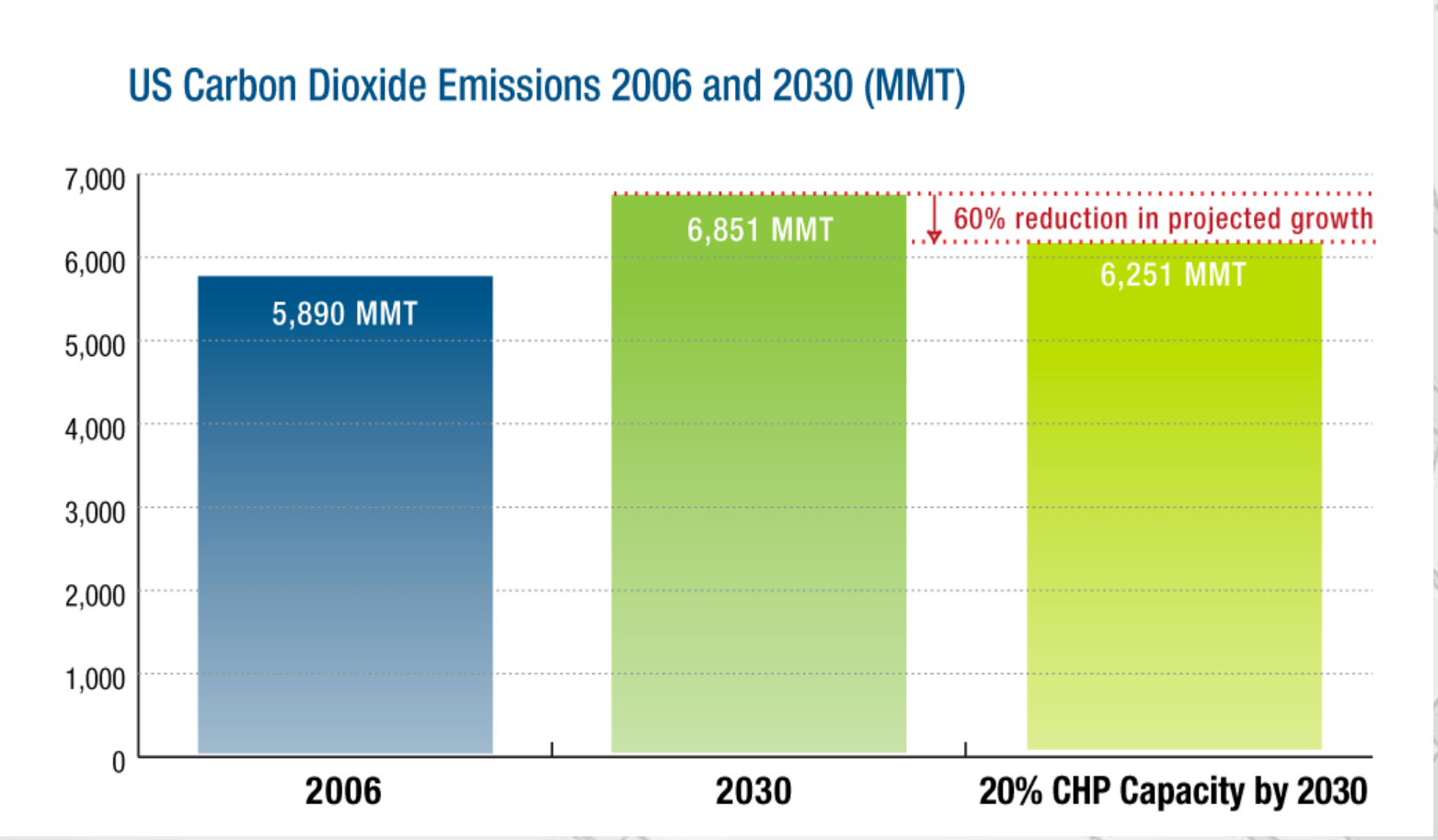
20% CHP Could Reduce Projected CO_2 Emissions Increase by More than 60%



Source: ORNL

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CHP Value Proposition

Category	10 MW CHP	10 MW Wind	10 MW Natural Gas Combined Cycle
Annual Capacity Factor	85%	34%	70%
Annual Electricity	74,446 MWh	29,784 MWh	61,320 MWh
Annual Useful Heat	103,417 MWh	None	None
Footprint Required	6,000 sq ft	76,000 sq ft	N/A
Capital Cost	$20 million	$24.4 million	$9.8 million
Cost of Power	7.6 ¢/kWh	7.5 ¢/kWh	6.1 ¢/kWh
Annual Energy Savings	316,218 MMBtu	306,871 MMBtu	163,724 MMBtu
Annual CO_2 Savings	42,506 Tons	27,546 Tons	28,233 Tons
Annual NOx Savings	87.8 Tons	36.4 Tons	61.9 Tons

Source: ICF International, prepared for the EPA CHP Partnership

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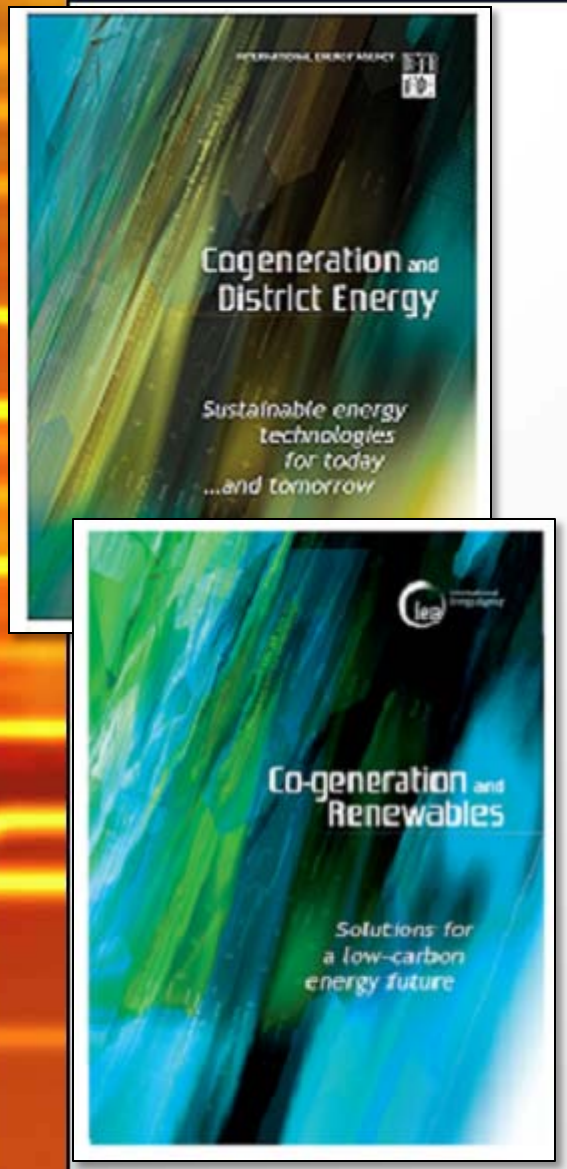
District Energy & CHP



- EPA & IEA recognize district energy is a key to increased CHP use
  - District energy can support increased CHP and increased renewables
    - biomass, geothermal, and concentrating solar
- Low-carbon electricity & heat
  - Offers an opportunity to reduce the carbon content from thermal energy production
- Reduces the cost of GHG reductions from generation of both electricity and thermal energy

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U.S. Policy Environment

- Lacking comprehensive federal climate & energy policies
  - No price on carbon
- EPA is addressing GHG emissions
  - Regulatory & non-regulatory means
- States and regional efforts continuing
  - Electric utility portfolio standards for RE and EE
  - Regional carbon cap and trading programs
- Evolving playing field for new electricity generation
  - Natural gas reserves
  - Biomass emissions permitting

Current Market Conditions

- Most activity in states with favorable regulatory treatment and/or specific incentives
- Natural gas CHP in areas with supportable spark spread (Northeast, Texas, California)
- Biomass and opportunity fuels in Southeast, Midwest and Mountain
- “Hot” applications: universities, hospitals, waste water treatment, other institutional applications
- Growing interest in waste heat to power applications
- Project inquiries increasing

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Incentives to System Adoption

- Developing standard interconnection rules.
- Implementing reasonable utility rates such as standby rates, backup rates, and exit fees.
- Developing incentive programs for CHP in clean energy funds.
- Include CHP/waste heat recovery in renewable portfolio standards and energy efficiency portfolio standards.
- Establishing output-based emission regulations and incorporating other efficiency measures into state implementation plans.

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Continuing Challenges to CHP Adoption

- Capital requirements
- Project and operational risks
- Lack of awareness and limited management support
- Pricing distortions
  - Interconnection requirements
  - Standby rates and exit fees
- Site permitting and environmental regulations

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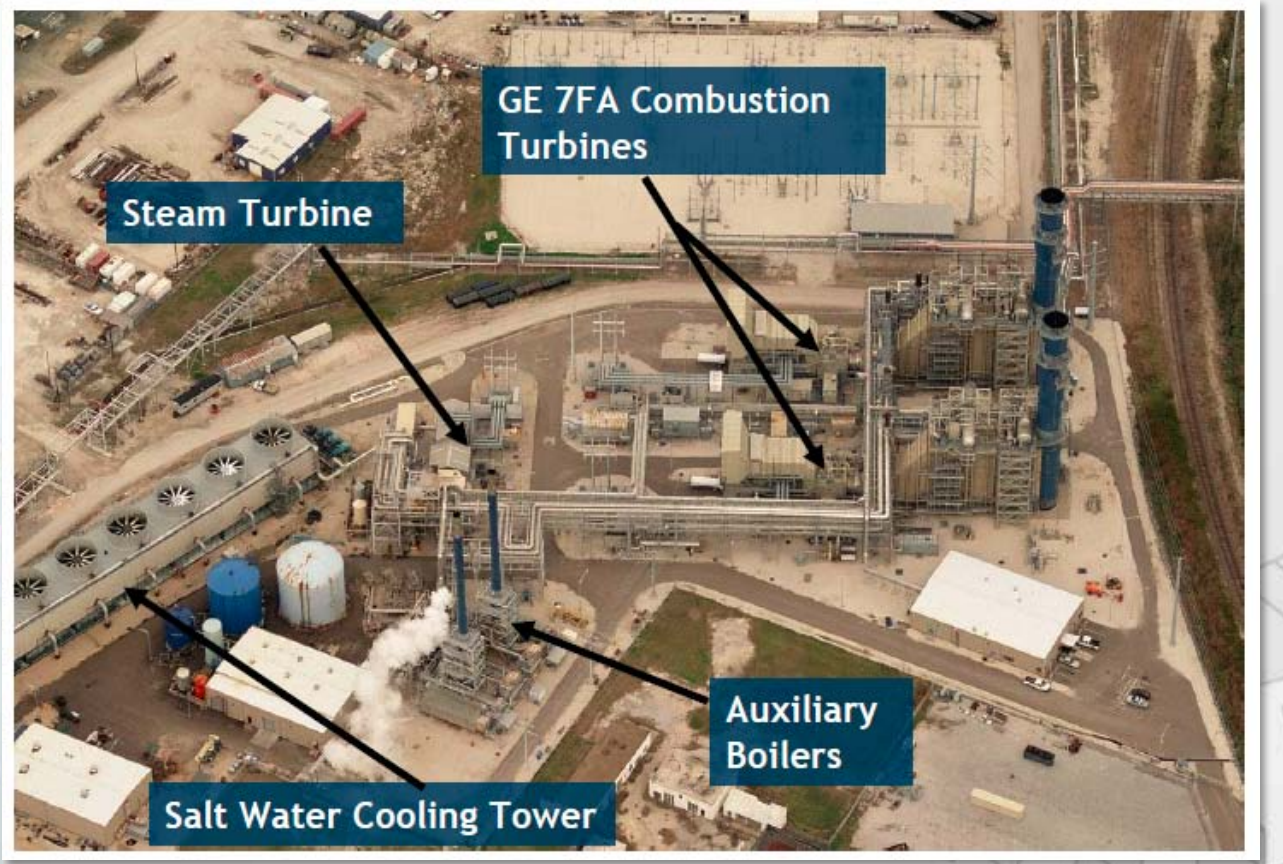
Case Study: Industrial Application

Calpine Corpus Christi Energy Center, Texas



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Calpine Corpus Christi Energy Center System Background

- Plant Location: Corpus Christi, Texas
- Operation Commenced: 2002
- System Location Statistics:
  - Footprint: nine-acre Brownfield site
- System Operating Features-
  - Natural gas fired systems
  - 500 MW combined cycle CT facility
  - Large multi-fuel duct firing capacity
  - Shared services from multiple hosts: 20 year power and steam sales agreements in place
  - Saltwater cooling tower
  - Incremental peaking capability
- More details can be found at: http://www.calpine.com/power/

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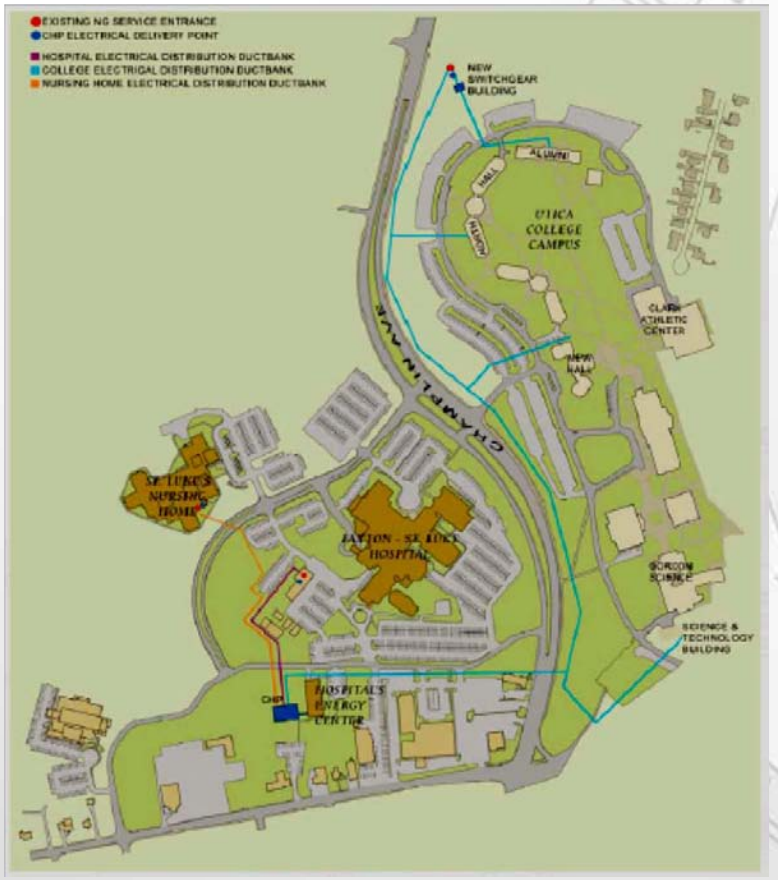
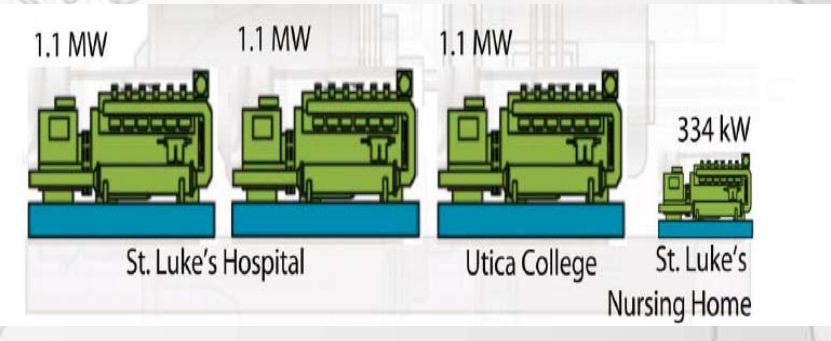
Case Study: Commercial/Institutional Application

Burrstone Energy Center Plant





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Burrstone Energy Center Plant System Background

- Plant Location: Utica, NY
- Operation Commenced: 2009
- System Statistics:
  - $15 million plant that provides annual $800,000 energy savings
  - Co-operative effort by Faxton-St. Luke's Healthcare and Utica College.
- System Operating Features-
  - Natural gas fired systems
  - 3.6 MW four engine generators
  - Each engine includes a heat recovery steam generator (HRSG) as well as heat exchangers to transfer heat from the engine jacket water to meet hot water loads in the hospital.
  - Steam from the HRSG offsets boiler steam loads, including summertime loads for a steam-driven absorption chiller.
- More details available with: Jim Moynihan (jmoynihan@cogenpowertechnologies.com)

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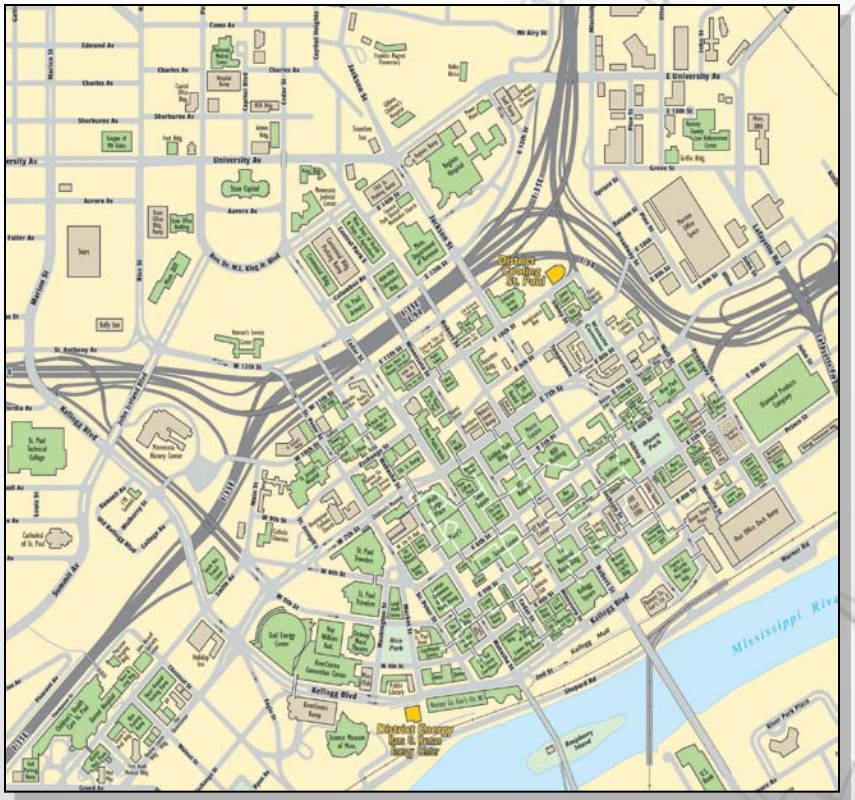
Case Study: District Energy Application

District Energy St Paul



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District Energy St Paul System Background

- Plant Location: St Paul, MN
- Operation Commenced: 2003 (CHP system)
- System Statistics:
  - Serves more than 80 percent of the downtown area - over 31 million sq. ft
  - CHP integration shifted fuel use for system away from fossil fuels to primarily renewable fuels
  - A public/private partnership among the City of Saint Paul, State of Minnesota, U.S. Department of Energy and the downtown business community
- System Operating Features-
  - Wood residue, natural gas, low-sulfur Eastern coal, and fuel oil
  - A CHP plant adjacent to District Energy produces 25 MW of electricity for the local utility and 65 megawatts of thermal energy for customers.
  - Greenhouse gas CO_2 reduced by 280,000 tons per year
- More details available at: http://www.districtenergy.com/services/heatingfacts.html

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CHP Partnership Contact Information

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