7.3 Combined Heat and Power

Part Two: Clean Energy Strategies for Local Governments							
6.0 Energy Efficiency	**7.0 Energy Supply**					**8.0 Transportation**	**9.0 Urban Planning and Design**
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7.3.1 Overview

Combined heat and power (CHP), also known as cogeneration, refers to the simultaneous production of electricity and thermal energy from a single fuel source. CHP systems can significantly reduce a facility's energy use by decreasing the amount of fuel required to meet the facility's electrical and thermal base loads. This reduction in energy use can produce a number of benefits, including energy cost savings, reduced greenhouse gas (GHG) emissions, and other environmental impacts, especially when renewable fuel sources are used.

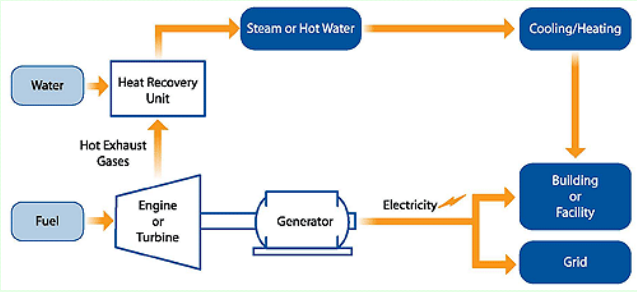
CHP systems are a type of distributed generation (also referred to as distributed energy and distributed energy resources), because they involve non-centralized, often small-scale, projects. Distributed generation offers significant benefits, such as reduced risk of energy supply disruption, lower transmission and distribution losses, and reduced peak electricity demand on the grid. CHP systems produce the same benefits as typical distributed generation projects, but have the added benefit of increased energy efficiency (U.S. EPA, 2002).

CHP System Configurations

CHP systems consist of three primary components: the unit in which the source fuel is combusted, the electric generator, and the heat recovery unit. CHP systems are differentiated by a "prime mover," the device used to convert fuel (e.g., natural gas, biomass, biogas, coal, waste heat, and oil) into electricity.

The most common CHP system configurations use gas turbine or steam turbine prime movers. A CHP system with a gas turbine generates electricity by combusting a fuel (often natural gas or biogas) and using a heat recovery unit to capture the byproduct heat. Gas turbine configurations are most compatible with large industrial or commercial CHP applications that require large quantities of heat and power. The graphic below demonstrates how a typical gas turbine CHP system is configured.

Unlike the gas turbine configuration, which produces heat as a byproduct of electricity generation, CHP systems with steam turbines generate electricity as a byproduct of steam production. Steam turbine configurations are most compatible with industrial facilities where solid fuels (e.g., biomass) feed the boiler.



Source: U.S. EPA, 2007.

This section provides information on how local governments have planned and implemented activities to increase use of CHP in local government facilities and throughout the community. It includes an overview of CHP system benefits, costs, sources of funding, and case studies. Additional examples and information resources are provided at the end of this section in Table 7.3.1, *Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources.*

7.3.2 Benefits of Combined Heat and Power

CHP systems can achieve higher system efficiencies than conventional separate heat and power (SHP) systems that obtain their power and heat from different sources, such as central coal-fired power plants and onsite natural gas heating systems. Fossil-fueled power plants, for example, generally achieve a total system efficiency of approximately 33%, meaning 67% of the energy used to generate electricity is lost, often vented as heat. A typical heat-generating boiler system achieves a total system efficiency of between 75% and 85%. If a facility were to obtain its electricity through the grid from a fossil-fueled power plant and its thermal energy from an on-site boiler, the overall efficiency would be approximately 49%.[1] By utilizing thermal energy that would otherwise be wasted in the power generation process, CHP systems can achieve total system efficiencies of approximately 75%, or a 50% improvement in overall efficiency (U.S. EPA, 2007b). The higher efficiency of CHP systems compared to SHP systems can help local governments and their communities to:

- *Demonstrate leadership.* Using CHP systems at local government facilities can be an effective and visible way of demonstrating environmental and fiscal responsibility to the public. Installing CHP systems at facilities that are frequently visited by the public can lead to greater community awareness of local government leadership and the benefits of clean energy.

Methods for Calculating CHP System Efficiency

Two efficiency metrics are used to compare CHP systems to SHP systems:

- *Total system efficiency* is the more commonly cited efficiency metric. Presented as a percentage, it refers to the sum of the useful power output (in MW) and useful thermal outputs (in BTU/hr) divided by the total fuel input (in BTU/hr).
- *Effective electric efficiency* refers to the electricity output divided by the additional fuel the CHP system uses over and above what would have been used by a conventional system to meet the facility's thermal energy load. This approach accounts for the multiple outputs of CHP and allows for a direct comparison of CHP and conventional electricity production by crediting that portion of the CHP system's fuel input allocated to thermal output, thus measuring how effectively the CHP system generates power once the thermal demand of a site has been met.

Both efficiency metrics consider all the outputs of CHP systems and reflect the benefits of CHP. However, since each metric measures a different performance characteristic, the purpose and calculated value of each type of efficiency metric differs. For example, the total system efficiency is typically most appropriate for comparing CHP system energy efficiency to the efficiency of a site's SHP options. The effective electric efficiency is typically used to compare the CHP system to conventional electricity production (i.e., the grid).

- In general, a CHP system's total system efficiency exceeds its effective electric efficiency by 5% to 15%.

Source: U.S. EPA, 2007c.

South El Monte, California, has installed a CHP system with a 70 kW microturbine prime mover at its popular community pool facility. The system provides electricity to the pool facility, the city hall, and the local community center, while the byproduct heat is captured for use at the pool facility and the city hall. The system saves the city nearly $34,000 annually net of all maintenance and fuel costs (PowerHouse, Undated).

[1] This calculation assumes that 64% of the facility's total input fuel is used to produce electricity, with the remaining 36% of the input fuel used to produce heat. See http://www.epa.gov/chp/basic/efficiency.html for more information on the efficiency benefits of CHP technologies.

- *Hedge against financial risks.* The higher efficiencies of CHP systems relative to SHP systems translate into significant energy cost savings. A CHP system, for example, can consume up to one-third less energy than an SHP system depending on total system efficiencies (U.S. EPA, 2007b).[2] The cost of generating a specified quantity of electricity in a facility that uses CHP can therefore be lower than the average retail price for electricity.[3]

  The CHP system installed at the Essex Wastewater Treatment Facility in Essex Junction, Vermont generates electricity for as low as 2.46¢/kWh, which has reduced the facility's electricity costs by 37% (Energy Vortex, Undated).

  The East Bay Municipal Utility District Wastewater Department, which serves seven San Francisco Bay communities, is saving approximately 40% on energy costs by using a CHP system fueled by methane from a wastewater treatment facility. The CHP system provides between 40% and 50% of the electricity needed to power the facility (EBMUD, 2001).

Efficiencies of Different CHP Systems

Not every CHP system operates at the same total system efficiency. Total system efficiency typically depends on the prime mover used. The most common prime movers include:

- Steam Turbine: 80% efficiency
- Diesel Engine: 70%-80% efficiency
- Natural Gas Engine: 70%-80% efficiency
- Gas Turbine: 70%-75% efficiency
- Mircroturbine: 65%-75% efficiency
- Fuel Cell: 65%-80% efficiency

Sources: U.S. EPA, 2007; 2007b.

  In addition, because CHP systems require less fuel to produce the same output as SHP systems, they can help reduce local government susceptibility to risks associated with volatile energy prices. Local governments can achieve additional protection from volatile energy prices by siting CHP projects where biomass (e.g., wood and agricultural wastes) or biogas resources are in close proximity. Using renewable fuels means that the cost of operating CHP systems can remain stable even as fossil fuel prices fluctuate. In addition, using biomass or biogas as a fuel source provides a use for material that would often be wasted otherwise (U.S. EPA, 2007f).

EPA CHP Emissions Calculator

The EPA CHP Emissions Calculator can be used to compare anticipated emissions from a CHP system with those from an SHP system. The calculator, which provides estimates for emissions of CO_2, SO_2, and NO_x, is designed for users with at least moderate familiarities with CHP technologies.

http://www.epa.gov/chp/basic/calculator.html

  An example of a local government that has mitigated energy costs and reduced susceptibility to price volatility is Winnebago County, Wisconsin, where the county has installed a 1.06 MW and 4,700 MBtu/hr landfill gas-fueled CHP system to provide energy to the local sheriff's office. The county estimates that it saves between $50,000

[2] Based on a 5 MW natural gas-fired combustion turbine CHP system (U.S. EPA, 2007b).

[3] The average retail price of electricity is approximately 9¢/kWh (as of May 2007) (EIA, 2007).

and $100,000 in annual energy costs due to the volatility of natural gas prices (Winnebago, 2007).

- *Reduce greenhouse gas (GHG) emissions and other environmental impacts.* Because CHP systems require less fuel to produce the same energy output as SHP systems, CHP systems can reduce emissions of GHGs and air pollutants, such as NO_x and SO_2. For example, a 5 MW CHP system with a natural gas turbine typically produces 23 kilotons of CO_2 emissions annually, while an SHP system designed to achieve the same output would produce 49 kilotons (U.S. EPA, 2007f).

  The CHP system at the sheriff's office in Winnebago County, Wisconsin reduces the county's annual CO_2 emissions by 46 metric tons (including direct emission reductions from preventing methane emitted from the landfill from escaping to the atmosphere and indirect emission reductions from avoiding use of fossil fuels) (Winnebago, 2007).

- *Increase economic benefits through job creation and market development.* Investing in CHP systems can help stimulate local, state, and regional economies. Demand for raw materials and for construction, installation, and maintenance services can create jobs and develop markets for CHP technologies (NECHP, 2006). According to the Department of Energy (DOE), approximately 60% of the cost of energy efficiency investments goes to labor costs. In addition, half of all energy-efficient equipment is purchased from local suppliers (U.S. DOE, 2004).

- *Offset Capital Costs.* CHP systems can offset capital costs that would otherwise be needed to purchase and install certain facility components, such as boiler and chiller systems in new construction (U.S. EPA, 2007g). In addition, installing CHP systems with back-up capability can enable a local government to avoid having to purchase a conventional back-up electricity generator. A typical back-up diesel generator (with accompanying controls and switchgear) can cost as much as $550 per kW capacity (U.S. EPA, 2007d).

- *Increased Electricity Reliability.* CHP can offer increased electricity reliability, which can be critical for institutions that are particularly vulnerable to power disruptions, such as hospitals and schools. In addition, using CHP to generate electricity on-site avoids the need to rely on non-CHP back-up generators.

  During the New York City blackout in the summer of 2003, half of the city's hospitals that used non-CHP back-up generators experienced failures (U.S. EPA, 2007d; ORNL, 2003).

- *Energy System Benefits.* In addition to providing reliability benefits to the CHP system owner, using CHP systems can improve the overall reliability of the electricity grid by reducing peak load and thus reducing the risk of blackouts (U.S. EPA, 2007d).

7.3.3 Energy Supply Measures

CHP systems can provide energy to be used in several applications, including power for facility operations and waste-heat recovery for facility heating, cooling, dehumidification, and other

processes (U.S. EPA, 2007). Several types of facilities can be strong candidates for CHP systems, including:

- *Wastewater Treatment Facilities.* CHP systems are very compatible with wastewater treatment facilities that use anaerobic digesters. Anaerobic digesters produce a continuous flow of biogas that can be used as a fuel source. In addition, anaerobic digesters have a heat load small enough to be met by most CHP systems. As of May 2008, CHP systems were in operation at 105 wastewater treatment facilities in the U.S., accounting for 465 MW of electric capacity. Seventy-five of these sites are fueled by biogas generated at the facility, for a total of 210 MW (U.S. EPA, 2006).

  Santa Cruz, California installed a biogas-fueled CHP system to replace an outdated 650 kW generator for its city wastewater treatment facility. The new system, which includes 850 kW and 500 kW generators, saves the city $20,000 monthly (Santa Cruz, 2003).

Gresham, Oregon – CHP at a Wastewater Facility

A 395 kW CHP system was installed at the 20 million gallon per day wastewater treatment plant in Gresham, Oregon in 2005. The system, which is fueled using byproduct gas from the anaerobic digestion of sewage (consisting of 60% methane and 40% CO_2), provides more than 50% of the plant's electricity needs in addition to providing a substantial amount of the plant's heat. Annual energy cost savings are estimated to be approximately $200,000.

Source: Energy Trust, 2006.

- *Landfill Gas Energy (LFGE) Projects.* Landfill gas (LFG), which consists of approximately 50% methane and 50% CO_2, can be captured at municipal solid waste (MSW) landfills and used as a fuel source for CHP systems. LFG is generated in landfills continuously; it typically has a heating value of 500 Btu per standard cubic foot (scf), but values can range from 350 Btu per scf to 600 Btu per scf (U.S. EPA, 2007i). The economics of an LFGE project (i.e., a project or facility that captures LFG for fuel use) improve the closer the landfill is in relation to the end-user.[4]

  In Burlington County, New Jersey, a developer is generating electricity using LFG from the county's landfill. The county leases the facility to the developer, which operates four 30 kW microturbines, and sells the electricity and waste heat to nearby Rutgers University (Simon et al., 2007).

In addition, LFG can be a green power source. Local governments can sell LFG to LFGE energy project developers while retaining the environmental and technological attributes associated with the green power in the form of renewable energy certificates. For more information on landfill gas, see *Section 7.4, Landfill Methane Utilization.*

- *K-12 Schools.* A number of schools around the country are using CHP systems to reduce energy costs and improve energy supply reliability.

[4] The piping distance from an LFGE project to its end-user is typically less than 10 miles, although piping LFG up to 20 miles can be economically feasible, depending on gas recovery at the landfill and energy load at the end-use equipment (U.S. DOE, no date given).

In Antioch, Illinois, the local high school is meeting 100% of its electricity and heating requirements using an LFG-fueled CHP system. In 2002, the school partnered with an LFG energy project developer to build an LFG collection system with twelve 30 kW microturbines. The $1.9 million project is saving the school $100,000 in energy costs annually (RMT, 2008).

- *Multi-family Housing.* Many local governments partner with private and not-for-profit organizations to develop multi-family affordable housing. Through these affiliations, local governments can encourage developers to use CHP systems in multi-family housing units.[5] In some local governments, public housing authorities have taken the initiative of installing CHP systems in the facilities they manage.

  In 1998, the Danbury, Connecticut Public Housing Authority installed a 60 kW CHP system at Wooster Manor, 100-unit multi-family residential building. The power generated by the gas-fueled CHP system meets 60% to 70% of the building's load, while the captured heat provides for 100% of the building's hot water and 50% of its space heating needs. The housing authority received a 10-year, $275,000 loan to finance the project, and pays $10,000 annually in maintenance contract fees. The project has reduced the building's annual energy costs by approximately 50%, saving the housing authority $40,000 annually (U.S. HUD, Undated).

  HUD CHP Screening Tool

  The Department of Housing and Urban Development (HUD) has developed a tool to determine the potential for CHP systems in multi-family housing. Users enter twelve months of energy use data, which the tool uses to calculate the potential savings and payback period from using a CHP system instead of obtaining heat and power separately.

  http://www.hud.gov/offices/cpd/library/energy/software.cfm

- *District Energy Systems*. In a district energy system, steam, hot water, or chilled water is generated at a central plant and then piped to many facilities throughout the district. District energy systems reduce energy consumption and capital costs by eliminating the need to install chillers and boilers in individual facilities. District energy systems can incorporate CHP systems into their configuration, leading to greater energy efficiency (IDEA, 2007; IDEA, 2007a; IEA, 2002).[6]

  St. Paul, Minnesota contracts with a private district energy provider to obtain hot water and cooling for many of its local government facilities. The district energy system relies on a 25 MW CHP system to generate energy. St. Paul has formed an agreement that allows the district energy provider to obtain approximately 300,000 tons of wood waste from the city's recycling center to be used to fuel the CHP system (St. Paul, Undated).

[5] The Department of Housing and Urban Development (HUD) has developed guidance materials for using CHP technologies in affordable housing. These materials, which include a question-and-answer guide, a feasibility screening guide, and a library of resources including case studies are provided at http://www.hud.gov/offices/cpd/library/energy/index.cfm and http://www.hud.gov/offices/cpd/energyenviron/energy/library/#chp.

7.3.4 Key Participants

Several participants are important to help mobilize resources and ensure effective implementation for CHP projects at local government facilities, including:

- *Mayor or County Executive.* The mayor or county executive can play a key role in increasing public awareness of the benefits of CHP. Including CHP goals in a mayor or county executive's priorities can lead to increased funding for CHP potential studies and/or projects.

  In Boston, Massachusetts the mayor's Energy Management Board has been leading an effort to increase use of CHP in the city (Boston, 2008).

- *City or County Council.* Clean energy activities, including efforts to increase use of CHP, are often initiated by city and county councils. In many local governments, city or county councils must authorize large capital expenditures, such as purchasing CHP systems. Securing support from city or county council members can be important for ensuring that CHP initiatives receive the resources necessary to produce results.

  The Modesto city council approved a $126,100 contract with an engineering firm to assist in preparing the preliminary design report and RFP for a digester gas-fired cogeneration unit at the city's primary wastewater treatment plant (Modesto, 2006).

- *Local Code Enforcement Officials and Planning Departments*. In some local jurisdictions, older zoning, building, and fire codes can present barriers to CHP project permitting. Local governments can work with their code enforcement officials and planning departments to update codes to accommodate CHP projects (Virginia DEQ). Some local governments, such as Boston, Massachusetts and Epping, New Hampshire, have modified zoning ordinances to provide permitting incentives for CHP projects. Planning departments can also be responsible for developing local energy plans that can include CHP-specific goals and activities.

- *State Energy and Environmental Departments*. State energy offices can provide local governments with information resources and technical assistance in planning CHP systems for local government facilities.

  Energy offices in some states, such as Delaware, have sponsored informational seminars on CHP for key stakeholders, including local governments (Delaware, 2007).

  In Lancaster County, Pennsylvania, the county partnered with the Pennsylvania Department of Environmental Protection to install a 3.2 MW CHP system that uses methane produced at two local landfills (U.S. EPA, 2007h).

- *State Public Utilities Commissions (PUCs)*. Local governments can work with state PUCs to obtain information on connecting CHP systems to the electricity grid and to obtain information on funding opportunities available for CHP projects. Some state PUCs administer programs that provide financial incentives for distributed generation (DG) projects, including CHP.

In Connecticut, the state Department of Public Utility Control offers low-interest loans to retail energy customers that install distributed generation systems, including CHP (CDPUC, 2008).

- *Local Businesses.* Local governments can contract with local businesses to provide electricity or thermal energy generated by local government CHP systems, or to purchase the energy generated by a privately-owned CHP system.

  Lancaster County, Pennsylvania, for example, has partnered with a local dairy to provide the business with enough steam to offset 80% of its diesel fuel needs, resulting in significant GHG emission reductions (U.S. EPA, 2007h).

  In Cleveland, Ohio, the city is considering purchasing the electricity generated by a proposed privately-owned CHP system. The city is working with a local non-profit organization to review the plans for the proposed system to determine the arrangement's feasibility (GCBL, 2008).

- *Utilities.* Local governments can work with utilities to connect CHP systems to the grid. Connecting to the grid allows local governments to help meet electricity loads when demand exceeds the capacity of the CHP system, and can create opportunities for local governments to sell electricity to the utility when capacity exceeds demand and where state interconnection and net metering rules permit (see Section 7.3.7, *Implementation Considerations* for more information on selling excess electricity). Information on state interconnection and net metering rules, which determine whether and how a utility allows customers to connect to the grid, can be accessed through the EPA CHP Partnership Web site (http://www.epa.gov/chp/funding/regulatory.html). In addition, many utilities offer financial incentives for CHP projects through energy conservation programs.[7]

  A number of municipally-owned electric utilities, such Austin Energy in Austin, Texas and Victorville Gas and Electric Utilities in Victorville, California, are taking advantage of the efficiency benefits of CHP systems to provide customers with clean energy while reducing the utilities' operating costs (Burns & McDonnell, 2005 and VMUS, 2006).

- *Energy Service Companies (ESCOs).* Local governments can contract with ESCOs to purchase and install CHP systems and to obtain operations and maintenance services.

  Klamath Falls, Oregon, for example, has contracted with an ESCO affiliate of the local utility to maintain its CHP plant (PPM Energy, 2007).

[7] The Database of State Incentives for Renewable Energy provides access to a collection of utility incentives for CHP (http://dsireusa.org/index.cfm?&CurrentPageID = 2&EE = 1&RE = 0).

- *Non-Profit Organizations.* Local governments can work with non-profit organizations to obtain technical or financial assistance for implementing CHP-related activities.

  Milwaukee, Wisconsin received technical assistance from a non-profit organization, the Milwaukee School of Engineering, and an ESCO when installing a 60 kW CHP system at one of the city's office buildings (We Energies, Undated).

Cambridge, Massachusetts – Cambridge Energy Alliance

Cambridge, Massachusetts partnered with a non-profit foundation to create the Cambridge Energy Alliance, a community initiative, to invest over $100 million in clean energy projects over 5 years. The initiative will target energy efficiency and distributed generation projects, including CHP.

The city has established a goal for the initiative to reduce the city's annual energy use by approximately 10% and its annual peak energy use by approximately 15%. The city expects to save approximately $160 million over 10 years as a result of the investments, and to achieve GHG emission reductions of approximately 10% by 2011.

Source: Cambridge Energy Alliance, 2007.

7.3.5 Mechanisms for Implementation

Local governments use several mechanisms to promote CHP systems in local government facilities and throughout the community, including:

- *Local Planning Process.* A number of local governments have included goals for CHP in local planning documents.

  Chicago, Illinois committed to producing 1.5 billion kWh of electricity from CHP systems by 2010 in its 2001 *City Energy Plan.* In 2007, the city completed an initial assessment of progress toward achieving the plan's CHP goals and found that between 2000 and 2005, the city assisted in installing about 54 MW of CHP capacity at eight sites (Chicago, 2007; Chicago, 2008). For more information on Chicago's CHP development, see Section 7.3.9, *Case Studies.*

- *Modification to Zoning Ordinance*. Local governments can encourage using CHP systems by modifying zoning ordinances.

  Boston, Massachusetts adopted a Green Building Ordinance in January 2007 that applies to building that are new public and private construction of 50,000 square feet or greater. To encourage CHP, the city included an additional provision that awards an extra credit point for buildings that draw 10% of their total energy use from CHP systems (Boston, 2007).

- *Incentives for Other Private and Public Entities*. In addition to installing CHP systems at local government facilities, local

Epping, New Hampshire – Energy Efficiency and Sustainable Design Ordinance

In March 2007, the town of Epping, New Hampshire adopted a local energy efficiency and sustainable design ordinance. The ordinance requires new non-residential facilities to meet specific scores based on the size of the development (from 5 points for 0 to 5,000 square feet to 25 points for greater than 50,000 square feet). Points are awarded based on a rating scale that considers a facility design's compliance with a set of energy production and sustainable design requirements.

The ordinance awards points for facilities that incorporate CHP systems that have effective electric efficiencies of at least 25%, total system efficiencies of at least 65%, and meet at least 30% of the facility's base load. Compliance merits 10 points, while additional points (up to 15 total) are awarded for larger generation capacities or for combining multiple CHP systems.

Source: Epping, 2007.

governments can work with the private sector to encourage CHP systems in industrial manufacturing facilities, institutions, commercial buildings, and multi-family housing complexes (U.S. EPA, 2007). Local government activities to encourage CHP in the private sector include:

- *Financial Incentives.* A number of local governments offer financial incentives to local businesses and residents to install CHP systems at their facilities.

  In 2003, Chicago, Illinois organized a seminar to provide local hospital administrators with information on how CHP technologies can be applied cost-effectively at hospitals. The city followed this seminar with an offer to fund 50% (up to $5,000) of the cost of a CHP screening analysis to provide estimates of the costs, savings, paybacks, and internal rates of return for each participating hospital (Chicago, 2008).

- *Outreach.* Some local governments are encouraging local businesses to install CHP systems at their facilities through educational outreach.

  In Kauai County, Hawaii, for example, the local government has been offering technical workshops through its Energy Extension Service to advise local businesses of opportunities to use CHP systems (U.S. EPA, 2008b).

7.3.6 Implementation Considerations

Local governments have used a number of implementation approaches to enhance the benefits of CHP-related activities, including:

- *Assess local CHP potential.* Local governments can obtain assistance from a number of resources to help assess CHP potential. For example, EPA has developed a CHP Project Development Handbook that local governments can use as a guide throughout the five stages of developing a CHP project – from initial assessment to operations and maintenance (for more information on these stages, see the text box at right). Several local governments have hired consultants to assess local potential for government, commercial, and residential CHP systems.

CHP Project Development

Planning, installing, and operating CHP systems requires attention to multiple implementation issues. These issues can be addressed in five steps:

1. *Qualification Assessment*. At this early stage it is important to determine whether CHP is appropriate for the site in consideration. Diverse technical and economic factors need to be considered, such as electricity and thermal energy demand and source fuel availability.
2. *Level 1 Feasibility Analysis*. Goals at this stage include identifying project goals and potential barriers and quantifying technical and economic opportunities.
3. *Level 2 Feasibility Analysis*. Goals at this stage include optimizing CHP system design, accounting for capacity, thermal output, and operation needs. This stage should also involve final CHP system pricing and a determination of expected investment return.
4. *Procurement*. This stage involves selecting a qualified contractor or developer, financing the project, and ensuring and recording compliance with siting and permitting requirements.
5. *Operations and Maintenance*. This stage involves maintaining a CHP system so that it continues to provide expected energy savings and emission reductions.

The EPA CHP Partnership has developed tools and services, including a CHP Project Development Handbook, to assist with these CHP project development stages. Local governments can find these resources at the Partnership Web site (http://www.epa.gov/chp/project-development/index.html).

Source: U.S. EPA, 2007h.

San Francisco, California contracted for a study to evaluate CHP potential across the city. The study identified potential demand for CHP in the city, assessed CHP equipment supply in the region, and identified local installation concerns, such as site selection and permitting issues (San Francisco, 2007).

Santa Monica, California evaluated CHP opportunities as part of a larger analysis of clean energy options for a planned Energy Program (Santa Monica, 2003).

- *Choose whether to self-develop, purchase "turnkey," or involve partners.* Some local governments have chosen to self-develop CHP projects, hiring consultants to help plan and manage the design and construction process. This option can maximize financial returns to the local government, but involves more risk and requires significant personnel resources. Other local governments have purchased turnkey CHP systems that are planned, designed, and constructed by private developers. Local governments can also team with partners (e.g., an engineering firm) to develop the project and share financial returns (U.S. EPA, 2007j). The EPA CHP Partnership has developed a guidance document that provides information on determining whether to hire or partner with a developer, and how to select one that is qualified.[8]

  In Gresham, Oregon, the city used a design-build procurement process to develop a CHP system at the city's wastewater treatment facilities. This process integrated the design and construction phases of the project. The objective of this single-contractor approach was to ensure that the CHP system would operate as designed (Energy Trust, 2006).

- *Enter maintenance contracts.* CHP systems involve complex components. It is essential that these components are working as designed. Local governments can enter maintenance contracts with equipment manufacturers and ESCOs for regular maintenance and operations services on CHP systems (U.S. HUD, 2005).

  Millbrae, California, for example, incorporated provisions into an energy performance contract with an ESCO to have future maintenance and potential renovations performed on a new CHP system (Chevron, 2006).

- *Involve local planning departments.* Local government planning departments will often need to verify that CHP projects are consistent with local land use and zoning regulations. In some localities, special use permits might be required for the construction of CHP systems.

  The San Jose, California Department of Planning, Building, and Code Enforcement has developed a set of instructions for obtaining a special use permit to construct CHP systems (San Jose, 2008).

[8] See http://www.epa.gov/chp/documents/pguide.pdf.

- *Sell excess energy.* In states where interconnection and net metering rules permit, local governments can sell some or all of the electricity they generate from CHP systems.

  Winnebago County, Wisconsin earns between $400,000 and $500,000 annually from selling electricity generated by a 1.06 MW CHP system at the county sheriff's office to the local electric utility. The office retains the 4,700 MBtu per hour of thermal energy for space heating and domestic hot water (Winnebago, 2007).

Connecting to the Grid

Local governments can connect to the grid to obtain electricity to supplement the power produced by the CHP system, and to sell excess electricity to a local utility or provider. Interconnection rules vary by utility, but a number of states have adopted standardized rules that make interconnection more streamlined. The EPA CHP Partnership has developed a guidance document on permitting CHP projects that provides information on the steps involved in establishing interconnection, available at http://www.epa.gov/chp/documents/pguide_permit_reqs.pdf.

The Interstate Renewable Energy Council tracks state interconnection regulation activities. A table of these activities is available at http://www.irecusa.org/fileadmin/user_upload/ConnectDocs/December_2007_IC_Table.doc.

7.3.7 Costs and Funding Opportunities

CHP systems involve a significant financial commitment. Fortunately, many funding opportunities are available for purchasing and installing CHP systems. This section provides an overview of the costs associated with CHP systems and opportunities to manage these costs.

Costs

The actual cost of a CHP project varies depending on a number of characteristics, including who develops the project (i.e., the local government or a private developer as part of a "turnkey" arrangement), system capacity, availability and type of fuel, prime mover, and overall system configuration. A typical CHP system can cost $1,000 - $4,000 per kilowatt (kW) installed capacity (U.S. EPA, 2007g; CEC, 2007). In addition to the cost of purchasing and installing the system, a CHP project can incur other associated costs. Preliminary feasibility studies, for example, can range from $10,000 to $100,000 (U.S. EPA, 2007l). Operations and maintenance costs can range from $0.005 per kWh to $0.015 per kWh (U.S. EPA, 2007k). The U.S. EPA has a procurement guide that discusses various financing methods for CHP projects and can be found at: http://www.epa.gov/chp/documents/pguide_financing_options.pdf.

In addition, EPA's CHP Catalog of Technologies (http://www.epa.gov/CHP/basic/catalog.html) also provides info on cost and performance characteristics for 5 different CHP prime movers.

Funding Opportunities

Many funding opportunities are available to local governments to help finance CHP installations, including:

- *Performance Contracting.* Several local governments have used energy performance contracts to purchase, install, and maintain CHP systems. An energy performance contract is an arrangement with an ESCO that bundles together various elements of an energy-efficiency investment, such as installation, maintenance, and monitoring of energy-efficient equipment. These contracts, which often include a performance guarantee to ensure the investment's

success, are typically financed with money saved through reduced utility costs but may also be financed using tax-exempt lease-purchasing agreements.

Millbrae, California used an energy performance contract to install a CHP system at its wastewater treatment facility (see text box at right).

- *State Government Programs*. In addition to offering financial incentives for distributed generation (including CHP) projects and projects that use biomass/biogas (which many CHP systems are capable of doing), CHP qualifies as renewable energy in the renewable portfolio standards in 10 states. The most frequent state incentives include tax credits, rebates, and low-interest loans for CHP and biomass/biogas projects.

  An example of a state using financial incentives can be found in Connecticut: the state offers long-term low-interest loans of up to $150 million for distributed generation projects, including CHP, that generate between 50 kW and 65 MW capacity. The loans are made available through the state Clean Energy Fund or through two investor-owned utility conservation programs (U.S. EPA, 2007e).

  When the City of Albert Lea, Minnesota installed a CHP system at the municipal wastewater treatment facility, it received financial assistance from the Minnesota Department of Conservation, which provided $85,000 of the total installed cost of $250,000 (Albert Lea, 2005).

  In addition, California, Connecticut, and New Jersey have included CHP as a critical part of the states' energy strategy.

- *Federal Government*. Local governments can obtain financial assistance for CHP projects from the federal government. For example, under the Energy Policy Act of 2005, owners or operators of advanced power system technologies, including CHP systems, are eligible for rebates of 1.8¢ per kWh electricity generated, up to the first 10 million kWh produced in a fiscal year (U.S. EPA, 2008). The EPA CHP Partnership maintains a database of federal and

Millbrae, California – Energy Performance Contracting

Millbrae, California used an energy performance contract to install a 250 kW methane-fueled microturbine CHP system at its wastewater treatment facility. The ESCO also integrated a grease receiving station into the facility to receive waste grease from local businesses, providing the CHP system with an additional source of fuel. The city is saving $112,000 in energy costs by producing heat and power on-site and is receiving $152,000 annually in grease receiving fees. These savings are being used to pay for the system, which was installed at no up-front cost. This integrated system reduces the city's annual CO_2 emissions by approximately 1.2 million pounds.

Source: Chevron, 2006.

Antioch, Illinois – State Government Grant

When the Antioch, Illinois Community School District wanted to construct a $1.9 million LFG-fueled CHP system at the local high school in 2002, it looked to the state Department of Commerce and Economic Opportunity for assistance. Working with a project developer, the school district completed the requisite department applications. Through the Renewable Energy Resources Program, the department provided the school district with a $550,000 grant, which was supplemented with a revenue bond.

Source: RMT, Undated.

state financial assistance opportunities for CHP projects.[9] The EPA database also provides information on non-financial incentives, including favorable regulatory treatment.

- *Utilities.* Local governments can also obtain financial assistance to purchase and install CHP systems from some utilities. A number of utilities offer rebates for CHP systems.

  The East Bay Municipal Utility District, a publicly-owned utility that serves two counties in California, received a $900,000 rebate from an investor-owned utility through the state's Self-Generation Program. The municipally-owned utility used the rebate to offset the $2.5 million cost of a new 600 kW CHP system (EBMUD, 2006).

Combined Heat and Power Partnership Funding Database

CHP funding opportunities are offered by state, federal, and other entities, and take a variety of forms, including:

- *Financial incentives*, such as grants, tax incentives, low-interest loans, favorable partial load rates (e.g., standby rates), and tradable allowances, and
- *Regulatory treatment* that removes unintended barriers, such as standard interconnection requirements, net metering, output-based regulations, and environmental regulations.

The CHP Partnership Funding Database lists incentives applicable to CHP systems and biomass CHP systems, as well as other biomass and biogass projects. This information is presented by type of project (i.e., CHP and biomass/biogass) and incentive (i.e., financial incentives and regulatory treatment).

http://www.epa.gov/chp/funding/index.html

- *Non-Profit Organizations.* Local governments can often obtain financial assistance for CHP projects through non-profit organizations. A number of these organizations are focused on activities that promote clean energy.

  A non-profit teamed with Essex Junction, Vermont when the municipality wanted to install a $300,000 CHP system at its wastewater treatment facility. Essex Junction was able to obtain $45,000 from Efficiency Vermont, a state-run non-profit organization dedicated to improving energy efficiency in the state. Another non-profit contributed $10,000 to the project to be used to purchase renewable energy credits to offset the system's GHG emissions (Energy Vortex, Undated).

EPA's Combined Heat and Power Partnership Funding Database provide a valuable resource for identifying the most appropriate funding options (see text box on above).

7.3.8 Interaction with Federal, State, or Other Programs

Local governments can obtain information on developing CHP projects and about CHP systems in general through many federal, state, and other programs.

Federal Programs

- *U.S. EPA Combined Heat and Power Partnership*. The EPA CHP Partnership is a voluntary program that seeks to reduce the environmental impact of power generation by promoting the use of highly-efficient combined heat and power (CHP). The Partnership works with clean

[9] See http://www.epa.gov/chp/funding/index.html.

energy stakeholders from the private and public sectors to support the deployment of new CHP projects and to promote their energy, environmental, and economic benefits. CHP systems that require at least 5% less fuel than state-of-the-art SHP generation can qualify for the ENERGY STAR® CHP Award.

Web site: http://www.epa.gov/chp/

- *U.S. EPA Clean Energy-Environment State and Local Program*. This program assists state and local governments in their clean energy efforts by providing technical assistance, analytical tools, and outreach support. It includes two programs:

  - The *Clean Energy-Environment Municipal Network* provides a resource network that supports local governments' efforts to use clean energy strategies to advance their community priorities.

  - The *Clean Energy-Environment State Program* supports state efforts to develop and implement cost-effective clean energy strategies that achieve public health and economic benefits. Through this partnership program, EPA provides technical assistance tailored to states' needs.

  A key resource for both Clean Energy-Environment programs is the *Clean Energy Resources Database*, which provides planning, policy, technical, analytical, and information resources for state and municipal governments.

  Web sites:
  http://www.epa.gov/cleanenergy/
  http://www.epa.gov/cleanenergy/energy-programs/napee/resources/database.html (Clean Energy Resources Database)
  http://www.epa.gov/cleanenergy/energy-and-you/affect/index.html
  (environmental impacts of renewable energy technologies)

- *U.S. DOE Distributed Energy Program.* The DOE Distributed Energy Program focuses on developing small-scale modular technologies for on-site, grid-connected, or stand-alone energy generation and integrated energy systems, such as CHP. Local governments can access information on CHP technologies and financial opportunities for CHP and other distributed energy technologies through the program's Web site.

  In addition, DOE has established several regional CHP application centers (now referred to as Clean Heat and Power Centers) across the country. These centers can provide information on the benefits of CHP systems and project-specific support, including feasibility screenings and third-party reviews of vendor proposals.

  Web sites:
  http://www.eere.energy.gov/de/ (Distributed Energy Program)
  http://www.eere.energy.gov/de/chp/chp_applications/information_resources.html
  (CHP Applications Information Resources)
  http://www.eere.energy.gov/de/chp/chp_applications/chp_application_centers.html
  (Regional Application Centers)

- *Oak Ridge National Laboratory (ORNL) Cooling, Heat, and Power Technologies Program.* ORNL works with industry and the federal government to develop CHP technologies. The CHP Program can provide local governments with information resources on assessing site feasibility, evaluating CHP system benefits and performance, and capacity optimization.

  Web site: http://www.ornl.gov/sci/engineering_science_technology/cooling_heating_power/

- *Department of Housing and Urban Development (HUD).* HUD administers a number of programs intended to improve energy efficiency in the nation's public housing. Through these programs, HUD provides information on energy efficiency measures that can be implemented in multi-family developments as well as financial assistance available for local governments and public housing authorities. The HUD Office of Energy and Environment, for example, provides information on CHP systems in multi-family housing.

  Web site: http://www.hud.gov/offices/cpd/library/energy/index.cfm

State Programs

Some states have developed programs that promote CHP and other distributed generation technologies. Local governments can look to these programs for information resources on the benefits and applicability of CHP systems, as well as information on available financial assistance.

The California Energy Commission, for example, has developed a distributed energy resource guide that includes information on CHP systems, including cost ranges, efficiency performance estimates, relative strengths and weaknesses of CHP technologies, and lists of vendors (CEC, 2007).

The Massachusetts Technology Collaborative administers a distributed generation policy collaborative that provides local governments with assistance in developing distributed generation technologies, including CHP (MTC, 2007).

NYSERDA CHP Program

The New York State Energy Research and Development Authority (NYSERDA) CHP Program provides technical and financial assistance to energy customers for using CHP technologies. NYSERDA helps local governments gather data and assess energy trends to determine CHP project feasibility. From 2000 through 2006, NYSERDA assisted in the development of 100 projects that will produce a combined 100 MW of power when all projects become operational. As of December 2007, 30 projects had made their performance data available via NYSERDA's Web site http://chp.nyserda.org/home/index.cfm.

Source: NYSERDA, 2008.

Other Programs

- United States Clean Heat & Power Association (USCHPA). The USCHPA is a membership organization that encourages increased deployment of CHP technologies. The USCHPA has worked with EPA and DOE to develop a number of resources to address existing barriers to the development of CHP technologies. Local governments can access many information resources through the USCHPA Web site, including policies encouraging CHP, overviews of CHP basics, and several databases of CHP projects and resources.

  Web site: http://www.uschpa.org

- *Database of State Incentives for Renewable Energy*. A project of the North Carolina Solar Center and the Interstate Renewable Energy Council, DSIRE provides information on federal, state, and local incentives for renewable energy and energy efficiency projects, including tax credits, loans, and grants. The database also provides information on state and local regulations pertaining to renewable energy purchases and on-site renewable energy generation, including overviews of state and local net metering rules, renewable portfolio standards, and requirements for renewable energy use at public facilities.

- **Web site:** http://www.dsireusa.org/

7.3.9 Case Studies

The following two case studies describe CHP projects implemented at local government facilities. Each case study describes how the project was initiated, key project activities and features, and project benefits.

Chicago, Illinois – Cogeneration Program

Chicago, Illinois has established a goal of using CHP systems to generate 1.5 billion kWh of electricity annually by 2010. The city is implementing activities to increase the amount of CHP-generated electricity used in local government facilities and to identify opportunities to encourage CHP technology deployment in the private sector through incentives.

Profile: Chicago, Illinois

Area: 240 square miles

Population: 2.8 million

Structure: Chicago residents elect a mayor to a four-year term and 50 aldermen from each city ward to serve on the city council. The city's activities for promoting CHP are coordinated by the local Department of Environmental Protection.

Program Scope: The Department of Environmental Protection works with local businesses, organizations, medical facilities, and public entities to provide technical assistance and information on CHP technologies.

Program Creation Mechanism: The city's 2001 Energy Plan established a goal for 1.5 billion kWh of the city's annual electricity use to be generated using CHP technologies by 2010.

Program Results: Since 2000, the city has assisted in the installation of eight CHP systems, which offer a combined installed capacity of 54.4 MW.

Program Initiation

The 2001 Chicago Energy Plan included an estimate that the city's total electricity demand would increase by 20% by 2020 from 2000 levels, an increase of approximately 27 billion kWh. To address this increase in demand, the city established a number of clean energy goals, including a commitment to using CHP systems to generate 1.5 billion kWh of electricity annually by 2010 (Chicago, 2001; Chicago, 2007; Chicago, 2008).

Program Features

Beginning in 2000, the city has been implementing activities to increase the amount of electricity generated in the city from CHP systems. These activities have included:

- *Outreach to hospitals.* The city Department of Environmental Protection (DEP) has been working with the Metropolitan Chicago Healthcare Council and the American Society of

Healthcare Engineers to educate decision makers at local hospitals. This outreach has also involved providing technical assistance in evaluating CHP potential at hospitals and other healthcare facilities.

- *Technical assistance for private and public facilities.* DEP has been conducting feasibility studies for private businesses and public entities to evaluate the potential for CHP systems. Seven of these evaluations resulted in CHP system installations.

- *Case study development*. DEP has worked with the Midwest CHP Application Center to develop case studies of successful CHP projects throughout the city to encourage interested parties to invest in CHP systems.

- *Workshops and seminars.* DEP has been helping to coordinate CHP workshops and seminars for local businesses and organizations to provide information on CHP systems and advise them of DEP's activities.

- *Interconnection standards.* The city has worked with the Illinois Commerce Commission to establish statewide interconnection standards that will enable facilities with CHP systems to connect to the electricity grid, thereby creating the opportunity to earn revenues for excess power generated (Chicago, 2001; Chicago, 2007; Chicago, 2008).

Program Results

Between 2000 and 2005, the city assisted in installing a total of more than 54 MW of CHP capacity, at eight sites, including three educational facilities, several private businesses, the local VA hospital and two other medical facilities. These projects represent 42% of the total CHP capacity installed throughout the state of Illinois since 2000 (Chicago, 2001; Chicago, 2007; Chicago, 2008).

Web site:
http://www.cityofchicago.org/city/webportal/portalContentItemAction.do?contenTypeName = COC_EDITORIAL&contentOID = 536912225&topChannelName = HomePage

St. Paul, Minnesota – District Energy

District Energy is a private, non-profit, community based firm in St. Paul Minnesota that was incorporated to provide district heating and cooling to commercial and residential customers, including the local government. Since 2003, the local government has been working with the corporation to provide biomass fuel for a CHP system installed at one of District Energy's facilities.

Program Initiation

In 1978, the city was selected by DOE and the Minnesota Energy Agency for a feasibility study to evaluate the potential for a district hot water system. The study led to the incorporation of the District Heating Development Company, later renamed District Energy. In 1998, District Energy partnered with an affiliate to evaluate the potential for a biomass-fueled CHP system to be integrated into the district hot water system. The 25 MW CHP system, which is fueled by wood refuse obtained from local sources, was installed in 2003.

Profile: St. Paul, Minnesota

Area: 56 square miles

Population: 290,000

Structure: City residents elect a mayor and seven city council representatives to four-year terms. The city's CHP activities are incorporated into the energy efficiency and conservation component of the Sustainable St. Paul Initiative.

Program Scope: District Energy's services extend to more than 400 customers, including several downtown local government facilities.

Program Creation Mechanism: Efforts to develop a district energy system began in 1978, when DOE and the Minnesota Energy Agency conducted a local facility study for a district energy system. In 1998, a second study was conducted to evaluate the potential for integrating a biomass-fueled CHP system into the existing district energy system.

Program Results: Use of district energy technology and renewable sources translates into stable rates that are less susceptible to fluctuations in fossil fuel prices. In addition, using a biomass fuel source reduces the district energy system's GHG emissions by more than 280,000 tons annually.

Program Features

The district energy system in St. Paul includes a number of energy and environmental features, including:

- *Renewable fuel source.* The CHP system is fueled by wood waste biomass, which reduces District Energy's reliance on coal by 80%.
- *Contract with the city.* The wood waste that is used to fuel the CHP system is purchased from the city, which operates a wood recycling center. The city converts approximately 300,000 tons of wood waste into biomass fuel for the CHP system each year.
- *Enhanced efficiency.* By capturing waste heat, the CHP system achieves an overall efficiency that is nearly double the efficiency of obtaining heat and power separately.

A second district energy system, owned by the St. Paul Port Authority's Energy Park Utility Company, was installed in 1997 to provide heating and power to the Port Authority's Energy Park complex, which includes housing, industrial facilities, and retail establishments.

Program Results

Installing a CHP system has resulted in significant energy and environmental benefits for the city and its residents. Use of district energy technology and renewable sources of fuel have enabled District Energy to offer stable rates that are less susceptible to fluctuations in fossil fuel prices. In addition, using a biomass fuel source has reduced the district energy system's GHG emissions by more than 280,000 tons annually. Economically, the community benefits from the fact that the source of fuel for the CHP system is obtained from local sources (St. Paul, 2008; District Energy, 2008).

Web site: http://www.stpaul.gov/index.asp?NID = 501

Resources

Table 7.3.1 Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources	
Title/Description	**Web Site**
Examples of Combined Heat and Power Opportunities for Local Governments	
Albuquerque, New Mexico. Albuquerque uses a CHP system at its Southside Water Reclamation Plant that saves the city $70,000 in energy costs each month.	http://www.abcwua.org/content/view/91/80/
Antioch, Illinois. In 2003, a CHP system that utilizes twelve 30 kW generators and two heat exchangers was installed at the Antioch Community High School. The system saves the school $165,000 annually.	http://public.ornl.gov/mac/pdfs/factsheets/Antioch%20-%20Project%20Profile.pdf
Austin, Texas. Austin Energy, the municipally-owned utility in Austin, Texas, has added a CHP system to an existing district energy system at an industrial park.	http://www.burnsmcd.com/portal/page/portal/Internet/Content_Admin/Publications%20Repository/Others%20Link%20Repository/article-tecnicalpaper-AustinEnergysPackagedCHPSystem.pdf
Bergen County, New Jersey. The Bergen County Utility Authority operates a CHP system at its wastewater treatment facility. The authority serves 48 municipalities throughout the county.	http://www.caddet.org/public/uploads/pdfs/Brochure/r380.pdf
Boston, Massachusetts. Boston has passed a Green Building Ordinance that requires all new construction over 50,000 square feet to meet LEED certification. The ordinance awards extra credit for buildings that incorporate CHP systems.	http://www.masstech.org/renewableenergy/public_policy/DG/resources/2006-Boston-Zoning-Article37-ModernGrid.pdf
Brentwood, California. The city of Brentwood has installed a cogeneration system at its Family Aquatic Complex to heat swimming pools and to produce electricity for the facility. The system is expected to reduce the facility's energy costs by 50%.	http://www.ci.brentwood.ca.us/pdf/newsletters/summer2004/page6.pdf
Cheyenne, Wyoming. The Laramie County School District Number 1 in Cheyenne has installed 90 kW of electricity generating capacity at East High School to supply part of the school's power load and to light the football stadium. The waste energy will be captured and used to heat the Olympic-size swimming pool.	http://www.eere.energy.gov/state_energy_program/project_brief_detail.cfm/pb_id = 323
Chicago, Illinois. Chicago has committed to providing 1.5 billion kWh of electricity from CHP by 2010. As part of this initiative, the city is working with hospitals to encourage implementation of CHP systems.	http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?contentOID = 536912225&contenTypeName = COC_EDITORIAL&topChannelName = Dept&channelId = 0&programId = 0&entityName = Environment&deptMainCategoryOID = -536887205
Danbury, Connecticut. The Danbury Public Housing Authority has installed a 60 kW capacity CHP system at the Wooster Manor, a 100-unit affordable housing building.	http://www.hud.gov/offices/cpd/energyenvironment/energy/library/hudchpDanburyCt.pdf

Table 7.3.1 Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources	
Title/Description	**Web Site**
East Bay – San Francisco, California. The East Bay Municipal Utility District has installed ten 60 kW microturbines at a wastewater facility as part of a CHP system. The system's primary objective is to support the building's heating load.	http://www.chpcentermw.org/rac_profiles/pacific/EBMUD_v1_2.pdf
Elkhart, Indiana. The community-owned Elkhart General Hospital operates a 745 kW CHP system that provides domestic hot water to 700,000 square feet of the building, and well as up to 20% of the building's electricity needs, resulting in energy cost savings of approximately $12,000 monthly.	http://public.ornl.gov/mac/pdfs/factsheets/Elkhart%20Hospital.pdf
Essex Junction, Vermont. Essex Junction has installed a 40 kW CHP system at its wastewater treatment facility. The system has produced energy cost savings of 37%.	http://www.chpcentermw.org/rac_profiles/Northeast/Essex%2520Junction%2520Project%2520Profile.pdf
Evanston, Illinois. Evanston Township High School operates a 2.4 MW CHP system that provides cooling, heating, and electric service.	http://public.ornl.gov/mac/pdfs/casestudies/cs-ETHS030324.pdf
Honolulu, Hawaii. The city and county of Honolulu is exploring the option of installing CHP systems that use biogas at two new wastewater treatment plants. The City Hall has installed CHP equipment that will soon become operational.	http://www.epa.gov/chp/partnership/partners/citycountyofhonolulu.html
Gresham, Oregon. Gresham installed a 395 kW CHP system at the local wastewater treatment plant in 2005. The system produces over half of the plant's power needs and saves the city $166,000 annually.	http://files.harc.edu/Sites/GulfCoastCHP/CaseStudies/GreshamORWastewaterServices.pdf
Jersey City, New Jersey. The Jersey City Housing Authority has installed a CHP system at the Summit Plaza Complex. The system saves approximately 160,000 gallons of fuel annually.	http://rehabadvisor.pathnet.org/sf.asp?id = 863
Kauai, Hawaii. Kauai provides businesses with information on CHP systems through educational workshops.	http://www.epa.gov/chp/partnership/partners/countyofkauaienergyextens.html
Klamath Falls, Oregon. Klamath Falls sells electricity generated from its 500 MW CHP plant to municipal and public power entities.	http://www.ppmenergy.com/klamath.html
Lancaster County, Pennsylvania. Lancaster County has partnered with an ESCO, the state of Pennsylvania, and a local business to install a 3.2 MW landfill gas CHP system across two local landfills.	http://www.epa.gov/lmop/proj/prof/profile/lancastercountylfgenergyp.htm
Outagamie, Wisconsin. Since 1991, Outagamie County has operated a 2.6 MW CHP system at its landfill to convert landfill gas into electricity and heat for the county's solid waste and highway buildings. Excess electricity is sold to an energy provider.	http://www.co.outagamie.wi.us/county_executive/Press%20Releases/SW-Flare.htm
Palo Alto, California. The municipal electric utility in Palo Alto, an EPA CHP Partner, is evaluating opportunities to install a 3 MW to 5 MW CHP system at various candidate sites.	http://www.epa.gov/chp/partnership/partners/cityofpaloaltoutilities.html
Pima County, Arizona. The Pima County Wastewater Management Department has installed a 3.3 MW CHP system at the Ina Road Water Pollution Control Facility that has produced energy cost savings of greater than $1.2 million annually.	http://www.chpcentermw.org/rac_profiles/intermountain/Ina_Road.pdf

Table 7.3.1 Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources	
Title/Description	**Web Site**
Rochester, Minnesota. The Rochester Water Reclamation Plant captures biogas produced from wastewater treatment to fuel a combined heat and power system that provides 100% of the plant's short-term power needs.	http://files.harc.edu/Sites/GulfCoastCHP/CaseStudies/RochesterWaterReclamationPlant.pdf
St. Paul, Minnesota. St. Paul contracts with a private district energy provider to obtain hot water and cooling for many of its local government facilities. The district energy system relies on a 25 MW CHP system to generate energy. St. Paul has formed an agreement that allows the district energy provider to obtain approximately 300,000 tons of wood waste from the city's recycling center to be used to fuel the CHP system.	http://www.stpaul.gov/index.asp?NID=501
Salt Lake City, Utah. Salt Lake City has installed a CHP system at its municipal wastewater treatment facility. The system, which will produce approximately 16,000 kWh daily, will meet 60% of the facility's electricity demand. The recovered thermal energy will be used to heat water for the facility's four anaerobic digesters.	http://www.slcgov.com/utilities/NewsEvents/news2003/news552003.htm
San Diego, California. San Diego Metropolitan Wastewater Department operates methane-fueled CHP systems at three of its facilities. In addition, the city has been exploring opportunities for using landfill gas to fuel a CHP system to power facilities at Balboa Park.	http://www.sandiego.gov/environmental-services/energy/programsprojects/saving/cogeneration.shtml
San Francisco, California. San Francisco conducted a CHP potential study that evaluated the feasibility of using CHP technologies at a range of local facilities.	http://www.sfenvironment.org/our_programs/interests.html?ssi = 0&ti = 15&ii = 60
Santa Margarita, California. The Santa Margarita Water District has installed four 30 kW microturbines with a hot water generator at the district's water reclamation facility.	http://www.chpcentermw.org/rac_profiles/pacific/SantaMargarita_v1_2.pdf
Victorville, California. Victorville Municipal Utility Services owns and operates two CHP systems.	http://www.districtenergy.org/06AnnConfProceedings/4A2Haines.pdf
Virginia, Minnesota. The Department of Public Utilities operates a 30 MW cogeneration facility.	http://www.vpuc.com/electric.htm
Willmar, Minnesota. The Willmar Municipal Utility operates a district energy system that incorporates CHP technology.	http://www.cleanenergyresourceteams.org/westcentral/CS-Willmar%20Municipal%20CHP.pdf
Information Resources for Combined Heat and Power Opportunities for Local Governments	
The Benefits of Distributed Resources to Local Governments. This NREL report provides an overview of the local government benefits of investing in distributed generation, including CHP.	http://www.clean-power.com/research/distributedgeneration/DGandLocalGoverments.pdf
Calculating Reliability Benefits. This EPA CHP Partnership Web site provides information on how to calculate the reliability benefits of installing CHP systems as opposed to non-CHP back-up power generators.	http://www.epa.gov/chp/basic/benefits.html
Catalog of CHP Technologies. This EPA CHP Partnership manual provides an overview of multiple CHP technologies. It also provides information on the benefits and costs of CHP.	http://www.epa.gov/chp/basic/catalog.html

Table 7.3.1 Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources	
Title/Description	**Web Site**
CHP and Bioenergy for Landfills and Wastewater Treatment Plants. The Intermountain CHP Center held a workshop on CHP systems for municipal landfills and wastewater treatment plants in 2005. Links to presentations and papers are available.	http://www.intermountainchp.org/events/landfills/050811/default.htm
CHP Calculation Methodology for LEED-NC v2.2 EA Credit 1. This document provides guidance on accounting for CHP systems when using the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system for new construction.	https://www.usgbc.org/ShowFile.aspx?DocumentID = 1354
CHP Emissions Calculator. EPA has developed this tool to assist CHP project developers and policy makers in estimating the environmental benefits of installing CHP systems. The Calculator allows users to characterize a model CHP system by selecting attributes from several drop-down menus.	http://www.epa.gov/chp/basic/calculator.html
***CHP Guide #1: Q&A on Combined Heat and Power for Multi-family Housing*.** This Department of Housing and Urban Development (HUD) guide provides information to affordable housing administrators on the benefits of CHP for housing units.	http://www.hud.gov/offices/cpd/library/energy/pdf/chpguide1.pdf
CHP on Campus Online Guidebook. The International District Energy Association has developed this guidebook to demonstrate the feasibility of siting CHP projects.	http://www.districtenergy.org/guidebook/CHP.Webdoc.Homepage.htm
***CHP Project Development Handbook*.** Intended for CHP project developers and end-users, this is an easily accessible technical guide on streamlining the CHP project development process. It describes the technical and economic considerations for properly sizing CHP systems and lining up the resources to build a system.	http://www.epa.gov/chp/project-development/index.html
***CHP Screening Tool and CHP Guide #2: Feasibility Screening for Combined Heat and Power in Multi-family Housing*.** The HUD CHP Screening Tool was developed to evaluate combined cooling, heating, and power in multi-family housing. The HUD guide describes the screening tool and shows screens for the computer software.	http://www.hud.gov/offices/cpd/library/energy/ (Screening Tool) http://www.hud.gov/offices/cpd/library/energy/pdf/chpguide2.pdf (Guide)
Clean Energy-Environment Guide to Action. This EPA guide provides an overview of clean energy policies, best practices, and action steps for states. Local governments can use this resource to obtain information on CHP systems, benefits of CHP, and funding opportunities.	http://www.epa.gov/cleanenergy/stateandlocal/guidetoaction.htm
Clean Energy Resource Teams Clean Energy Manual. This manual was developed to identify opportunities for communities to promote and use clean energy. Chapter 10 describes opportunities for CHP systems and includes several case studies.	http://www.cleanenergyresourceteams.org/files/CERTsManualCh10.pdf
***Combined Heat and Power: An Emerging Technology*.** This ENERGY STAR article describes the energy, environmental, and economic benefits of using CHP technology.	http://www.energystar.gov/index.cfm?c = healthcare.ashe_nov_dec_2005

Table 7.3.1 Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources	
Title/Description	**Web Site**
Combined Heat and Power and Distributed Energy Resources: Summary and Synthesis of Regulatory and Administrative Impediments. This report was completed for the Virginia Department of Environmental Quality. It includes descriptions of regulatory, financial, and administrative barriers to CHP systems for local governments.	http://www.deq.virginia.gov/innovtech/pdf/ARI04.pdf
Combined Heat and Power: Capturing Wasted Energy. This ACEEE report provides a basic primer on CHP technologies and an overview of the benefits of CHP.	http://www.aceee.org/pubs/ie983.htm
Combined Heat and Power Partnership Funding Database. The EPA CHP Partnership maintains a database of funding opportunities available for CHP projects.	http://www.epa.gov/chp/funding/funding.html
Combined Heat and Power in the Gulf Coast Region: Benefits and Challenges. This report by the Gulf Coast CHP Applications Center provides an overview of benefits of and implementation barriers to CHP applications in the Gulf Coast.	http://files.harc.edu/Sites/GulfCoastCHP/Reports/GulfCoastCHPBenefitsChallenges.pdf
Combined Heat and Power Resource Guide. This guidebook was developed by DOE with assistance from its regional application centers to provide resources on CHP technologies and applications.	http://www.chpcentermw.org/pdfs/chp_resource_guide_2003sep.pdf
Cooling, Heating, and Power for Commercial Buildings Benefits Analysis. This DOE report provides a technical analysis of the benefits of CHP for commercial buildings. The report includes a determination of the optimum cost/performance tradeoff for microturbine-equipped CHP systems.	http://www.eere.energy.gov/de/pdfs/chp_benefits_commercial_buildings.pdf
Customer-Owned Utilities and Distributed Energy: Potentials and Benefits. This DOE report provides an overview of the potential for distributed energy technologies, including CHP for customer-owned utilities.	http://www.ornl.gov/~webworks/cppr/y2007/rpt/124344.pdf
Distributed Energy Case Study Database. DOE maintains this database of distributed energy projects, including CHP. Users can narrow database searches based on market sector, power size range, prime mover, thermal energy use, and fuel type.	http://www.eere.energy.gov/de/casestudies/
Distributed Energy Information Resources. This DOE Distributed Energy Program Web site provides numerous resources on distributed generation and CHP technologies, technologies, and market studies.	http://www.eere.energy.gov/de/publications.html
Distributed Energy Resources Guide. This California Energy Commission guide provides information on several distributed generation resources, including CHP. The guide provides information on costs, benefits, applicability, strengths, and weaknesses of CHP systems.	http://www.energy.ca.gov/distgen/equipment/chp/performance.html
***Distributed Generation Primer*.** This DOE report includes information on how local regulations can affect CHP systems.	http://www.casfcc.org/2/StationaryFuelCells/PDF/Distributed%20Generation%20Primer.pdf

Table 7.3.1 Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources	
Title/Description	**Web Site**
DOE CHP Applications Information Resources. DOE has compiled a collection of information resources on CHP applications that includes publications, presentations, and a "toolbox."	http://www.eere.energy.gov/de/chp/chp_applications/information_resources.html
DOE Regional Application Centers. DOE has established several regional CHP application centers to provide information on CHP technologies and to offer project-specific support to facilitate CHP deployment.	http://www.eere.energy.gov/de/chp/chp_applications/chp_application_centers.html
Experiences with Combined Heat and Power During the August 14, 2003 Northeast Blackout. This Oak Ridge National Laboratory report addresses the reliability benefits of CHP systems in light of the 2003 blackout, in which many non-CHP back-up generators failed at New York City hospitals.	http://www.ornl.gov/~webworks/cppr/y2001/pres/121715.pdf
Guidance on CHP Systems in LEED Rating Systems. This methodology provides information on how the benefits of CHP systems can be recognized under the energy requirements of the LEED rating system for new construction.	http://www.usgbc.org/ShowFile.aspx?DocumentID = 1384
High-Density Housing, Mega-Developments: An Assessment of Arizona and Nevada Comparing Central Power to a Distributed Energy Approach. This report assesses the relative contribution potential of distributed energy and CHP technologies for reducing energy costs and minimizing impacts on the environment resulting from energy generation in Arizona and Nevada.	http://www.eea-inc.com/natgas_reports/FinalMegaDevelopmentReport.pdf
HUD CHP Resources Library. The Department of Housing and Urban Development has collected several resources pertaining to CHP applications in housing, including CHP project profiles and PowerPoint presentations.	http://www.hud.gov/offices/cpd/energyenviron/energy/library/#chp
HUD CHP Screening Tool. The Department of Housing and Urban Development has created this tool to help housing administrators determine the feasibility of installing CHP systems at multi-family housing developments.	http://www.hud.gov/offices/cpd/library/energy/software.cfm
An Integrated Assessment of the Energy Savings and Emissions-Reduction Potential of Combined Heat and Power. This ACEEE paper provides an overview and a prospectus of U.S. deployment of CHP technologies across different sectors, such as buildings and district energy services.	http://www.cleanenergyresourceteams.org/pdf/CERTsCh10.pdf
International District Energy Association. The IDEA Web site provides information on district energy systems, which can often be configured to use CHP. IDEA maintains a list of CHP-related district energy resources.	http://www.districtenergy.org/DE_CHPResearch.htm#IEA%20Report%20Summaries
Landfill Gas As A Fuel for CHP. This paper describes opportunities to capture LFG from landfills and use it as a source of fuel for CHP systems in various applications.	http://www.energyvortex.com/files/Landfill_Gas_as_Fuel_for_Combined_Heat_and_Power.pdf
Monetizing Environmental Benefits. This EPA CHP Partnership Web site provides guidelines for calculating the monetary value of environmental benefits resulting from CHP systems as compared to SHP systems.	http://www.epa.gov/chp/funding/monetizing.html

Table 7.3.1 Combined Heat and Power Opportunities for Local Governments: Examples and Information Resources	
Title/Description	**Web Site**
Municipalities Fact Sheet. This EPA CHP Partnership Web site provides local governments with an introduction to CHP and guidelines to determine which facilities are good candidates for CHP.	http://www.epa.gov/CHP/markets/municipalities_fs.html
Municipal Wastewater Treatment Facilities. This EPA CHP Web site provides information on the compatibility of CHP systems with wastewater treatment facilities.	http://www.epa.gov/CHP/markets/wastewater.html
New Jersey Clean Energy Program: Combined Heat and Power. The New Jersey Clean Energy Program provides numerous incentives for CHP systems to customer, contractors, and energy service companies.	http://www.njcleanenergy.com/commercial-industrial/programs/combined-heat-power/incentives/incentives
Opportunities for CHP at Wastewater Treatment Facilities. This EPA guide describes the benefits of installing CHP systems at wastewater treatment facilities that have anaerobic digesters. It is intended primarily for facility operators and CHP project developers.	http://www.epa.gov/chp/documents/chp_wwtf_opportunities.pdf
Procurement Guide: CHP Financing. This EPA CHP Partnership guide provides an overview of financing strategies for CHP systems.	http://www.epa.gov/CHP/markets/wastewater.html
Public Buildings Manual. The National Association of State Energy Officials published this manual as a guide to state and local governments. The manual addresses financing, benchmarking, retro-commissioning, and CHP systems.	http://naseo.org/committees/buildings/documents/NASEO_Public_Buildings_Manual.pdf
Screening Sheet for CHP Applications. This EPA Web page provides a list of criteria that local governments can use to assess the appropriateness of installing CHP systems at their facilities.	http://www.epa.gov/chp/project-development/qualifier_form.html
State Opportunities for Action: Review of States' Combined Heat and Power Activities. This ACEEE report outlines current state activities pertaining to CHP systems, focusing on interconnection, emissions standards, and financial incentives.	http://www.aceee.org/pubs/ie022.pdf

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