COMBINED HEAT and POWER REPORT

July, 2010

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July 1, 2010

Honorable Barry J. Hobbins, Senate Chair
Honorable Jon Hinck, House Chair
Joint Standing Committee on Utilities and Energy
115 State House Station
Augusta, Maine 04333-0115

RE: Combined Heat and Power, Report July 2010

Dear Senator Hobbins and Representative Hinck:

The 123[rd] Legislature enacted "Resolve, To Encourage Renewable Energy and Energy Conservation in Maine."

As directed, the Governor's Office of Energy Independence and Security (OEIS) prepared the accompanying report to "examine opportunities for energy conservation through the reuse of waste heat and make recommendations for eliminating barriers to and creating incentives for the installation of systems that conserve energy through the reuse of waste heat." The report, "Combined Heat and Power, July 2010," also examines technical and policy issues and makes recommendations to encourage such systems.

The 124[th] Legislature enacted "Resolve, To Promote Cogeneration of Energy at Maine Sawmills." This report responds to the Resolve's request to the OEIS to examine and make recommendations regarding the concept of cogeneration energy zones to promote cogeneration at sawmills in the State.

If you have any questions regarding the report, please do not hesitate to contact us.

Sincerely,

John M. Kerry

PHONE: (207) 287-3292

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SPECIAL ACKNOWLEDGEMENTS

I would like to offer special thanks to Erika Lloyd, Project Manager of Woodard & Curran for overseeing, coordinating and drafting this report.

ACKNOWLEDGEMENTS

I would like to thank Paul Aubrey, President of Technical Support, Inc. & Self-Gen, Inc. for his role in drafting this report. Additionally, I also want to thank members of the Governor's Office of Energy Independence and Security for their assistance with this report, including Jennifer Puser (Deputy Director of Research and Legislation), Jeffrey Marks (Deputy Director of Policy and Planning), and intern Nik Rodrigues. Lastly, I would like to thank the stakeholder group for their participation, educational information sharing, stimulating discussions, and input for this report. In particular I would like to thank Ian Burnes, former Deputy Director of Policy and Planning and now with the Efficiency Maine Trust, for his help with this report and his initial involvement organizing the taskforce.

EXECUTIVE SUMMARY

The United States has become dangerously dependent on foreign energy sources that are warming the earth, damaging the environment, threatening public health, undermining our economic vitality, eroding national security and diminishing our quality of life. The State of Maine exports more than $5 billion dollars each year because of its inordinate dependence on foreign oil. State and national energy policies need to support clean, renewable and affordable energy sources; in addition, the United States and the State of Maine need to employ more energy efficient technologies such as Combined Heat and Power (CHP) to save money and to advance our environmental and economic goals. Accordingly, the Governor's Office of Energy Independence and Security believes that a public policy environment needs to be established to create public-private partnerships that enable the State of Maine to take the bold steps needed to employ technologies such as CHP to secure a reliable, affordable and clean energy future.

CHP is an efficient, clean and reliable integrated "systems" approach to generating power and thermal energy from a single fuel source. CHP systems can significantly increase a facility's operational efficiency, decrease energy costs and reduce greenhouse gas emissions that contribute to climate change. CHP provides onsite, distributed generation of electrical power; waste-heat recovery for heating, cooling or process applications; and integration of a variety of technologies and fuel types into a facility's infrastructure. The energy efficiency, renewable energy, reliability, environmental quality and economic development benefits of CHP make it an attractive option to meet the goals of the State of Maine Comprehensive Energy Action Plan.

CHP technologies are available for a wide range of applications and uses, including industrial manufacturers (pulp and paper); institutions (universities, hospitals, prisons); commercial buildings (hotels, office buildings, airports); municipalities (district energy systems, wastewater treatment facilities, schools); and residential (multi-family housing). Depending on the facility type and size, CHP projects can be designed according to required components (heat engine, generator, heat recovery and electrical connection); prime mover (gas turbine, micro-turbines, reciprocating engine, steam turbine, fuel cell); and fuel source (natural gas, biomass and bio-fuels, waste heat, oil).

While the benefits are apparent, the use of CHP faces barriers and has thus far been underutilized in the market. The primary hurdles include, but are not limited to, fuel infrastructure, utility rate designs and interconnection issues. Fortunately, federal, state and regional governments and organizations are developing information resources and advocating for legislative and regulatory initiatives that will support the CHP industry. These efforts include support for financial incentives and policy initiatives targeting CHP and waste energy recovery programs. Appropriations, tax credits, renewable and energy efficiency programs, climate change revenues, standard interconnection regulations and other proposals are circulating in policy arenas around the country.

State partnerships with energy consumers, the CHP and natural gas industries, the U.S. Department of Energy, municipalities and other stakeholders are essential to facilitate the development of new projects, policies and resources in Maine. The Maine Legislature and Governor should review and consider all potential options to promote financial and policy tools for CHP development, including tax incentives, regulatory incentives and market-based approaches. The result will be deployment of technologies that will increase Maine's energy security, foster environmental quality and provide economic development opportunities and jobs in Maine.

The Governor's Office of Energy Independence and Security (OEIS) recommends consideration of the following policies, initiatives and action items:

- Establishment of an interconnection stakeholder taskforce by the Maine Public Utilities Commission (MPUC) to review and further explore how to streamline the technical and economic guidelines or requirements in order to quickly move CHP projects forward throughout the State of Maine.
- Review and further exploration of cost shifting to rate payers associated with utilities' potential lost revenue from CHP projects. This analysis should quantify the cost shifting, explore whether these rates and charges are creating unwarranted barriers to the use of renewable CHP projects, examine alternative rate designs and quantify and compare the system-wide benefits that CHP may provide.
- Pursuit of a Maine Energy Independence Fund (MEIF) which is a proposed public-private partnership that would match a potential federal grant or loan one to one with private investments. Funds would be invested in small-to-medium sized clean energy projects and companies located in Maine. These funds would also help with the project development costs.
- Expansion of natural gas in Maine as recommended in the Maine Comprehensive Energy Action Plan to reduce dependence on oil.
- Support for Congressional Delegation and Administration activities on Federal energy initiatives that seek to strengthen renewable energy, energy efficiency and CHP policies and programs.
- Support for current legislative and regulatory advocacy for strong CHP policies and programs.
- Establishment of a DOE/Maine Memorandum of Understanding (DOE-Maine Clean Energy and Efficiency Partnership) to integrate national and state energy, environmental and economic policies into a cohesive and sustainable energy strategy.
- Implement Grants Connector program to connect Maine businesses, institutions and other entities with federal and state financial opportunities for CHP projects.
- Fully implement An Act Regarding Maine's Energy Future (LD 1485), putting Maine on a path to reduce statewide heating oil consumption 20% by 2020.

1. INTRODUCTION

1.0 INTRODUCTION

Maine is inordinately dependent on foreign sources of fossil fuels to heat and power its homes and businesses. The Maine Comprehensive Energy Action Plan provides the framework for state and local governments, businesses, factories, buildings and residences to invest in energy efficiency, conservation and renewable and alternative clean energy. To accelerate the transformative process from a state dependent on oil to one that develops and uses energy efficiency and renewable technologies, Maine must make available the financial, regulatory and policy support for CHP applications.

Maine is making recognizable positive strides in energy efficiency. According to the 2009 State Energy Efficiency Scorecard, Maine ranked tenth, moving up 9 spots and into the "top-ten" (ACEEE, Oct. 2009). The American Council for an Energy-Efficient Economy (ACEEE) State Energy Efficiency Score Card ranks and scores states on adoption and implementation of energy efficiency policies and programs based on six categories: (1) utility-sector and public benefits programs and policies, (2) transportation policies, (3) building energy codes, (4) combined heat and power, (5) state government initiatives, and (6) appliance efficiency standards. The "top-ten" states lead the country in energy efficiency through best practices in most of the six ranking categories. Maine moved into the 'top-ten" due to a variety of increased energy efficiency efforts, including adoption of building energy codes, land-use planning management, Efficiency Maine efforts, and other activities (ACEEE, Oct. 2009). Through the information and guidance provided in this report, the OEIS strives to transform Maine into a leader on CHP as well.

1.1 PURPOSE OF REPORT

The purpose of this report is to provide information and recommendations pursuant to:

- LD 2149 "Resolve, To Encourage Renewable Energy and Energy Conservation in Maine" from the 123rd Legislature; and
- LD 1044 "Resolve, To Promote Cogeneration of Energy at Maine Sawmills" from the 124th Legislature.

This report will clearly define the technical background and benefits related to combined heat and power and waste heat recovery, provide examples of existing CHP facilities in Maine, identify barriers and current incentives for the installation of CHP systems, and make recommendations pursuant to our directive.

1.2 DEVELOPMENT OF COMBINED HEAT AND POWER STAKEHOLDER GROUP

Pursuant to its directive, the OEIS convened a stakeholder group in June 2009, which consisted of representatives from various groups, including the Energy Resource Commission (ERC), MPUC, the office of the Public Advocate, representatives from the forest products industry and transmission and distribution utilities, project developers and engineering firms, industrial users, economic development entities, and environmental groups.

The stakeholder group met in July, August, September, and December of 2009. The meeting goals were to define the stakeholder group's terms and the group was charged with making recommendations for eliminating/overcoming barriers and creating incentives for the installation of systems that conserve energy through the reuse of waste heat. To lay the technical foundation and to promote discussions, relevant and informative presentations were given by the members of the stakeholder group during the meetings. Copies of these presentations can be found in Appendix A.

1.3 MEMBERS OF CHP STAKEHOLDER GROUP

The following is a list of members of the established CHP Stakeholder Group:

Manisha Aggarwal, TransCanada
Glen Albee, Hancock Lumber
David Allen, Central Maine Power
Cynthia Armstrong, Portland Natural Gas Transmission System
Paul Aubrey, TSI / Self-Gen
Kathy Billings, Bangor Hydro
Rick Buotte, Bureau of General Services
Bruce Bornstein, Isaacson Lumber Company
Ian Burnes, Efficiency Maine
Patrick C. Cannon, Maine Public Service
Dick Davies, Maine Public Advocate
Stacy Dimou, Consultant
Joel Farley, Eastern Maine Medical Center
Stacy Fitts, House Representative, District 29
Ken Fletcher, House Representative, District 54
Chip Gavin, Maine Bureau of General Services
Todd Griset, Preti Flaherty
Marylee Hanley, Maritimes Northeast
John Joseph, JAI Software
John Kerry, Governor's Office of Energy Independence and Security
Christopher J. Leblanc, Unitil
Gus Libby, Colby College
Jerry Livengood, Bangor Natural Gas
Erika Lloyd, Woodard & Curran
Angela Monroe, Maine Public Utilities Commission
Jeff Mylen, Eastern Maine Medical Center
Tyler Player, Maine Public Service
Darrel Quimby, Maine Natural Gas
Jim Robbins, Robbins Lumber INC
Steve Schley, Pingree Associates
Mike Smith, Unitil
Patrick Strauch, Maine Forest Product Council
Sharon Sudbay, Maritimes and Northeast Pipeline
Don Tardie, Maine Woods Company
Greg Thompson, Self-Gen
Mary Usavic, REPSOL

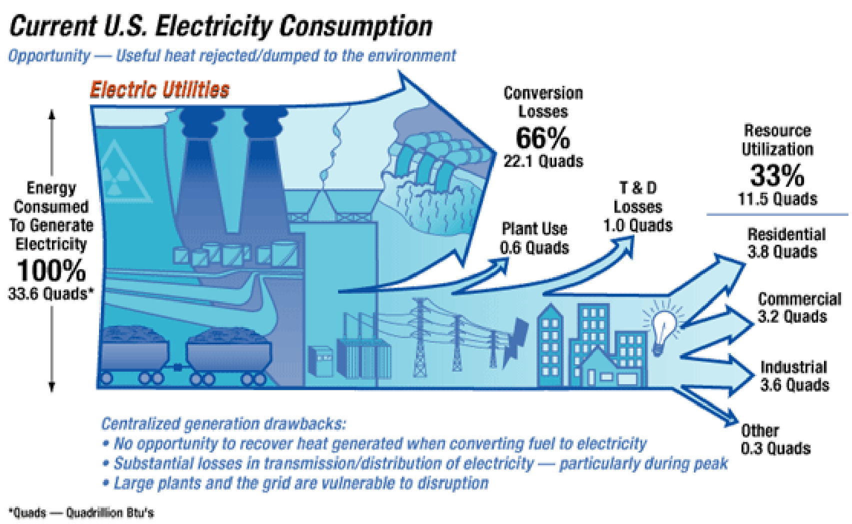
OEIS prepared this report with significant guidance and information provided by the CHP Stakeholder Group. However, while the report reflects the consensus of the CHP Stakeholder Group, some content and opinions expressed in the report may not reflect the positions of every Member of the Group.

2. COMBINED HEAT AND POWER

2.0 WHAT IS COMBINED HEAT AND POWER

CHP, also known as cogeneration, is a specific form of distributed generation (DG) which relates to the strategic placement of electric power generation units at or near customer facilities to supply on-site energy needs (US EPA, 2008). CHP enhances the advantages of DG by the concurrent production of thermal energy (heating or cooling) and electricity or mechanical power from a single fuel source, such as natural gas, biomass, biogas, coal, waste heat, or oil. CHP is not a single technology but rather an integrated energy system that can be customized and designed based on the needs of the energy end users' thermal (heating and cooling) baseload demand. More than two-thirds of our natural resources (mostly coal and natural gas) used to generate power are lost as waste heat to the environment (NREL, 2010). See Figure 2-1 which shows the current U.S Electricity Consumption.

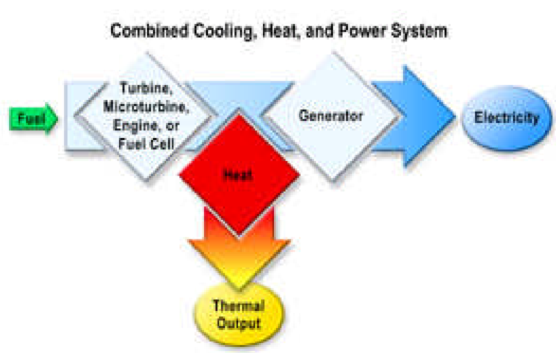
Figure 2-1: Current U.S. Electricity Consumption



Source: http://www.nrel.gov/dtet/about.html

The CHP energy model allows the heat (thermal energy) that would normally be lost in the power generation process to be recovered to provide thermal energy that can be used for process steam, hot water heating, space heating and cooling, and process cooling. See Figure 2-2 which shows a combined heat and power system diagram.

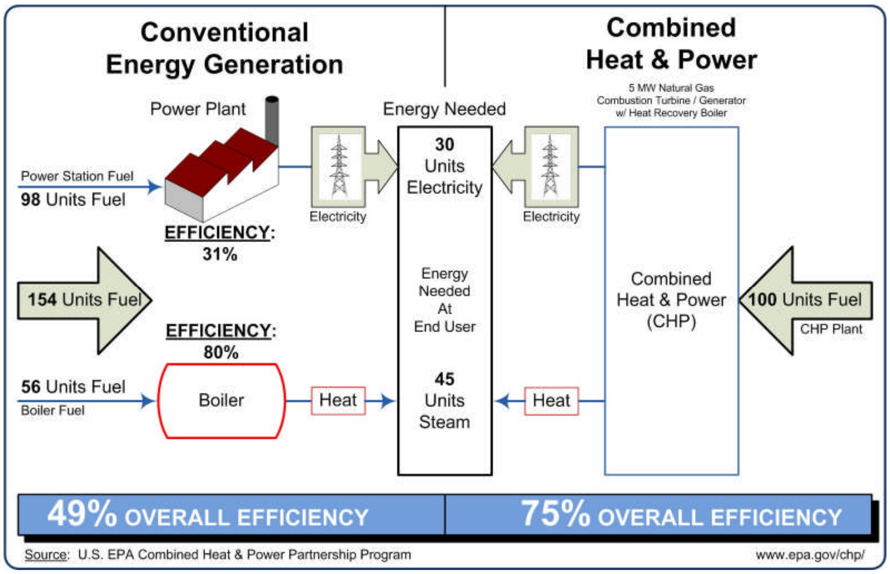
Figure 2-2: Combined Heat & Power System



Source: http://www.in.gov/oed/2414.htm

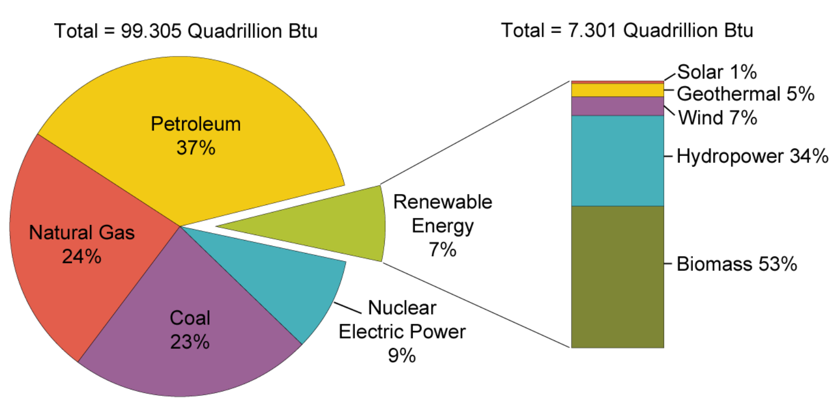
The CHP energy model can improve a facility's operational efficiency and decrease energy costs, as well as reducing greenhouse gas emissions. Figure 2-3 shows a comparison between conventional central utility power station generation and onsite boilers and the CHP energy model. CHP normally requires only ¾ the primary energy that separate heat and power systems require. Additionally, CHP systems utilize less fuel to achieve the same level of output, while producing fewer emissions (US EPA, 2008).

Figure 2-3: Separate Heat and Power Production versus Combined Heat & Power



In 2008, consumption of renewable sources in the United States totaled 7.3 quadrillion Btu or about 7% of all energy used nationally. Over half of renewable energy goes to producing electricity. About 9% of U.S. electricity was generated from renewable sources in 2008. The next largest use of renewable energy is the production of heat and steam for industrial purposes. Renewable fuels, such as ethanol, are also used for transportation fuels and bio-oil provides heat for homes and businesses (US EPA, 2010a).

The Role of Renewable Energy in the Nation's Energy Supply, 2008

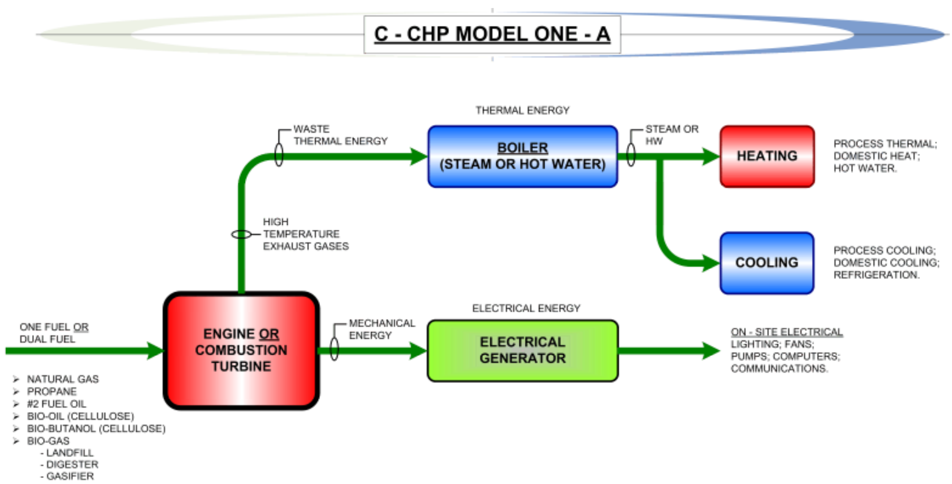


Note: Sum of components may not equal 100% due to independent rounding.
Source: Energy Information Administration, *Renewable Energy Consumption and Electricity Preliminary Statistics 2008*, Table 1: U.S. Energy Consumption by Energy Source, 2004-2008 (July 2009).

CHP plays an important role in meeting the United States' renewable energy needs as well as in reducing the environmental impact of power generation (US EPA, 2010a).

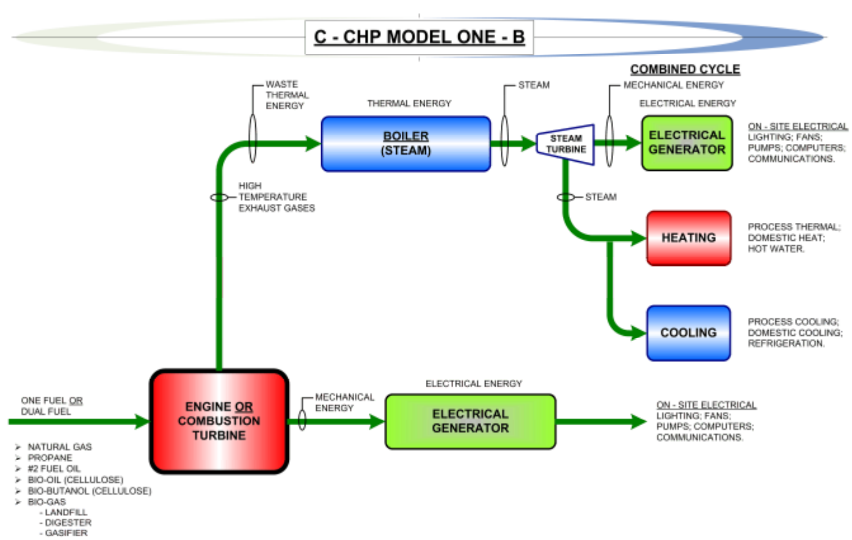
2.1 TYPES OF CHP SYSTEMS

There are two basic energy conversion models for CHP systems with variations on each model utilizing CHP technologies or systems that are suitable to the application. Several hybrid models exist but for this report the two most common models are identified. For Model 1A, the energy conversion process starts with the fuel, which is converted into mechanical energy; this mechanical energy is then converted into electrical energy; finally, recovered waste thermal energy is converted into steam or hot water.



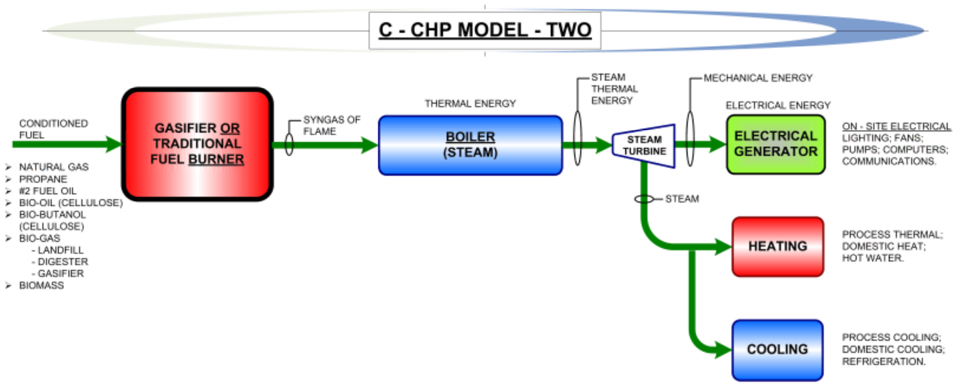
Source: Self-Gen, Inc.

For Model 1B, the energy conversion process starts with the fuel, which is converted into mechanical energy; this mechanical energy is then converted into electrical energy; finally, recovered waste thermal energy is converted into steam or hot water for heating and cooling needs of the host site. However, for Model 1B the waste thermal energy is first converted to mechanical energy to create additional electrical energy and finally the remaining recovered waste thermal energy is used for heating and cooling loads. This energy model is defined as a combined cycle where electrical energy is created twice during the energy conversion process.



Source: Self-Gen, Inc.

For Model 2, the energy conversion process starts with the fuel which is converted into thermal energy first (usually high pressure steam); the steam is then converted to mechanical energy (steam turbine) that is used to create electrical energy; and finally, recovered waste thermal energy from the steam turbine is utilized for heating and cooling needs of the host site.



Source: Self-Gen, Inc.

For each CHP energy conversion model there are many technologies available for each phase of the energy conversion process. Suitability-to-application should always be one of the key criteria when considering which energy conversion model and associated technologies to utilize for each site specific application. A vendor-neutral energy expert should be engaged when determining the best energy conversion model and associated technologies.

CHP systems consist of a number of individual components which are configured into an integrated system. The table below defines the typical components based on the energy conversion model utilized.

Table 2-1: Typical Components Based on Energy Conversion Model

CHP Core Component	Component Description	Model 1A *Fuel-to-Mechanical Energy-to-Electrical Energy & Waste Thermal Energy Recovery*	Model 1B *Fuel-to-Mechanical Energy-to-Electrical Energy & Waste Thermal Energy Recovery-to-Mechanical Energy-to-Electrical Energy & Waste Thermal Energy Recovery*	Model 2 *Fuel-to-Thermal Energy-to-Mechanical Energy-to-Electrical Energy & Waste Thermal Energy Recovery*
Combustion Turbine/Generator	Converts fuel into mechanical energy to electrical energy with high temperature waste exhaust gases for thermal energy recovery & conversion	Yes	Yes	No
Reciprocating Engine/Generator	Converts fuel into mechanical energy to electrical energy with high temperature waste exhaust gases, jacket water & lube oil cooler for thermal energy conversion	Yes	Yes	No
Micro-Turbine/Generator	Converts fuel into mechanical energy to electrical energy with high temperature waste exhaust gases for thermal energy recovery & conversion	Yes	No (combined cycle models are for larger systems)	No
Exhaust Gas Waste Heat Steam Generator or Boiler (HRSG)	Converts waste high temperature exhaust gases into steam or hot water	Yes	Yes	No
Jacket Water & Lube Oil Cooling Heat Exchangers	Converts waste thermal energy from jacket water and lube oil coolers into hot water	Yes	Yes	No
Gasifier/Boiler	Converts solid waste fuel (biomass) into a syngas that is used to make high pressure steam in a boiler	No	No	Yes
Stoker Solid Fuel Boiler	Converts solid waste fuel (biomass) into a thermal energy that is used to make high pressure steam in a boiler	No	No	Yes
Fluidized Bed Solid Fuel Boiler	Converts solid waste fuel (biomass) into a thermal energy that is used to make high pressure steam in a boiler	No	No	Yes
Steam Turbine	Converts steam into mechanical energy	No	Yes	Yes
Generator	Converts mechanical energy into electricity	No	Yes	Yes
Economizer	Recovers thermal energy from boiler flue gases for energy optimization	No	No	Yes
Absorption Chiller	Coverts steam or hot water into chilled water for cooling energy	Yes	Yes	Yes
Steam Turbine Chiller	Converts steam into mechanical energy to drive a chiller for sub-40 deg. refrigeration or freezer cooling applications	Yes	Yes	Yes
Fuel Cells (three types)	Electro-chemical energy conversion process for electrical and thermal energy production. Can be integrated with other CHP technology components	Possible	Possible	Possible with Digester
Power Interconnection	Power system interconnection equipment to include switchgear or switchboard. Protective relaying, metering and controls.	Yes	Yes	Yes
Automation & Controls	Process automation and controls including PLC or DCS and operator interface station	Yes	Yes	Yes

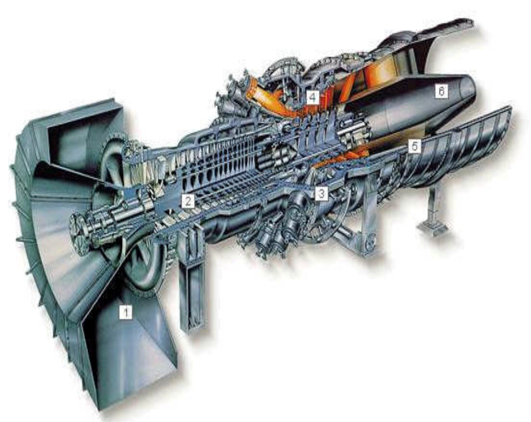
The CHP prime mover typically identifies the CHP components and there are five principle types:

1. Combustion or gas turbines;
2. Micro-turbines;
3. Reciprocating engines;
4. Steam turbines; and
5. Fuel cells.

These prime movers are able to burn a variety of fuels such as natural gas, coal, oil, and alternative fuels such as biomass, bio-gas, or bio-fuels to produce mechanical or thermal energy. Typically this mechanical energy is used to power a generator to produce electricity; however it can also be used to power rotating equipment including compressors, pumps, and fans (US EPA, 2008). The recovered thermal energy from the CHP system can be used two different ways: “in direct process application or indirectly to produce steam, hot water, hot air for drying, or chilled water for process cooling” (US EPA, 2008). The following subsections will briefly describe the five different types of CHP prime movers. Detailed information can be found in the Catalog of CHP Technologies, Appendix B.

2.1.1 Combustion or Gas Turbines with Heat Recovery

Combustion or gas turbines are much like a jet aircraft engine coupled to an electric generator. It’s an internal-combustion engine consisting essentially of an air compressor, combustion chamber, and turbine wheel that is turned by the expanding products of combustion. Gas turbines can be used in a variety of configurations: (1) a single gas turbine producing power only, referred to as simple cycle operation, (2) a simple gas turbine with a heat recovery heat exchanger, which recovers the heat in the turbine exhaust and converts it to useful thermal energy, referred to as CHP operation, or (3) where high pressure steam is produced from the recovered exhaust heat and used to create additional power using a steam turbine/generator, referred to as combined cycle operation (NortheastCHP, 2010a).



1. Inlet Section
2. Compressor
3. Combustion System
4. Turbine
5. Exhaust System
6. Exhaust Diffuser

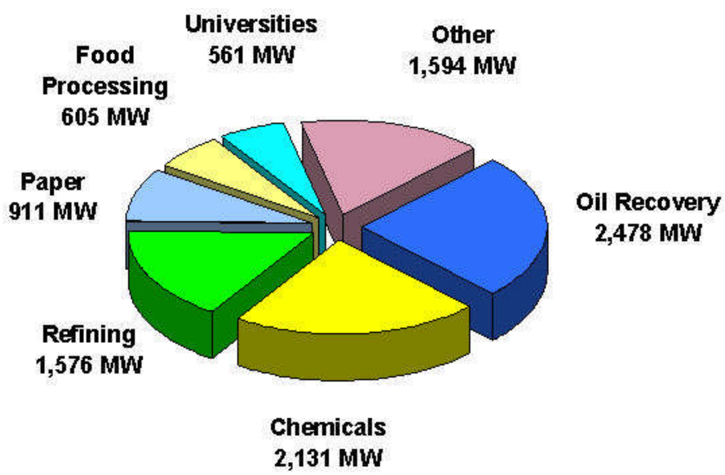
Courtesy of siemens Westinghouse

Gas turbines are available ranging in size from 500 kilowatts (kW) to 250 megawatts (MW) and can utilize a variety of fuels such as natural gas, synthetic gas, landfill gas, and fuel oils (US EPA, 2008). Simple cycle gas turbines are available with efficiencies reaching 40% Lower Heating Value (LHV); however gas turbines used in the CHP configurations can achieve overall system efficiencies, including both electric and useful thermal energy, of 70-80% LHV (NortheastCHP, 2010a). Gas turbines in CHP models have been used successfully nationwide in many industrial and institutional facilities to generate power and thermal energy. There are several examples of CHP technology in Maine, including Eastern Maine Medical Center, which is an example of a medium-sized (5,000 kW) CHP combustion turbine/generator system and will be discussed in Section 3, and Verso Paper Jay Mill Cogeneration System, an example of a large-size combustion turbine (50,000 kW each).

Compared to any other fossil technology in general commercial use, gas turbines emit substantially less carbon dioxide (CO_2) per Kilowatt-hour (kWh) generated because of their high efficiency and reliance on natural gas as the primary fuel (NortheastCHP, 2010a).

Gas turbine based CHP systems are used in a variety of different applications in the United States, including oil recovery, chemicals, refining, large hospitals, large universities, pharmaceuticals and the paper industry to name a few. Figure 2.4 below shows the distribution of an estimated 359 industrial and institutional facilities operating in the United States in 2000.

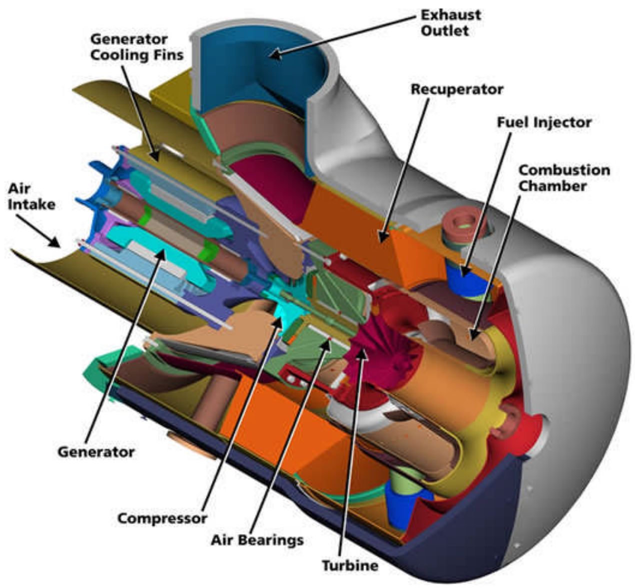
Figure 2-4: Existing Simple Cycle Gas Turbine CHP – 9,854 MW at 359 Sites



Source: www.energysolutionscenter.org

2.1.2 Micro-Turbines with Heat Recovery

Micro-turbines are a type of combustion turbine that produces both heat and electricity on a relatively small scale. The micro-turbine technology was pursued by the automotive industry beginning in the 1950's, entered CHP field testing approximately in 1997, and began initial commercial service in 2000 (NortheastCHP, 2010a). Micro-turbines are small electricity generators that burn gaseous fuels including natural gas, sour gases (high sulfur, low Btu content) and liquid fuels such as gasoline, kerosene, and diesel fuel/distillate heating oil/bio-fuels, to create a high-speed rotation that turns an electrical generator to produce electricity (US EPA, Dec. 2008). Micro-turbines can also burn waste gases that would otherwise be emitted directly into the atmosphere and have extremely low emissions.



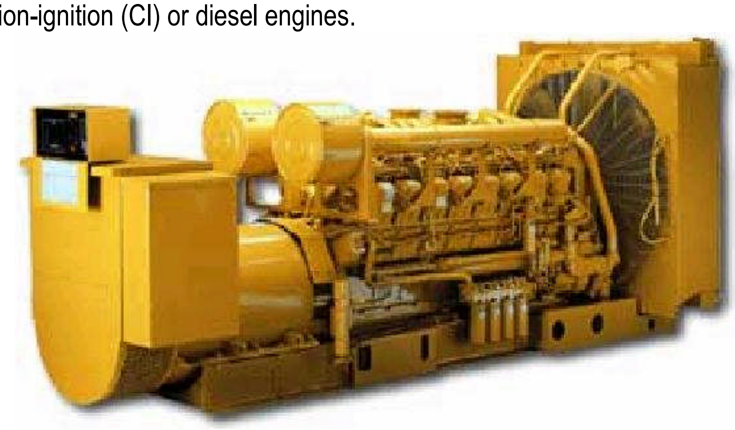
Source: http://www.greenprophet.com/

Most micro-turbines are comprised of a compressor, combustor, turbine, alternator, recuperator (a device that captures waste heat to improve the efficiency of the compressor stage), generator, and heat exchanger. Micro-turbines are available in sizes ranging from 30kW to 350kW (NortheastCHP, 2010a).

They can be used in power-only generation or CHP systems. In CHP operation, a heat exchanger, also known as the exhaust gas heat exchanger, "transfers thermal energy from the micro-turbine exhaust to a hot water system" (US EPA, 2008). The exhaust heat can also be used for space heating, process heating, absorption chillers, desiccant dehumidification equipment, and other building uses. Heat Recovery Steam Generators are now also readily used with micro-turbines for CHP steam applications (Cain, undated).

2.1.3 Reciprocating Engines with Heat Recovery

Reciprocating engines are a well known and widespread technology developed more than 100 years ago. They were the first of the fossil fuel-driven distributed generation technologies. Reciprocating engines are a subset of internal combustion engines, which also include rotary engines. They are machines in which pistons move back and forth in cylinders. There are two common types of reciprocating engines used in CHP systems: spark-ignition (SI) gas engines and compression-ignition (CI) or diesel engines.



Source: http://www.energysolutionscenter.org

SI gas engines use "spark plugs with a high-intensity spark of timed duration to ignite a compressed fuel-air mixture within the cylinder" (US EPA, 2008). The preferred fuel in electric generation is natural gas; however they can also run on gasoline, propane, bio-gas and landfill gas. For power generation, SI engines range in size from a few kW to over 5 MW.

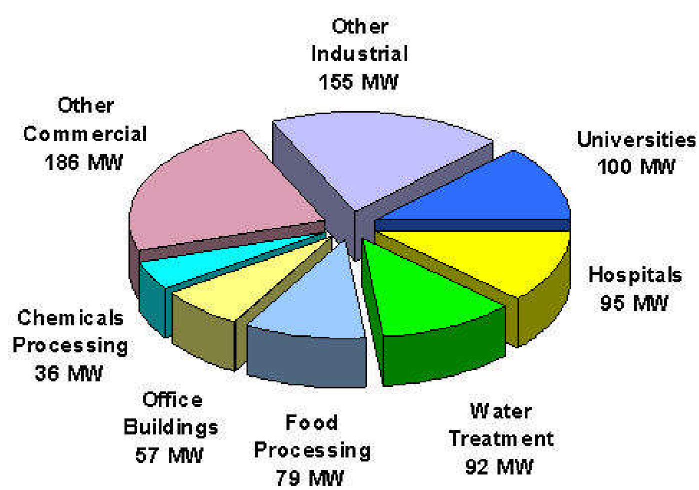
CI engines, otherwise referred to as diesel engines, run on diesel fuel or heavy oil or bio-fuels. They can also be set-up as dual fuel engines to run on primarily natural gas with small amounts of diesel pilot fuel (US EPA, 2008).

Reciprocating engines start quickly, have excellent load-following characteristics, have high reliabilities when maintained properly, and have significant heat recovery potential. They are well suited for applications that require low-pressure steam or hot water, and many times multiple reciprocating engine units are utilized in the CHP model to enhance the capacity and availability of the facility.

The electric efficiency of natural gas engines ranges from 28% LHV for smaller engines (<100 kW) to over 40% LHV for large lean-burning engines (>3 MW) (NortheastCHP, 2010a). For CHP applications, hot water or low pressure steam is produced from the waste heat recovered from the hot engine exhaust and from the engine cooling systems. As a result, the natural gas engines in CHP systems commonly have an overall efficiency of 70-80%, which includes both electricity and useful thermal energy (NortheastCHP, 2010a).

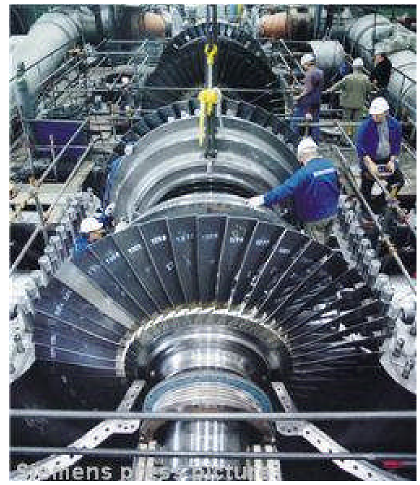
Reciprocating engine CHP systems are used in a variety of different applications in the United States, including chemical processing, food processing, universities, and hospitals to name a few. Figure 2-5 below shows the distribution of an estimated 1,055 engine based CHP systems operating in the United States in 2000.

Figure 2-5: Existing Reciprocating Engine CHP - 801 MW at 1,055 Sites



Source: www.energysolutionscenter.org

2.1.4 Steam Boilers with Steam Turbine Generators (CHP Model 2)



One of the most versatile and oldest prime mover technologies used to run a generator or mechanical system is a steam turbine. Most of the electricity produced in the United States is generated by conventional steam turbine power plants. The capacity of steam turbines ranges in size from 50 kW to more than 1,300 MW for larger utility power plants.

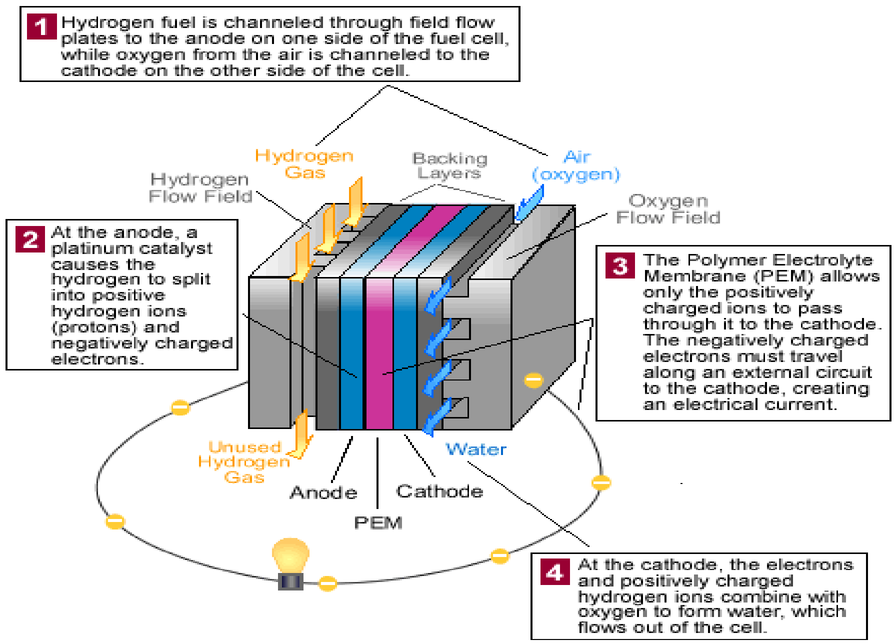
Steam turbines are unlike gas turbines and reciprocating engines because they produce electricity as a byproduct of heat (steam) generation. Steam turbines do not directly convert fuel to electrical energy; instead the energy is transferred from the boiler to the turbine through high-pressure steam that in turn powers the turbine and generator (NortheastCHP, 2010a). Steam boilers for steam turbines operate with a variety of different fuels, ranging from natural gas to solid waste, including all types of wood, wood waste, coal, and agricultural byproducts such as fruit pits, sugar cane bagasse, and rice hulls.

Steam turbines are well suited for CHP applications. In CHP systems, steam is extracted from the steam turbine after electrical generation at lower pressure and used directly or converted to other forms of thermal energy. To match the preferred application and/or performance specifications for either utility or industrial applications, steam turbines are available in a wide variety of designs and complexity. Steam turbines can be specified as full condensing type, extraction type and back-pressure type. Each of these configurations is dependent on the CHP application and the overall energy balance for both thermal and electrical energy at the host site.

2.1.5 Fuel Cells with Heat Recovery

Fuel cell systems produce energy differently than traditional prime mover technology – they produce electricity and heat without combustion or moving parts. Instead, they use an electrochemical process to convert the chemical energy of hydrogen and oxygen into electricity and heat.

Figure 2-6: Fuel Cell System



Source: www.nersc.gov

Fuel cells consist of two electrodes, an anode and a cathode, separated by an electrolyte. See Figure 2-6 above. Electrochemically, power is produced when charged particles, ions, formed at one end of the electrodes pass through the electrolyte with the aid of catalysts (NortheastCHP, 2010a). The produced current can be used for electricity.

Fuel cells use hydrogen as their fuel, which can be derived from natural gas, coal gas, methanol, and other hydrocarbon fuels. There are five types of fuel cells under development, and they include:

1. Phosphoric Acid (PAFC);
2. Proton Exchange Membrane (PEMFC);
3. Molten Carbonate (MCFC);
4. Solid Oxide (SOFC); and
5. Alkaline (AFC).

The electrolyte and operating temperature distinguish each type of fuel cell; however each fuel cell system is composed of three primary subsystems: (1) the fuel cell stack that generates direct current electricity, (2) the fuel processor that converts the natural gas into a hydrogen-rich feed stream, and (3) the power conditioner that processes the electric energy into alternating current or regulated direct current. All types of fuel cells have low emissions due to the burning of low energy hydrogen exhaust stream that is used to provide heat to the fuel processor (US EPA, 2008).

Fuel Cell Application: Sierra Nevada Brewing

Sierra Nevada recently completed one of the largest fuel cell installations in the United States: they installed four 250-kilowatt co-generation fuel cell power units to supply electric power and heat to the brewery. Natural gas or bio-gas is fed to the fuel cell, where hydrogen gas is extracted and combined with oxygen from the air to produce electricity, heat, and water. Their one megawatt of power output will produce most of the brewery's electrical demand, and the co-generation boilers will harvest the waste heat and produce steam for boiling the beer and other heating needs. Fuel cells are efficient, quiet, and produce extremely low emissions. The overall energy efficiency of the installation is double that of grid-supplied power and air emissions are significantly reduced. Surplus electrical energy will be sold back into the power grid.

Sierra Nevada's commitment to energy efficiency and reducing the company's environmental impact led them to look at many alternatives for their energy needs. The fuel cell was one of the cutting-edge new technologies they chose to embrace that has exciting potential for meeting the United States' future energy needs. Sierra Nevada's decision was based on dramatically lower emissions than conventional power generation, minimal electrical line transmission loss, and their ability to co-generate and use the waste heat from the fuel cell in their brewing process, for further information see Appendix C.

2.1.6 Comparison of CHP Configurations

There are several factors to consider when comparing CHP technologies, including installed costs, operation and maintenance (O&M) costs, start-up time, availability, thermal output, efficiency, and emissions (US EPA, 2008). Table 2-1 compares the different CHP technologies by listing key performance characteristics and cost information.

Table 2-2: Summary of CHP Technologies

<table>
<tr><th>CHP system</th><th>Advantages</th><th>Disadvantages</th><th>Available sizes</th></tr>
<tr><td>Gas turbine with heat recovery</td><td>• High reliability.
• Low emissions.
• High grade heat available.
• No cooling required.</td><td>• Require high pressure gas or in-house gas compressor.
• Poor efficiency at low loading.
• Output falls as ambient temperature rises.</td><td>500 kW to 250 MW</td></tr>
<tr><td>Micro-turbine with heat recovery</td><td>• Small number of moving parts.
• Compact size and light weight.
• Low emissions.
• No cooling required.</td><td>• High costs.
• Relatively low mechanical efficiency.
• Limited to lower temperature cogeneration applications (low pressure steam and hot water)</td><td>30 kW to 250 kW</td></tr>
<tr><td>SI reciprocating engine with heat recovery</td><td rowspan="3">• High power efficiency with part-load operational flexibility.
• Fast start-up.
• Relatively low investment cost.
• Can be used in island mode and have good load-following capability.
• Can be overhauled on site with normal operators.
• Operate on low-pressure gas.
• Can be configured in multiple models.</td><td rowspan="3">• High maintenance costs.
• Limited to lower temperature cogeneration applications.
• Relatively high air emissions.
• Must be cooled even if recovered heat is not used.
• High levels of low frequency noise.</td><td>< 5 MW in DG applications</td></tr>
<tr><td rowspan="2">CI reciprocating engine (dual fuel pilot ignition) with heat recovery</td><td>High speed (1,200 RPM) ≤4MW</td></tr>
<tr><td>Low speed (102-514 RPM) 4-75 MW</td></tr>
<tr><td>Steam boilers with steam turbine generators</td><td>• High overall efficiency.
• Any type of fuel may be used.
• Ability to meet more than one site heat grade requirement.
• Long working life and high reliability.
• Power to heat ratio can be varied.</td><td>• Slow start up.
• Low power to heat ratio.</td><td>50 kW to 250 MW</td></tr>
<tr><td>Fuel cells with heat recovery</td><td>• Low emissions and low noise.
• High efficiency over load range.
• Modular design.</td><td>• High costs.
• Low durability and power density.
• Fuels require processing unless pure hydrogen is used.</td><td>5 kW to 2 MW</td></tr>
</table>

Source: US EPA, Catalog of CHP Technology, Dec. 2008

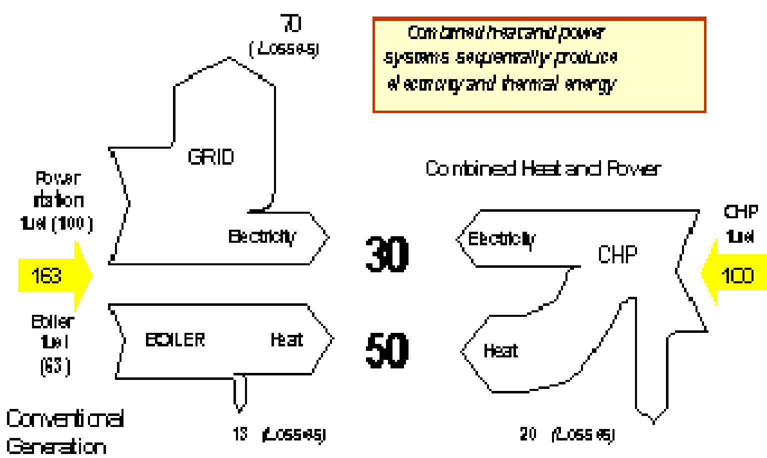
2.2 BENEFITS OF CHP

Cogeneration benefits include increased energy efficiency, decreased operating costs, improved environmental quality and economic development opportunity (US EPA, 2010b). For industrial facilities, there are additional benefits such as increased reliability, power quality, and higher productivity (ESC, 2004). For deregulated areas, host CHP sites can bilaterally distribute excess electricity to other business units within the deregulated territory providing low cost electricity supply to other non-CHP business sites.

Efficiency Benefits

Integrated CHP systems increase efficiency of energy utilization to as much as 85% from 51% for conventional power generation systems (NortheastCHP, 2010c). Conventional systems require 65% more energy than integrated CHP systems. Using CHP systems can reduce the consumption of fossil fuels (for a unit of energy needed) by about 40% compared to conventional systems. This is a key factor in reducing our dependence on imported fuels.

Figure 2-7: Example of CHP Energy Savings



Source: www.energysolutionscenter.org

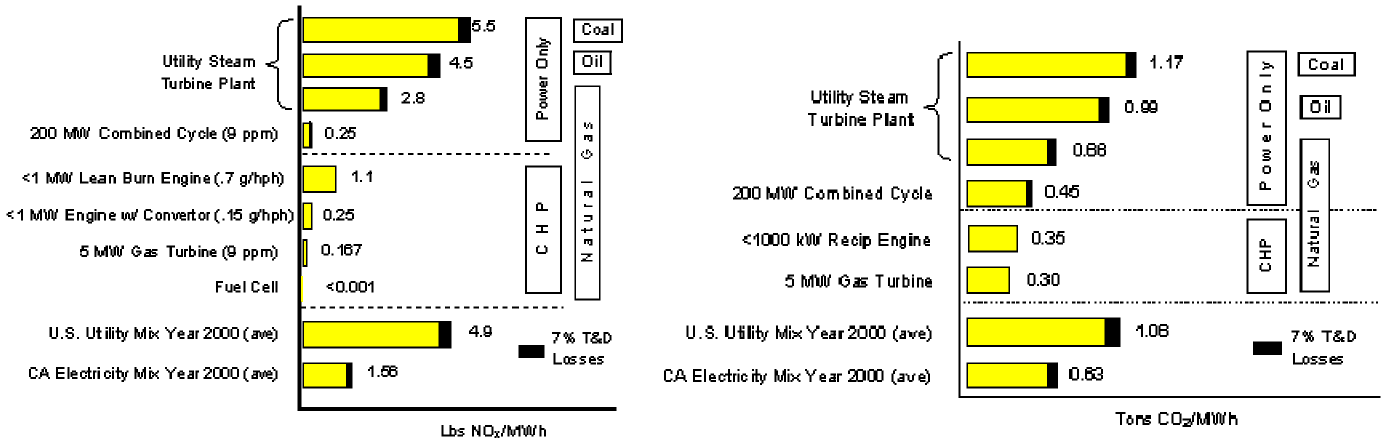
Figure 2-7 above demonstrates the energy savings. For 100 units of input fuel, CHP converts 80 units to useful energy of which 30 units are electricity and 50 units are for steam or hot water. However, traditional separate heat and power components require 163 units of energy to accomplish the same end use tasks (ESC, 2004).

Environmental Benefits

CHP reduces less air pollution and greenhouse gas emissions because less fuel is burned to produce each unit of energy output. By increasing energy efficiency, CHP also reduces emissions of criteria pollutants such as nitrogen oxides (NOx) and sulfur dioxide (SO_2) and non-criteria greenhouse gases such as CO_2. For CHP systems that utilize renewable fuel sources, the environmental benefits are even greater than using fossil fuels for the CHP energy model. For example, sustainably harvested biomass-fueled CHP systems are being defined as a net zero carbon emissions model.

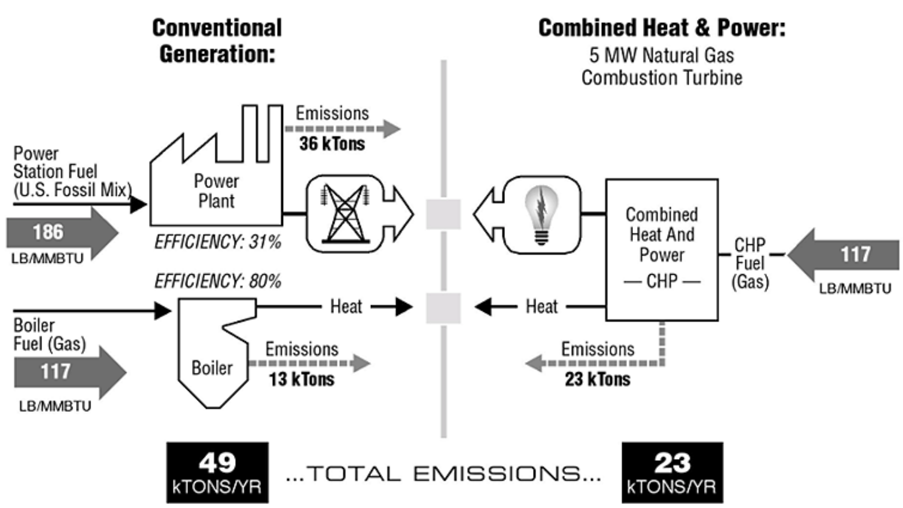
Figure 2-8 below shows NOx and CO_2 emission comparisons, respectively, by power generation technology and fuel type conducted in 2000. For reference, nationwide and California utility emissions are also shown.

Figure 2-8: NOx and CO_2 Reduction Benefits of CHP



Source: USCHPA, DOE, CEC, AGA, Onsite Energy

Figure 2-9: CO_2 Emission Output

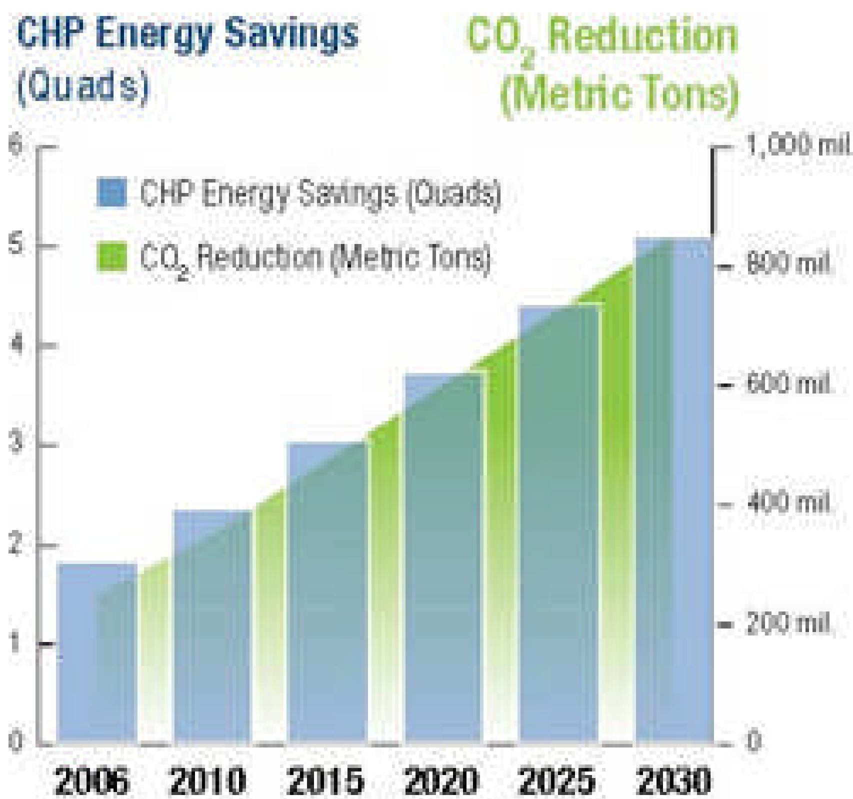


Source: http://www.epa.gov/chp/basic/environmental.html

Figure 2-9 above shows the CO_2 emissions output from power and thermal energy generation for a conventional separate heat and power system with a fossil fuel-fired power plant and a natural gas-fired boiler and a CHP system (5 megawatt combustion-turbine) powered by natural gas. The CHP system emits a total of 23,000 tons of CO_2 per year compared to more than twice the CO_2 emissions per year (49,000 tons per year) for the conventional system.

Currently in the United Sates, there are approximately 3,500 CHP systems with a generating capacity of 85 GW, which avoids more than 1.9 quadrillion Btu of fuel consumption and reduces 248 metric tons of CO_2 emissions. This is equivalent to removing more than 45 million cars from the road (EERE, 2009). In helping the United States achieve its goal of 20% of CHP power generation by 2030, there is the potential to save approximately 5.8 quadrillion Btu per year, 240 GW (equal to 200-300 coal-fire power plants), and 848 million metric tons of CO_2 emissions. See Figure 2-10 below. This is equivalent to removing more than 150 million cars off the road (EERE, 2009).

Figure 2-10: Potential Savings of 20% of CHP Generation Capacity by 2030



Source: http://www1.eere.energy.gov/industry/bestpractices/energymatters/archives/winter2009.html

As demonstrated here, CHP can significantly reduce emissions, thereby reducing Maine's carbon footprint and boosting environmental benefits. Summarized below are the emissions results using the US EPA CHP Partnership emissions calculator for small and large natural gas CHP systems.

Small CHP System (Tri-Generation) Emissions Summary (See Appendix D):

The small system is comprised of a 150 kW micro-engine generator, heat recovery system and absorption chiller to provide electricity, heating and cooling for a municipal facility in Maine. The basic emissions metrics are as follows:

Self-Gen, Inc.
Scarborough, Maine

Town Hall - Tri-Generation
Basic Emmissions Data

CHP Results

The results generated by the CHP Emissions Calculator are intended for eductional and outreach purposes only; it is not designed for use in developing emission inventories or preparing air permit applications.

Annual Emissions Analysis	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NOx (tons/year)	0.19	0.55	0.24	0.60	76%
SO2 (tons/year)	0.00	1.08	0.00	1.07	100%
CO2 (tons/year)	733	1,041	282	590	45%
Carbon (metric tons/year)	181	257	70	146	45%
Fuel Consumption (MMBtu/year)	12,562	17,459	4,828	9,725	44%
Acres of Forest Equivalent				122	
Number of Cars Removed				97	

This CHP project will reduce emissions of Carbon Dioxide (CO2) by 590 tons per year

This is equal to 146 metric tons of carbon equivalent (MTCE) per year

This reduction is equal to removing the carbon that would be absorbed by 122 acres of forest

OR

This reduction is equal to removing the carbon emissions of 97 cars

chp_emissions_calc, Results   Page 1 of 5   3/6/2010

Large CHP System (Tri-Generation) Emissions Summary (See Appendix D):

The large system is comprised of a 4.6 MW combustion-turbine generator, heat recovery steam generator/boiler (HRSG) and absorption chiller to provide electricity, heating and cooling for a large medical facility. The basic emissions metrics are as follows:

Large-Tri-Gen-NG Model
Emissions Metrics

Combine Metrics with attached
Combined-Cycle S/T/G emissions data.

CHP Results

The results generated by the CHP Emissions Calculator are intended for eductional and outreach purposes only; it is not designed for use in developing emission inventories or preparing air permit applications.

Annual Emissions Analysis	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NOx (tons/year)	52.33	16.25	22.45	(13.63)	-35%
SO2 (tons/year)	0.19	31.73	23.55	55.10	100%
CO2 (tons/year)	36,644	30,700	24,085	18,142	33%
Carbon (metric tons/year)	9,060	7,591	5,955	4,486	33%
Fuel Consumption (MMBtu/year)	627,996	514,877	299,382	186,264	23%
Acres of Forest Equivalent				3,738	
Number of Cars Removed				2,996	

This CHP project will reduce emissions of Carbon Dioxide (CO2) by 18,142 tons per year

This is equal to 4,486 metric tons of carbon equivalent (MTCE) per year

This reduction is equal to removing the carbon that would be absorbed by 3,738 acres of forest

OR

This reduction is equal to removing the carbon emissions of 2,996 cars

Emmissions-Example-Large-Tri-Gen-NG, Results Page 1 of 5 3/8/2010

Economic Benefits

CHP can offer a variety of economic benefits. The use of CHP will save facilities considerable money in reduced energy costs which is a direct result of the increased energy efficiency of CHP systems. Additionally, CHP systems can produce power at rates that are lower than the utility's delivered price; the cost of such power of course varies and is dependent on application, technology, and grid circumstances (ESC, 2004). There are also no utility transmission and distribution losses.

Small CHP System (Tri-Generation) Economic Benefits Summary (See Appendix D):

The small system is comprised of a 150 kW micro-engine generator and heat recovery system and absorption chiller to provide electricity, heating and cooling for a municipal facility in Maine. The basic economic metrics are as follows:

Energy Category	Existing Energy "Debits"	Tri-Gen Energy "Debits"	Tri-gen Energy "Credits"	
Existing Building Usage - Thermal 1:	-$24,957.00	-$122,289.71		
Excess Energy Required/Saved - Thermal 2:		$0.00	$0.00	Excess Thermal 'sold'
Chiller Electrical Savings - Thermal 3:			$30,120.65	Electric Chiller Savings (accounts for differentials in kWh $)
Town Hall Total - Electric:	-$66,169.00	$0.00	$116,496.35	Excess Electricity Net Metered with Other Municipal Meters (10)
Totals – 2006 - 2007:	-$91,126.00	-$122,289.71	$146,617.00	
Maintenance Cost / Year plus Escrow:			-$10,442.29	
Energy Difference Adjustment "+" or "-":			-$31,163.71	
TOTAL SAVINGS PER YEAR:			$105,011.00	
Estimated Project Cost - "1" - 150 kW Engine:			$498,629.40	
	4.75	Year Payback	$49,863	10% Grant
w/ 10% grant	4.27	Year Payback	$448,766.46	
w/ $200/kW credit	4.62	Year Payback	$485,629.40	

Large CHP System (Tri-Generation) Economic Benefits Summary (See Appendix D – 11"x 17" Calcs.):

The large system is comprised of a 4.6 MW combustion-turbine generator, heat recovery steam generator/boiler (HRSG) and absorption chiller to provide electricity, heating and cooling for a large medical facility. The basic economic metrics are as follows:

Simple Payback Summary for Large Tri-Generation Systems (CHP):

$ 2,361,068 – Electricity Savings with Tri-gen (CHP)
$ 500,492 – Thermal Savings with Tri-gen (CHP)
$ 2,861,560

$ 9,000,000 ÷ $ 2,861,560 = **3.14 Year Simple Payback**

(including Utility (Transmission and Distribution) T&D Fees of $ 525,000 or 100% of current T&D costs)

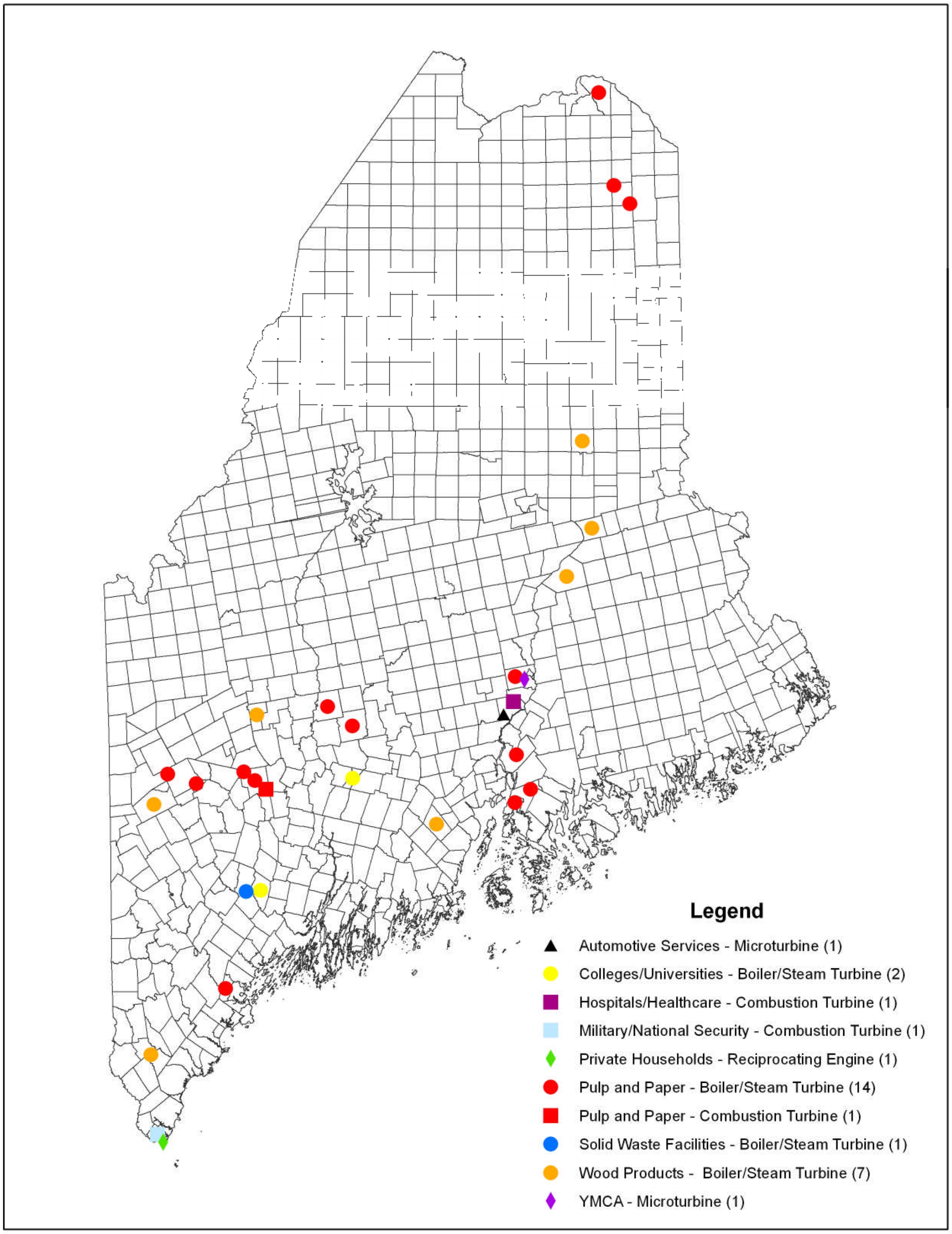
2.3 CHP IN VARIOUS FACILITY TYPES

CHP technology is used nationwide in a wide variety of energy-intensive facility types and sizes (US EPA, 2010b) including:

- Industrial manufacturers: pharmaceutical, chemical, refining, bio-fuels production, pulp and paper, sawmills, wood product manufacturers, food processing, and glass manufacturing;

- Institutions: colleges and universities, hospitals, prisons, and military bases;
- Commercial buildings: hotels and casinos, airports, high-tech campuses, large office buildings, and nursing homes;
- Municipal: district energy systems, wastewater treatment facilities, and K-12 schools; and
- Residential:multi-family housing and planned communities.

In Maine there are 24 boiler/steam turbines, three combustion turbines, two micro-turbine, and one reciprocating engine (Appendix E). These 30 CHP facilities with a total capacity of 1,130,880 kW, are in the following applications/industries: pulp and paper (15), wood products (7), colleges and universities (2), automotive services, health care, military, solid waste, one private household and one YMCA (EEA, 2009). See map below.



Source of current CHP facilities in Maine: http://www.eea-inc.com/chpdata/states/me.html, map provided by Woodard & Curran

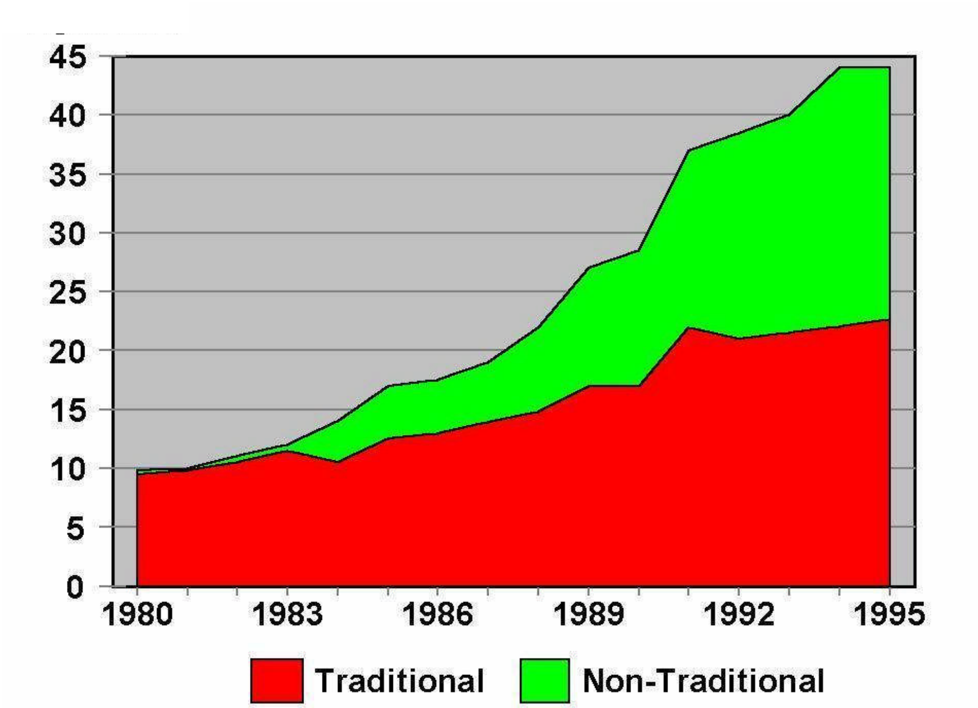
3. CHP BACKGROUND AND RESOURCES

3.1 PUBLIC UTILITIES REGULATORY POLICY ACT

In 1978 the US Congress passed the Public Utilities Regulatory Policy Act (PURPA) requiring electric utilities to interconnect with CHP and small renewable power sources and buy electricity from these sources at their avoided costs. This encouraged many large industrial customers to install CHP, interconnect to the utility grid, and sell power to the local utility. Since PURPA provided the only way for non-utility generators to sell excess electricity, many independent power producers found a use for some of their waste thermal energy. This allowed them to qualify as cogenerators under PURPA. These electricity-optimized CHP systems are called "non-traditional" cogenerators. (ACEEE, 2010).

During the 1980s there was a rapid growth of CHP capacity in the United States: installed capacity increased from less than 10 gigawatts electric (GWe) in 1980 to almost 44 GWe by 1993 (see Figure 3-1).

Figure 3-1: CHP Capacity in US from 1980 - 1995

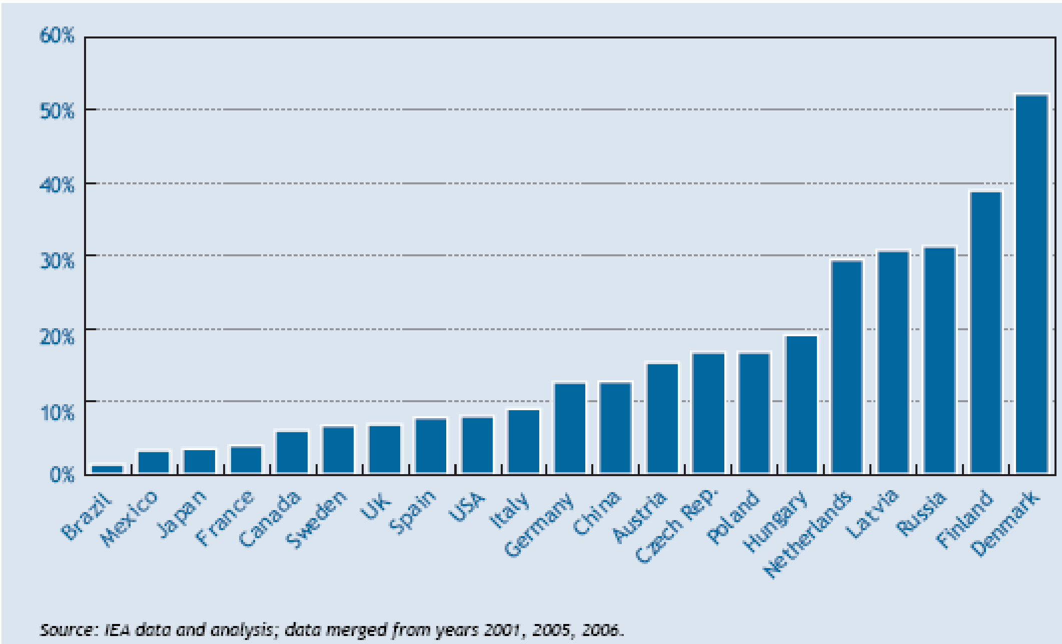


Source: www.aceee.org

Most of this capacity was installed at large industrial facilities such as pulp and paper, petroleum, and petrochemical plants, which provided a "thermal host" for the electric generator (ACEEE, 2010).

PURPA no longer provides sufficient incentive to install CHP. Nevertheless, it paved the way for an increased number of CHP facilities in the United States in addition to the pre-existing localized district heating systems that already existed in various cities like New York City, Boston, MA, Concord, NH and a number of older military bases. Currently, about 10% of total US electrical generation comes from CHP (see Figure 3-2).

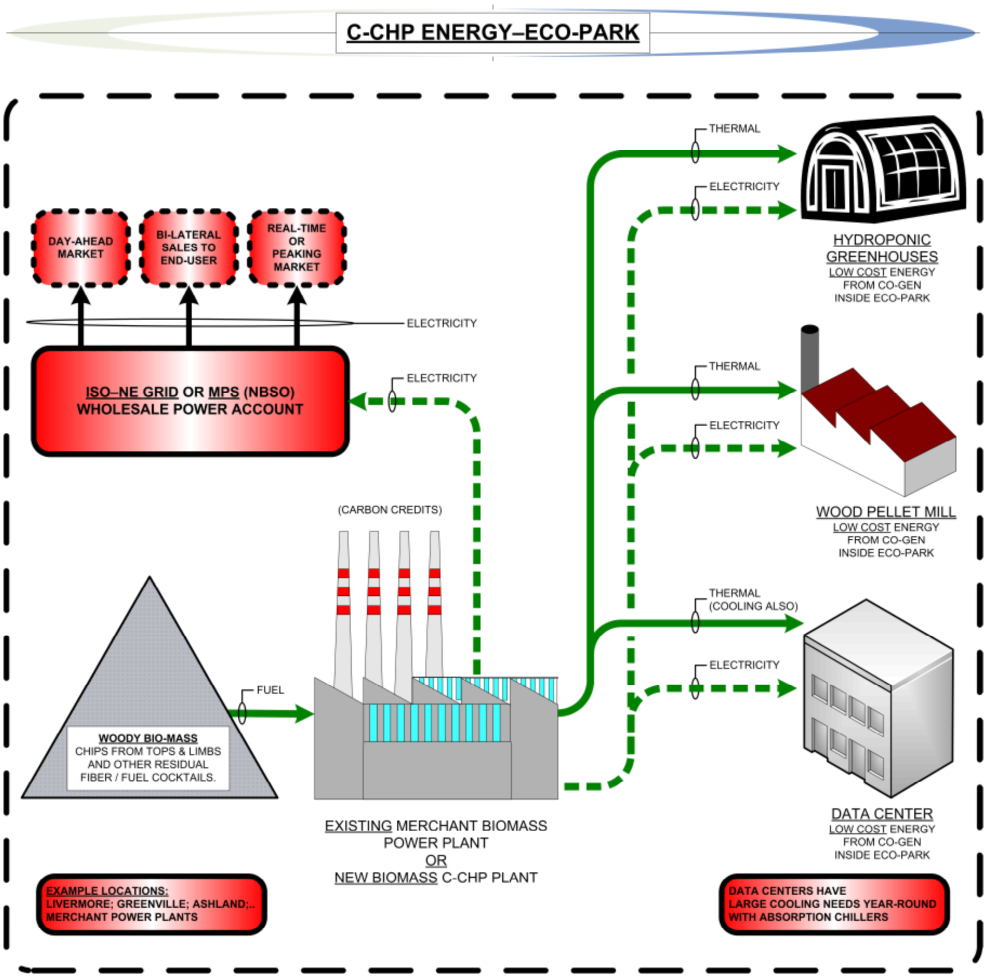
Figure 3-2: CHP as a Share of Electricity Generation



Denmark, Finland, Russia, and Latvia have expanded use of CHP between 30-50% of total power generation (IEA, 2009) and each took a different approach. One factor is common among the countries that have successfully implemented CHP, namely a focused government policy on electricity and heat supply (IEA, 2009). In Switzerland cogeneration accounts for about 77% of their total electricity production (BPE, 2010), of that, 56% is produced from hydropower and 40% is produced from nuclear power. As a consequence, Switzerland has almost CO_2-free electricity production.

Europe has been employing a district heating model for over thirty years. Switzerland uses "organic fuel pellets" for their power plants from the "organic" content of municipal solid waste (MSW) that is cleanly processed for all recyclable content with the remaining content being "organic." The recycled content is sold for value-added uses and the organic content is pelletized for the clean fuel at power plants sited for district heating using CHP. Oceanside Rubbish is proposing the same model for the York/Wells area and MERC is proposing a hybrid model for their Saco plant, but the sorting and fuel pelletizing will be done remotely instead of downtown.

Existing free-standing power plants and proposed future merchant power plants should be encouraged to explore CHP using their low-value waste thermal energy (i.e. Calpine in Westbrook providing thermal energy to IDEXX Labs (heating and cooling) and low cost electricity using the ECO Park Model – see graphic below).



Source: Self-Gen, Inc.

3.2 UNITED STATES CLEAN HEAT & POWER ASSOCIATION

The United States Clean Heat and Power Association (USCHPA) is a private non-profit trade association that was formed in 1999. At that time, USCHPA promoted combined heat and power and sought out public policy support for CHP, but in 2007 it expanded its focus. USCHPA continued its full support for CHP and also began advocating for recycled energy, bio-energy, and other local generation sources, all focused on reducing greenhouse gas emissions (USCHPA, 2010). The association consists of more than 60 organizations and their affiliates (including several Fortune 500 companies), 300 individuals, and allied industry groups. It sponsors workshops, advocacy events, and conferences to educate the public about clean heat and power. USCHPA is committed to the CHP program of the DOE and the US Environmental Protection Agency (US EPA) CHP Partnership, and is working to achieve a cleaner, more affordable, and more reliable national energy system (USCHPA, 2010).

3.3 US EPA CHP PARTNERSHIP

In 2001, US EPA formed the CHP Partnership, a voluntary program with the main goal of reducing the environmental impact of power generation by encouraging the installation and use of CHP. The Partnership works closely with entities such as energy users, the CHP industry, state and local governments, and other clean energy stakeholders to support and assist new cost-effective CHP projects and promote the economic and environmental benefits of cogeneration. Through 2007, the CHP Partnership helped install more than 335 CHP projects, representing an estimated 4,450 MW of capacity. The emissions reductions are equivalent to removing the annual emissions of more than two million automobiles or planting more than 2.4 million acres of forest. Using CHP technology equates to approximately 25% reduction of emissions (US EPA, 2010a)

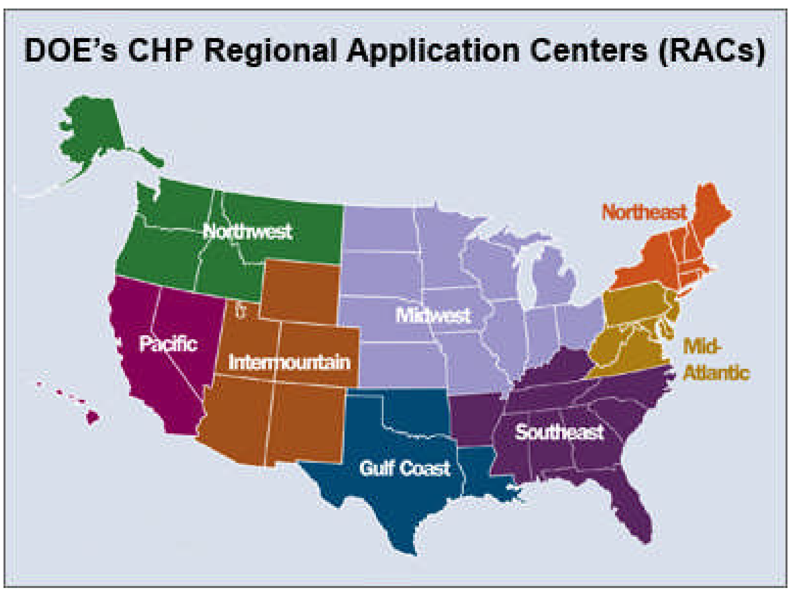
3.4 NORTHEAST CHP INITIATIVE

The Northeast Combined Heat and Power Initiative (NECHPI), a group of state and federal agencies, organizations and individuals, was established around 2000. This group is committed to promoting the use and implementation of CHP in the Northeast. Their mission is to encourage the use of CHP, support DOE's and US EPA's goal of doubling the CHP-produced power from 46GW to 92GW by 2010, and to be a communication and coordination central point for various CHP stakeholders in the Northeast, including state and federal agencies, utilities, project developers, CHP users, universities, research institutions, equipment manufacturers, and public interest groups (NECHPI, 2010).

3.5 NORTHEAST CHP REGIONAL APPLICATION CENTER

DOE formed the Northeast CHP Regional Application Center (NECHPRAC) at the University of Massachusetts Amherst (UMass) and Pace University (Pace) in October of 2003. The NECHPRAC is one of eight Regional Application Centers in the United States (see Figure 3-3).

Figure 3-3 CHP Regional Application Centers



Source: www.eere.energy.gov

NECHPRAC encourages the development and implementation of CHP systems, and it also provides consulting services for CHP in the seven Northeast states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. Additionally, NECHPRAC can address many technical and policy issues for industry, commercial and institutional energy end-users (NortheastCHP, 2010b).

3.6 MAINE COMPREHENSIVE ENERGY ACTION PLAN

The Maine Comprehensive Energy Action Plan recognizes and addresses CHP in the *Fostering Renewable Energy* section. The Plan calls for identifying, assessing and removing technical, regulatory, policy and economic barriers to the use of cogeneration or tri-generation facilities. Additionally, increasing the development and use of cogeneration and tri-generation is specifically listed as a goal to achieve improvements in fostering renewable energy (OEIS, 2009).

3.7 NET METERING AND NET ENERGY BILLING

Net metering enables electricity customers to use their own generation to offset their consumption. This flexibility allows customers to maximize the value of their production by either being paid for excess power supplied to the grid or "banking" their energy and carrying the surplus over to the next billing period. Providers can benefit through improvement (reduction) of their system's load during peak hours. Net metering provisions have a limited scope as to the size and types of facilities that may be subject to their provisions. As of 2010, 43 states, including Maine, and the District of Columbia have net metering provisions.

In Maine, all utilities must offer net energy billing, a type of net metering, for individual customers. According to MPUC Chapter 313 Rule, "net energy billing" is a "billing and metering practice under which a customer and the shared ownership customers are billed on the basis of net energy over the billing period taking into account accumulated unused kilowatt-hour credits from the previous billing period." Eligible facilities include those with capacity limits up to 660 kilowatts (kW) and include facilities generating electricity using fuel cells, tidal power, solar, geothermal, hydroelectric, biomass, generators fueled by municipal solid waste in conjunction with recycling, and eligible CHP systems. CHP systems must meet efficiency requirements in order to qualify – micro-CHP 30kW and below must achieve combined electrical and thermal efficiency of 80% or greater and micro-CHP 31kW to 660 kW must achieve combined efficiency of 65% or greater. (DSIRE, 2009). This leaves a large intermediate group of systems that have a nameplate capacity greater than the scope of Maine's net metering provisions. There are other MPUC rules that apply to groups above the net metering capacity levels, including Rule 315 for Small Generator Aggregation. Also, deregulation itself allows for excess electricity to be bi-laterally distributed into a wholesale power account of the host for use at other locations owned by the host or for direct sales to ISO-NE grid.

3.8 RGGI TRUST – PROJECTS AND OFFSETS

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by ten Northeast and Mid-Atlantic States to reduce greenhouse gas emissions through a mandatory, market-based CO_2 emissions reduction program. The states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont are signatory states to the RGGI agreement. These ten states have capped CO_2 emissions from the power sector, and will require a 10% reduction in these emissions by 2018. Regulated power plants can use a CO_2 allowance issued by any of the ten participating states to demonstrate compliance with the state program governing their facility. Maine is setting aside allowances to benefit CHP units at integrated manufacturing facilities. Such facilities are allowed to receive free allowances equal to their CO_2 emissions.

3.9 STATE'S RENEWABLE ENERGY PORTFOLIO AND RENEWABLE ENERGY CREDITS

Maine's renewable portfolio standard (RPS) originally required certain electricity providers to supply at least 30% of their total retail electric sales using electricity generated by eligible renewables and energy efficiency resources. In 2007, the Legislature enacted legislation mandating that specified percentages of electricity come from "new" renewable resources, reaching 10% by 2017. Eligible new renewables include those placed into service after September 1, 2005. To qualify, electricity must be generated at either a "Class I" or "Class II" facility. Class I facilities must be no greater than 100 megawatts (MW) in capacity and use fuel cells, tidal power, solar arrays and installations, wind power, geothermal power, hydropower, biomass power or generators fueled by municipal solid waste in conjunction with recycling. Electricity generated by CHP systems that burn an eligible fuel and meet other eligibility criteria may qualify for Class I. In CHP systems, the electric portion of a qualifying CHP project would be eligible (e.g., electricity from a new biomass CHP project at a sawmill would be eligible) while the thermal portion would be ineligible under the renewables goal. As Maine's RPS is reviewed and revised, it has been suggested that the thermal portion of an in-state CHP project should qualify in the RPS and receive renewable energy credit (REC) value in addition to any qualifying generation that is otherwise eligible under the RPS. Massachusetts law currently follows this path and other states are recognizing the value of CHP systems in their RPS requirements. This policy should be fully explored and modeled as appropriate for Maine.

The MPUC has approved the use of NEPOOL Generation Information System (GIS) certificates (which are similar to RECs) to satisfy the portfolio requirement. GIS certificates are awarded based on the number of kilowatt-hours (kWh) of eligible electricity generated. GIS certificates used to meet the Class I standard may not also be used to satisfy the Class II standard. Legislation enacted in June 2009 (L.D. 1075) provides a 1.5 credit multiplier for eligible community-based renewable energy projects.

3.10 DEREGULATION

Under deregulation, Maine utilities (CMP, BHE, MPS) could no longer generate as well as transmit and distribute electricity, so the utilities sold their generation plants and kept their transmission and distribution systems. In March 2000, Maine became a deregulated state which meant the billing for end-users of electricity would be split into supply (generators) and T&D. Deregulation is ideal for CHP applications since excess electricity is easily distributed back to the grid for sale or bilateral distribution to other CHP host facilities and other end-users. Deregulation helped create a model for super-net-metering throughout all of New England (ISO-NE). CHP facilities can now supply all their on-site electrical and thermal energy needs while maximizing the economic benefit of excess electricity by selling it to the grid. For example, the state's east campus has year-round thermal energy needs (heating & cooling) that are ideal for the CHP model. However, the heating and cooling needs using the CHP model result in significant excess electricity (i.e. meeting the thermal energy demands of the east campus with the CHP model generates excess electricity for the campus). Under deregulation, the excess electricity generated by the East Campus CHP plant can be bilaterally distributed via a State-established wholesale ISO-NE energy account to any other State facility as a low cost source of electric supply. The transmission and distribution component remains for the remote sites, but is reduced at the host site, or East Campus.

The diagram below shows how deregulation allows for CHP energy models to utilize excess electricity throughout the ISO-NE network. (MPS is not connected to ISO-NE but hybrid bi-lateral distribution models are available for CHP facilities in northern Maine; eventually MPS will be connected to ISO-NE if transmission upgrades are implemented as planned).

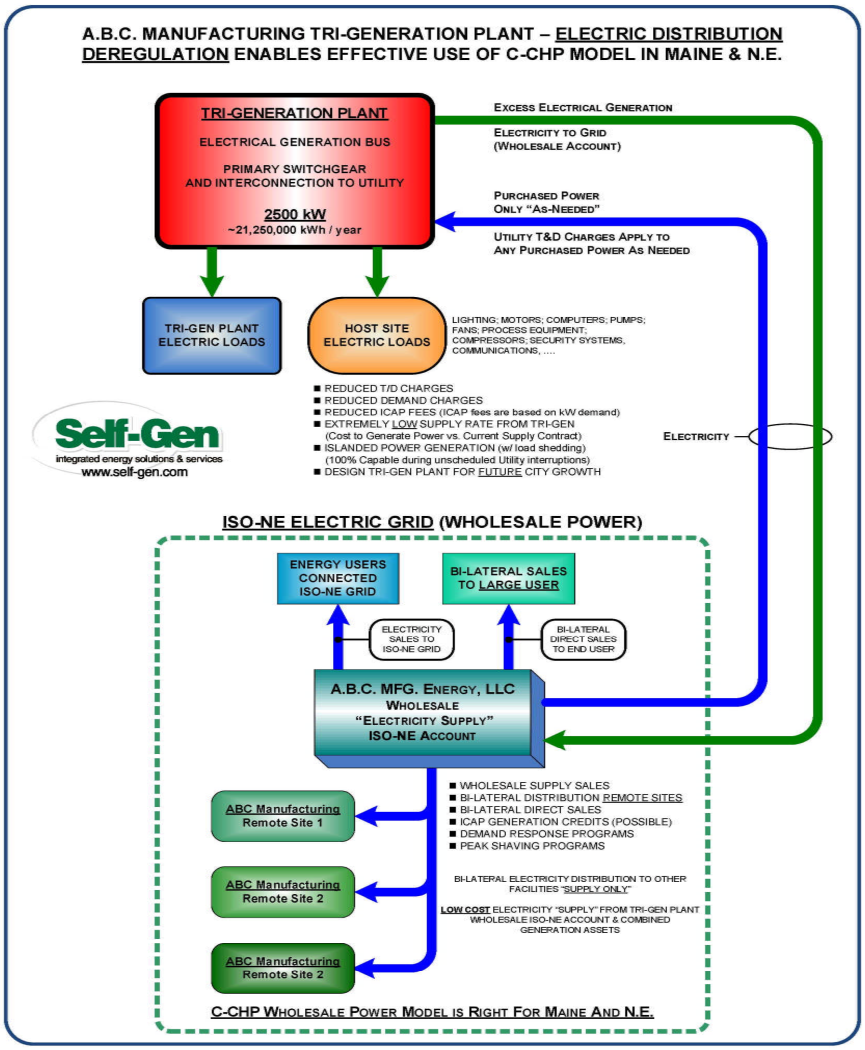


Diagram: C-CHP (Combined Cooling Heat & Power) Facility Electrical Distribution under Deregulated Structure, Source: Self-Gen, Inc

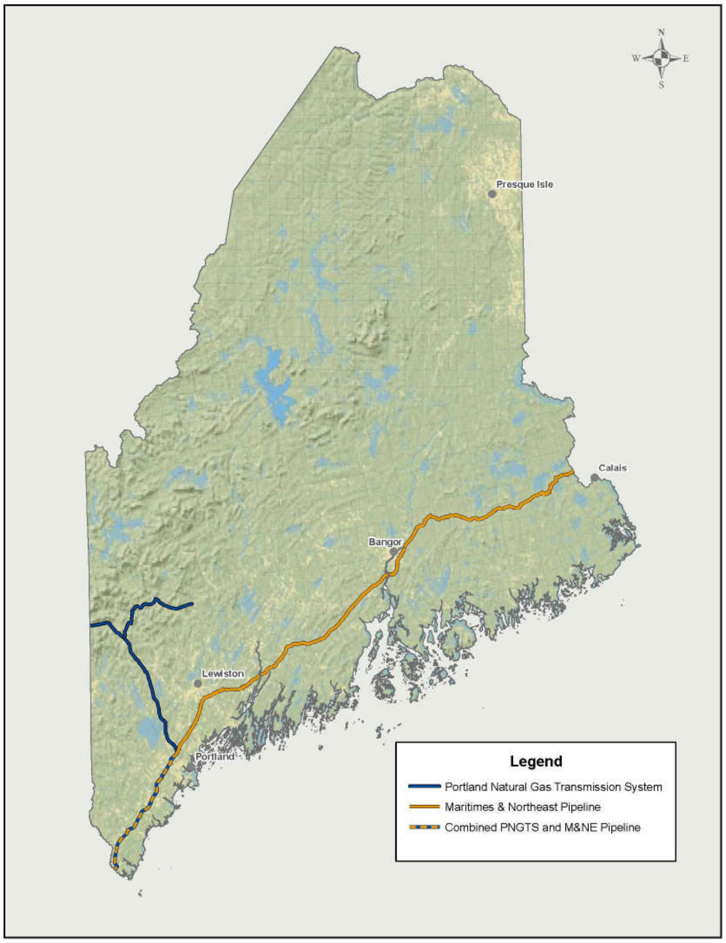
3.11 NATURAL GAS PIPELINE SUPPORT

Natural gas is a crucial element to Maine's efforts to better utilize fossil fuel usage. Natural gas CHP systems are very efficient and a clean, reliable energy source. Maine could meet or exceed its RGGI commitment by aggressively supporting and encouraging CHP applications where natural gas is currently available including at universities, hospitals, health care facilities and businesses.

Maine receives its natural gas by pipeline mostly from Canada, and ships over 50% of its natural gas to the Boston area via New Hampshire (EIA, 2010). Maine's per capita natural gas consumption is low and supply is used primarily for electricity generation. There are three natural gas transmission pipelines in Maine, the Maritimes and Northeast

Pipeline, the Portland Natural Gas Transmission System, and the Granite State Gas Transmission Co. See Figure 3-4 below.

Figure 3-4: Map of Natural Gas Transmission Pipelines



Source: Map provided by Woodard & Curran

Maine Natural Gas provides natural gas service in the towns of Windham, Gorham, Brunswick, Topsham, and Bowdoin and will bring natural gas services to Freeport in 2010. Towns currently served by Bangor Gas Company distribution system are Old Town, Orono, Veazie, Bangor, Brewer, and Bucksport (Verso Paper Mill). Unitil provides natural gas service to the following towns: Auburn, Biddeford, Cape Elizabeth, Cumberland, Eliot, Gorham, Kennebunk, Kittery, Lewiston, Lisbon, Lisbon Falls, New Gloucester, North Berwick, Old Orchard Beach, Portland, Saco, Sanford, Scarborough, South Berwick, South Portland, Wells, Westbrook and York.

The emissions reductions possible using natural gas CHP systems cannot be ignored. Natural gas is the cleanest fossil fuel and has lower emissions than oil or coal because the principle products of combustion are carbon dioxide and water vapor.

Maritimes & Northeast Pipeline President Tina Faraca explains, "The expanded Maritimes & Northeast Pipeline has created a real opportunity for more Mainers to have access to natural gas. It's the cleanest-burning conventional fuel. As we bring more supplies to the state, it will bring more opportunities for use. This project also enables the state of Maine to gain access to new suppliers and ensures reliability of our supply." The project puts Maine in a unique position, at the beginning of the United States' interstate natural gas pipeline network.(De Houx, 2010)

OEIS worked on two natural gas expansion initiatives in 2008-2009. One initiative was the "Natural Gas to Augusta" initiative. Stakeholders attended several meetings to collaborate on the concept of bringing natural gas to Augusta, specifically the State's East Campus Complex first and then the rest of Augusta. The stakeholders for this initiative were The Bureau of General Services (BGS), Togus VA Medical Center (Togus VAMC), Riverview, Maine General Hospital, Maine Natural Gas (MNG) and OEIS. Energy metrics were obtained for all the stakeholders in order to create an energy model for implementing CHP at each site. A joint letter of intent was drafted between the stakeholders and MNG in order to engage additional resources for planning. Togus VAMC was to be the first major energy host in the natural gas to Augusta initiative. Installing distribution level natural gas infrastructure to the East Campus would afford even greater expansion of natural gas infrastructure in the Augusta area. Also, it's quite possible natural gas could utilize river, rail and power rights of ways to expand natural gas beyond Augusta to Waterville and other areas.

The other natural gas initiative was the "Natural Gas to Rockland" initiative. The City of Rockland assisted in obtaining all the energy metrics for the major stakeholders in the Rockland area. Meetings were convened with MNG, FMC, city representatives, OEIS, Penn Bay Medical Center and other healthcare facilities, Warren State Prison, municipal buildings, commercial businesses, wastewater treatment plants and others.

A task force should be convened to address the barriers to expanding natural gas infrastructure in Maine since this fuel source has significant economic and environmental benefits from immediate utilization. It is expected that natural gas transmission to New England is going to grow and Maine should have a strategic plan for off-take of this critical energy source.

Natural gas, wind, solar, biomass, geothermal and other resources are all elements of Maine's quest for independence from foreign fuels. Natural gas and CHP systems are readily available for immediate use with immediate benefits. Expanding Maine's natural gas use will advance CHP development and provide an alternative fuel source for domestic heating. Natural gas continues to be a clean, efficient fuel source for Maine's CHP system. The natural gas pipeline infrastructure should be expanded and is part of the State's Comprehensive Energy Plan.

3.12 BIOMASS TO ENERGY INITIATIVES

Biomass-to-energy initiatives will become a cornerstone of Maine's economic and energy future. Fiber optimization is critical for proper utilization of this resource. "Non-competitive" biomass – biomass fiber for energy that does not come from pulp-grade or forest-products-grade feedstock, such as from tops, limbs, and slash – should be encouraged as a resource for CHP systems. Non-competitive biomass sources include residual sources like tops, limb, bark, small de-limbed trees, slash and fiber thinnings left in the wood lots. Non-competitive biomass is not considered part of the round wood feedstock being used for wood pellet production, which is often considered a competitive source with the pulp and paper industry and other forest products businesses. However, some mill residue, such as bark and sawdust, is incompatible with higher-value uses such as pulp and could provide for on-site use in CHP projects.

Small and large scale non-competitive biomass-to-energy initiatives using the Energy Eco-Park Model and point of use model are prevalent. Non-competitive biomass is also being used for creating bio-fuels and bio-chemicals prior to using pre-treated biomass residuals for biomass waste-to-energy systems. These are typically located within Energy Eco-Parks.

For example, an existing biomass stand alone power plant or one located at a mill would first pre-treat the non-competitive biomass to extract up to 20% of it's dual energy use, hemi-cellulose. After this extraction process the remaining biomass residuals are dewatered, dried and then used as normal in the existing biomass-to-energy power plant. The hemi-cellulose is then used to create a value-added revenue stream by creating bio-fuels or bio-chemicals. Maine Renewable Energy Consortium, LLC is pioneering this model in their Bio-Energy Eco-Park currently under development in South Portland industrial park (MREC, undated).

Small point-of-use biomass systems are typically used for thermal energy only like schools or CHP systems at forest products facilities, however CHP can be accomplished even with smaller biomass systems. Biomass gasification systems are typically employed for these small, medium, and large applications. Wood pellets systems are currently not used for CHP systems because the boilers utilized for commercialized pellet fuels only generate hot water or low pressure steam; higher pressure steam is required for CHP systems. There are, however, redesigned small steam engine/generators currently available for low pressure steam CHP applications.

3.13 STATE SUPPORTED BCAP MAINE FARM AGENCIES

Biomass, including wood and wood wastes, can be used efficiently in a combined heat and power system. In February 2010, the Obama Administration proposed rules to implement the Biomass Crop Assistance Program (BCAP) designed to spur the development of bio-fuel and alternative energy markets. BCAP provides financial assistance for the establishment, harvest, storage and transport of biomass feedstocks for energy production, including a variety of heat and power applications. The Maine forest product industry is positioned to benefit from the proposed rule, as sawmills and pellet manufacturers could qualify as eligible conversion facilities if they convert renewable biomass into heat or power.

3.14 CHP IN OTHER STATES

There is a wide variety in the CHP applications and in the number of CHP facilities in the nation and particularly in the Northeast States. As mentioned earlier, Maine has a total of 30 CHP facilities with a total capacity of 1,130,880 kW. The number of CHP units is considerably lower than the number of CHP units in Connecticut, Massachusetts and New York. Massachusetts has total of 124 CHP units, with a total capacity of 1,907,742 kW, and ranked second in the 2009 State Energy Efficiency Scorecard (ACEEE, Oct. 2009). Third-ranked Connecticut has 141 CHP units with a total capacity of 674,284 kW. New York has a total of 399 CHP facilities with a total capacity of 5,836,533 kW (EEA, 2009) and is ranked fifth on the State Energy Efficiency Scorecard. The subsections below represent just a sample of the programs that are in place in Massachusetts, Connecticut and New York which enable those states to increase energy efficiency through CHP.

3.14.1 Massachusetts Green Communities Program

Massachusetts is viewed as a sustainability leader because of the Green Communities program. The Green Communities Division was created in October 2008 and their goal is to help all 351 cities and towns maximize energy efficiency in public buildings, generate clean energy from renewable sources, and manage rising energy costs, which leads them toward a path of zero-net energy use (Sylvia, 2009).

To achieve these goals, the Green Communities Division is helping the cities and towns by offering the following:

- Education about the benefits of energy efficiency and renewable energy;
- Guidance and technical assistance through the energy management process;
- Facilitation of informed decisions and actions;
- Collaboration through shared best practices among cities and towns;
- Local support from regional Green Communities coordinators; and
- Opportunities to fund energy improvements.

The Green Communities program consists of four programs or services described below.

The Energy Audit Program

The EAP is designed to assess energy use by establishing benchmarks and develop individualized strategies to improve energy performance by reducing the energy demand of municipally owned buildings. This program is supported through technical assistance from the Department of Energy Resources' (DOER) Green Communities Division and the utilities/energy providers who work with communities to establish accurate benchmarks for their buildings' energy use, develop an energy strategy to improve their buildings' energy performance, and manage their energy costs (EOEEA, 2010).

Energy Management Services

Energy Management Services (EMS) is a type of performance contracting that many cities and towns choose to use to execute their energy efficiency plans. EMS contracting is a practical financing option to reduce energy costs by improving a buildings' energy and water systems with little or no up-front capital investment. This is a seamless process and the "efficiency measure are paid for by the energy and water savings guaranteed from the project by the chosen vendor" (EOEEA, 2010).

Green Communities Grant Program

The Green Communities Grant Program (GCGP) helps communities improve their overall energy efficiency. It provides up to $10 million annually to qualifying communities to fund energy efficiency initiatives, renewable energy projects and innovative projects. Communities can apply for the GCGP after they have been officially designated as a "green community" and meet firm qualification criteria. Approximately $7 million (total) is expected to be distributed in late 2010 to help Massachusetts's communities manage their energy use and costs and advance the clean energy economy (EOEEA, 2010).

MassEnergyInsight

MassEnergyInsight is a free web-based tool, provided by the Department of Energy Resources, that helps communities manage energy use and maximize energy efficiency. MassEnergyInsight compiles energy use information for municipally owned and operated buildings, streetlights, and vehicles and allows communities to execute energy management tasks (EOEEA, 2010) such as:

- Developing an energy use baseline;
- Benchmarking building performance;
- Identifying priority targets for energy efficiency investments;
- Showing the results of energy efficiency investments;
- Highlighting any irregularities in energy use;
- Developing a greenhouse gas emissions inventory;
- Generating reports for stakeholders; and
- Forecasting energy budgets.

Based on this information, it allows communities to make key energy management decisions.

3.14.2 Interconnection Standards

Massachusetts Interconnection Standards – The goal is to provide project developers with a uniform and predicable process for interconnection with the local utility. Massachusetts's interconnection standards apply to all forms of DG, including renewables, and to all customers of the state's four investor-owned utilities. The original Model Interconnection Tariff was developed by the Massachusetts DG Collaborative and adopted by the Massachusetts Department of Telecommunications and Energy (DTE) in February 2004. (The DG Collaborative – a combination of the state's utilities and DG stakeholders – was created by the DTE in October 2002 to develop interconnection standards for Massachusetts. The DG Collaborative's work encompasses all sizes of DG on both radial and secondary network systems.) The Model Interconnection Tariff includes provisions for three levels of interconnection. Simplified interconnection applies to certified, inverter-based, single-phase systems less than 10 kilowatts (kW) and certified, three-phase systems up to 25 kW in capacity. For simplified interconnection, there are no fees for the interconnection approval process and applications must be processed within 15 days. However, if the proposed interconnection is on a distribution network circuit, the utility may charge a $100 fee to review the network protector's interaction with the system. For simplified network interconnection, the aggregate generating facility capacity must be less than 1/15th of the customer's minimum load. (The issue of interconnection to network systems is particularly important in Massachusetts because network systems are commonly used in dense urban areas, such as Boston). Other interconnections can either qualify for "expedited" interconnection or will have to undergo "standard" interconnection review. Under the expedited interconnection procedures, both the time frames and fees to complete the interconnection are limited. Fees are set at $3 per kW of generator capacity, with a minimum fee of $300 and a maximum of $2,500.

3.14.3 Standby Rates

Connecticut DPUC Backup Rates – Under the capital grant program, the electric cost associated with power used when base load customer-side generation is out of service can be reduced. This is done by eliminating backup rates and demand ratchets for customers who install these projects. In addition, generation that will be interconnected to the distribution system must comply with certain standards. Further, some projects are required to participate in the ISO-NE's Demand Response Programs.

3.14.4 Grants and Rebates

NYSERDA

Eligible Technology: Combustion Turbine, Reciprocating Engine. **Eligible Fuel:** # 2 Fuel Oil, # 6 Fuel Oil, Biogas, Biomass, LFG, Natural Gas, Other, Waste Heat Recovery. **Eligible Project Size:** >0.25kW

Size of Award: Incentives are performance based and correspond to the summer-peak demand reduction (kW), energy generation (kWh), and fuel conversion efficiency achieved by the CHP system on an annual basis over a two year measurement and verification period. For the Upstate region: $0.10/kWh + $600/kW. For the Con Edison region: $0.10/kWh + $750/kW. There is a $2,000,000 incentive cap per CHP project.

The Existing Facilities Program merges the previous Enhanced Commercial/Industrial Performance Program (ECIPP) and the Peak Load Reduction Program (PLRP). There are various pre-qualified incentives under the program for energy efficiency and conservation measures. There are also performance-based incentives for combined heat and power systems. To be eligible for the performance-based CHP incentives, a CHP system must be:

- Based on a commercially available reciprocating engine or gas turbine and result in an electrical peak demand reduction during the summer capability period;
- Have a 60% annual fuel conversion efficiency based on a higher heating value (HHV) including parasitic losses;
- Use at least 75% of the generated electricity on-site; and
- Have a NOx emission rate <1.6 lbs/MWhr

There are non-performance incentive reductions under the program and a two year measurement and verification period. Incentives are paid after review and approval of the M&V data.

Multi-family buildings are ineligible for this program, as are fuel cells, micro-turbines, direct drive natural gas engines providing mechanical energy only, and CHP systems currently contracted for installation under another NYSERDA program or projects eligible to submit to the customer sited tier of the Renewable Portfolio Standard.

3.14.5 Loans

New Jersey Clean Energy Solutions Capital Investment (CESCI) Loan/Grant. Interest-free loans are available through the CESCI Loan/Grant program in amounts up to $5 million (a portion of which may be issued as a grant).

- Scoring criteria based on the project's environmental and economic development impact determines the percentage split of loan and grant awarded. The maximum grant awarded is the lesser of 80% of the amount requested or $2.5 million.
- To be eligible for the CESCI Loan/Grant, total project capital equipment costs must be at least $1 million.
  - A minimum of 50% of project costs must be covered by project sponsor(s) (includes Federal funding).
  - Aggregate state public funding cannot exceed 50% of the project cost.

- Businesses benefiting from the CESCI Loan/Grant should create or maintain jobs in New Jersey.
- The loans have a term of up to a 10-years and amortization up to 20 years based on the depreciable life of the asset financed.
- Personal guarantees are required for any person or entity with 10% or more ownership in the project, if historical Adjusted Debt Service Coverage Ratio (ADSCR) is less than 1.2:1 (based on adjusted year-end financials).
    - The EDA may consider the assignment of other public grant funding in lieu of personal guarantees, provided the other public grants are no less than 120% of the loan amount and aggregate state funding does not exceed 50% of the project cost.
- The equity requirement is 10%.

4. CASE STUDY – EASTERN MAINE MEDICAL CENTER

Eastern Maine Medical Center (EMMC) is a critical regional tertiary hospital located in Bangor, Maine, and serves as the referral hospital for the largest geographical area of any hospital in the Northeast. Prior to 2006, the existing utilities and infrastructure at the hospital consisted of the following:

- Duel fuel high pressure steam boiler plant and distribution system;
- 2,300 ton electric chilled water plant;
- Two 12.4 kilovolt feeders on overhead poles from Bangor Hydro Electric Company with primary switchgear and site distribution; and
- Two 1,500 kilowatt diesel emergency generator sets and one 500 kilowatt set.

Between 1995 and 1997, EMMC began looking into turbine technology for its Bangor campus for the following reasons (EMMC, 2010; Mylen, 2009):

- The medical center never closes, and must remain operational at all times.
- The severe and ever-changing weather that affects central, eastern, and northern Maine is known to cause extended electrical outages and EMMC must deliver healthcare no matter what the weather conditions are. Having dual fuel capability (natural gas or oil) would greatly improve EMMC's ability to operate under any circumstances.
- High utility rates, high process thermal load, and a 12-month thermal requirement for heating or cooling.
- To reduce emissions of NOx, CO, SO2, VOCs, particulate matter, and other greenhouse gases.
- EMMC is an economic driver in the region and is mandated by the State of Maine to find ways to provide affordable and efficient healthcare for all of the people of central, eastern, and northern Maine. The CHP project would trim energy costs at the medical center by approximately $1,000,000 per year.

In 1998 an ice storm had a catastrophic effect on EMMC and the surrounding area, resulting in the loss of dependable power for more than 16 hours and reinforcing the fact that hospitals need secure electrical power. Much of the utility infrastructure was damaged, causing many homes and businesses to be without power for time periods that ranged from several days to six weeks.

In the spring/summer of 2003, EMMC assembled a team to assist with the procurement, design, construction, and information distribution for the CHP project. Team members included EMMC, Cianbro Construction Corporation, Vanderweil Engineers, Solar Turbines, Inc., and the International District Energy Association.

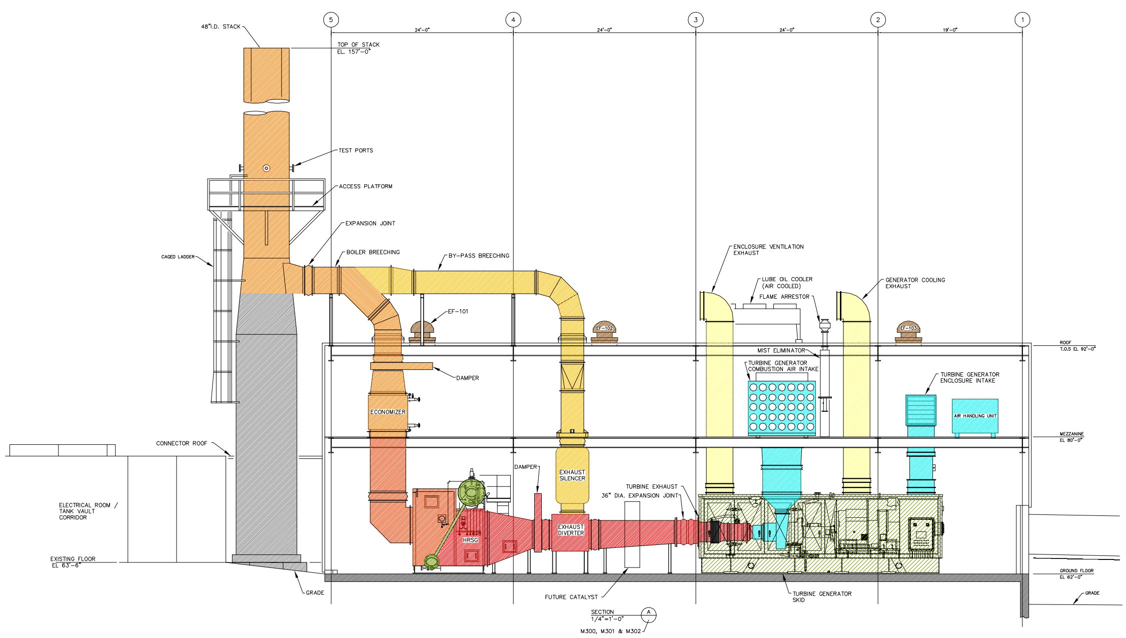
In the fall of 2003, after three years of working with Vanderweil Engineers to determine the feasibility of using turbine technology, EMMC applied for the DOE's Distributed Energy System Application grant to help finance the turbine project. In May 2004, EMMC was awarded a $3 million dollar DOE grant (administrated by Oak Ridge National Lab) to build and operate a CHP Plant. The balance would be internally financed by EMMC. On February 4, 2005, EMMC was awarded a Certificate of Need (CON) by the State of Maine to start construction of the CHP Plant, and construction of the Plant commenced in July 2005. The CHP Plant at EMMC was fully tested and online on October 16, 2006.

Figure 4-1 shows the CHP System, which consists of the following elements:

- Solar Centaur 50, 4.6 megawatts @ ISO with un-fired Heat Recovery Steam Generator (HRSG) generating 25,000 pounds per hour flow (PPH) of steam; and
- New 500 ton steam absorption chiller and ancillaries.

EMMC will stay connected to the Bangor Hydro Grid and still imports approximately 20% of its electricity from the grid on an annual basis. The generator connected to the turbine is 4.6 megawatts, which is equal to supplying electricity to 46,000 one-hundred watt bulbs or approximately 400 average size homes. The heat output of the HRSG (boiler) is equivalent to heating approximately 300 homes. In addition, during the summer months, surplus steam from the plant can be used to help cool the hospital through the 500 ton steam absorption chiller and two new cooling towers. This output is equivalent to helping cool approximately 500 homes on a hot day.

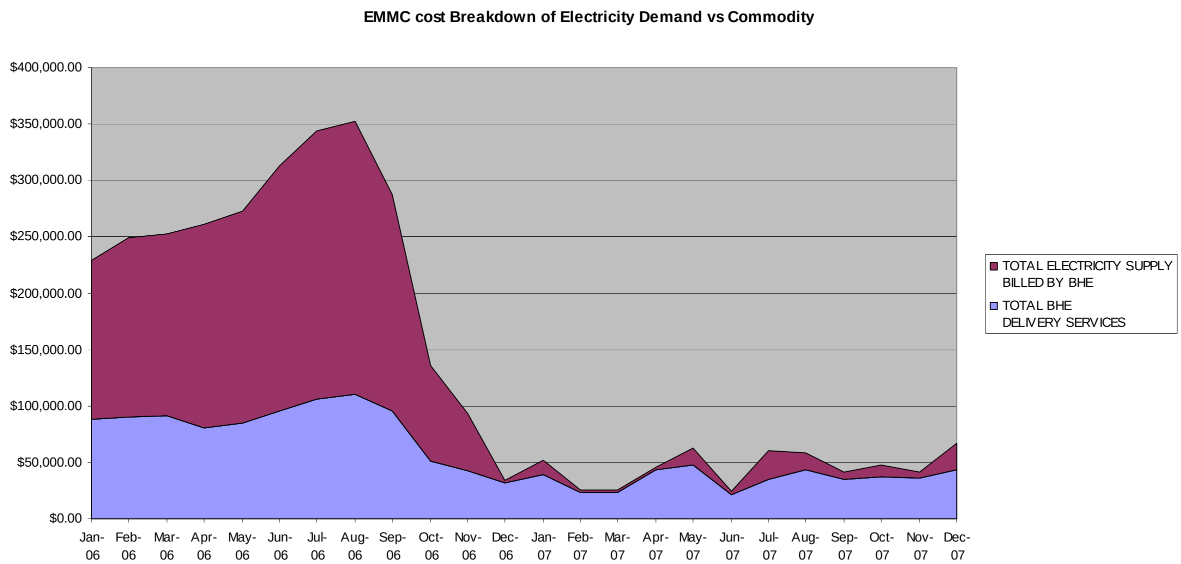
Figure 4-1: CHP System



Source: Mylen, 2009

The cost of the project was approximately $8.2 million and EMMC's cost was approximately $5.2 million. The expected energy savings are at least $1 million per year, yielding complete payback in less than 5 years. Additional benefits include reduced emissions, increased thermal and heating capacity, and emergency backup power. Figure 4-2 shows the cost breakdown of electrical demand versus commodity from January 2006 to December 2007.

Figure 4-2: EMMC Cost Breakdown



Source: Mylen, 2009

As stated above, the CHP Plant at EMMC was fully tested and online on October 16, 2006. The cost savings have been greater than expected and the system has already paid for itself in approximately three years.

5. IDENTIFYING BARRIERS

5.1 INTERCONNECTIONS (TECHNICAL & ECONOMIC)

Interconnection standards are the rules that establish uniform processes and technical requirements for utilities when DG systems of a particular type and size are connected to the grid. In general, interconnection standards consist of two components: technical requirements and an application process. Technical issues relate to the size and type of the generator and its connection and operation procedures that may affect grid stability and worker and public safety. Standards also make the application process as simple as possible, especially for small-scale DG developers who are more likely to be deterred by a strenuous application process because of their relatively small generating capacities.

Without uniform interconnection standards, consumers may find it time consuming and costly to install DG systems. Statewide interconnection standards provide clear and reasonable rules for connecting DG systems to the electric grid. Complexity, length of time to completion, and costly processes may act as reasons for the abandonment of efforts in installing DG systems.

As of February 2008, 31 states had adopted standard interconnection rules for DG. These include: Arkansas, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Indiana, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Mexico, New Jersey, Nevada, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Texas, Utah, Vermont, Washington, Wisconsin and Wyoming. Additionally, eleven other states are developing standards (*i.e.,* Alaska, District of Columbia, Idaho, Illinois, Iowa, Kansas, Kentucky, Maryland, South Dakota, Tennessee and West Virginia). Of the states that have adopted statewide interconnection standards, a range of technologies, including CHP systems, have been covered within the scope of the standard. According to a US EPA assessment, fifteen states (California, Connecticut, Delaware, Indiana, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Nevada, Ohio, Oregon, Pennsylvania, Vermont and Washington) have standards that are considered "DG-friendly."

After restructuring, Maine did not adopt statewide uniform interconnection standards. Instead, each utility used different procedures and each had its own requirements for the interconnection of small generators to their distribution systems. However, in 2003 the MPUC stated that it was "…not aware of any unwarranted barriers deriving from the interconnection procedures and the Federal Energy Regulatory Commission (FERC) [was] in the process of addressing the matter." Since 2003, FERC and other organizations have created a number of model interconnection standards that states may use for statewide needs. The three major uniform rules are FERC's Small Generator Interconnection Procedure (SGIP), Interstate Renewable Energy Council's (IREC) model standards, and Mid-Atlantic Demand Resources Institute's (MADRI) model standards.

FERC's SGIP has been the most widely used. The IREC model is based on the FERC model, but a few changes were made to improve timeframes and to lower remaining barriers to small generation. MADRI is less utilized by other states. It was originally developed for the Mid-Atlantic States and has at least informed Pennsylvania's small generator interconnection process, but few others.

During the 2008 session, the Maine State Legislature enacted "Resolve, To Encourage Renewable Energy and Energy Conservation in Maine." Section 2 of the Resolve directed the MPUC to conduct a review of the advisability of statewide interconnection standards for small renewable generation facilities. The MPUC concluded in its Draft Report that statewide interconnection procedures for Maine's utilities should be imposed. In particular, the MPUC concluded that "Standardized rules [would] increase the efficiency of the interconnection process, encourage the increased use of renewable energy and energy conservation, and may foster an easier business environment for the companies that sell and install small generation systems."

On January 4, 2010, the MPUC issued an order in docket No. 2009.219 adopting statewide interconnection procedures which apply to all technologies, regardless of system size. The following points are included in these interconnection procedures (IREC, 2010):

- All state-jurisdictional interconnections are applicable, regardless of size of the generator.
- Four Interconnection levels of review (including a non-export level).
- Spot and area network interconnection provisions are the same as those found in IREC's model procedures.
- Disconnect switch is prohibited for small inverter-based systems.
- Application fees are $50 for level 1; $50 + $1/kW for other levels.
- Engineering fees: fixed at $100/hour.
- Insurance provisions adopted levels from IREC's 2009 model.
- Timelines were similar to IREC's model.
- The dispute resolution adopts a flexible approach that allows MPUC to tailor to the circumstances, including use of informal methods such as teleconferences.

5.2 UTILITY ISSUES ON SAFETY AND COST SHIFTING

During the task force meetings, the largest barriers raised by the T&D utilities were 1) safety of the CHP interconnections and 2) cost shifting to rate payers for lost revenues.

Interconnection safety should not be taken lightly, but it should be noted that the technical component of interconnections follows very clear national guidelines for power generation, protection (safety), relaying, metering and controls. T&D utilities are upgrading or replacing their own protection and automation systems with new multifunctional protection relaying and metering. Maine has adopted statewide interconnection standards that address safety as a barrier.

During the CHP stakeholder meetings, "cost shifting" to the rate payers was one of the largest concerns of electric T&D utilities in the advancement toward CHP models in Maine. T&D utility rates in the state of Maine, as well as most other electric deregulated jurisdictions, are based upon the cost of serving customers, as well as the allowed regulated rate of return on the rate base. The cost of service and allowed rate of return components make up a utility's revenue requirement. A T&D utility's revenue requirement and rates are generally set through MPUC and FERC rate cases whereby rates or alternative rate plans establish rates for a predetermined period of time. There is no electric rate that a regulated utility charges that isn't explicitly approved through a regulatory process that, in many cases, has various interested stakeholders engaged throughout the process.

When rates are set and designed, these utility rates reflect the average cost to serve various classes of customers and this average cost may be higher or lower than the marginal cost to serve any one specific customer. Since an electric utility has an obligation to serve all its customers, which ultimately implies that it has the obligation to build the infrastructure to serve these customers at any peak or off-peak demand time period, the excess costs associated with some customers are spread across all customers and borne by all ratepayers.

When an existing electricity customer converts to CHP technology, their electricity consumption (kWh) drops, but is not totally eliminated. CHP customers generally remain connected to the electric system and take service when the CHP generator is out of service. Consequently, the revenue that a CHP customer contributes through minimal consumption may not be sufficient to cover the cost of service associated with that customer; therefore, the cost to serve the CHP customer may ultimately be shifted to other customers.

In an effort to reduce or eliminate "cost shifting" to other customers, some utilities, such as Bangor Hydro Electric Company, have sought to institute an approved tariff that accounts for the cost to provide standby electric service. Some feel that standby rates approved by a regulatory body generally represent an example of compromise between the CHP customer, other ratepayers, and the utility.

Some proponents of CHP consider standby rates to be excessive considering the limited use of the electrical system; however, others say that the cost to build and maintain the system is the same whether it is used by the customer 365 days a year or only 1 day a year. These stakeholders state that the CHP customer has lower energy (kWh) consumption, yet the utility must provide the infrastructure needed to serve the maximum demands (kW) of the customer. Generally speaking, CHP customers have high demands requiring a robust electrical system to serve them when their generator is out of service.

Electric utilities are allowed to recover their costs to serve their customers through rates by charging customers based on their energy consumption or demand levels. Some argue that standby rates attempt to balance the interests of the CHP customers, the ratepayer and the utility through the application of below average delivery rates and characteristics of service that lessen the ratepayer impact of normal cost recovery. The appropriate approach will require leadership to create a straight-forward policy that addresses this issue for the best interest of Maine. Perhaps there will be a hybrid model that solves this issue.

5.3 LIMITED FUEL SOURCE INFRASTRUCTURE

Natural gas is an ideal fuel source for small and medium sized CHP systems. Maine should maximize the advancement of the CHP energy model throughout existing natural gas infrastructure locations. A strong natural gas expansion initiative would create and retain Maine jobs as well as help realize our Regional Greenhouse Gas Initiative (RGGI) goals. There is currently an effort underway for the installation of liquefied natural gas (LNG) stations strategically located along major transmission pipelines. LNG would also help advance the CHP model where biomass-fueled systems may not be economically or technically feasible.

Biomass resources are also excellent fuel sources for CHP systems and extensive evaluation of Maine's biomass or wood fiber feedstock availability is ongoing. The cost for this feedstock can be impacted by various factors, including competitive use demands from forest products, pulp & paper and wood pellet industries. Further discussion is needed as to whether biomass CHP plants should be defined as non-competitive by specifying that their supplier provide feedstock fiber only from tops, limbs and small de-limbed trees, and other sources and not from pulp grade sources.

Bio-gas can be produced from many sources including capped landfills, anaerobic digesters and renewable fuel conversion processes. Landfill gas is already being used in Maine at the Hampton landfill and other smaller landfills and is being proposed for the West Old Town Landfill. An opportunity exists for the Energy Eco-Park Model to be employed at the Old Town landfill by constructing a bio-gas tri-generation plant as an energy hub for the Eco-Park. The Energy Eco-Park tri-generation plant would be designed to supply electricity and steam for heating and cooling for park tenants (new businesses) as well abutting neighbors, including the University of Maine in Orono and the Old

Town Fuel and Fiber Mill. This model would help businesses and the University control energy costs as well as create economic development opportunities by enticing new businesses into the Park with low-cost renewable energy guarantees.

Anaerobic digesters create bio-gas by digesting organic matter including agricultural animal waste, agricultural plant waste and energy crops. In this model, the bio-gas created is used in a reciprocating engine/generator as a fuel source or in traditional combustion boilers. The fuel can be used for CHP Model 1, 1A, or 2.

Bio-fuel is a large area for CHP fuel development or fuel optimization. For biomass-sourced CHP applications, the developer may want to consider the pre-treatment of the biomass prior to being utilized in the CHP plant in order to extract value-added energy content. In this model, the biomass is pre-treated and hemi-cellulose is extracted for use in creating bio-butanol (transportation fuel) or bio-chemicals. The remaining pre-treated biomass is then used in the CHP facility. In any case, all developers should be encouraged to explore and evaluate emerging technologies that may enhance their project's value.

Bio-oil is another fuel that is being created from non-competitive biomass to create a cellulose-based replacement for #2 fuel oil and # 6 fuel oil. In the CHP model for producing bio-oil, the refinery is co-located at a forest products facility that requires electrical and thermal energy. Some of the bio-oil produced is then used in a combustion-turbine-generator with heat recovery boiler to create electricity and steam for the host. The remaining bio-oil is sold to the market.

On this topic, we suggest further review of the "Liquid Biofuels Policy for Maine" report submitted by OEIS to the legislature in February of 2008.

5.4 LACK OF PRE-ENGINEERING PROJECT DEVELOPMENT FUNDING

For over a decade, one of the largest barriers to the advancement of the CHP energy model has been funding for pre-development and development. Even large Fortune 100/500 companies do not have the budgets to fund the feasibility studies that help build the business case for advanced projects. In most cases where a feasibility study is completed, the comprehensive pre-engineering funding is almost non-existent. Pre-engineering is the process by which a fiscal grade project scope and budget are created to within +/- 10%. Once this level of engineering has been completed, then traditional and non-traditional funding can be secured for project implementation.

One of the biggest barriers for launching CHP projects in Maine has been lack of funding for feasibility studies and comprehensive pre-engineering.

6. INCENTIVES AND FUNDING PROGRAMS

6.0 TYPES OF INCENTIVES

The incentive and funding program descriptions in Section 6 are primarily drawn from US EPA's CHP Partnership Program. For the most current incentives see the CHP Partnership webpage: http://www.epa.gov/chp/index.html.

For CHP systems, a number of Federal incentives and funding programs are available. Types of incentives include tax credits, rebates, grants and loans. Some of these incentives expire by the end of 2010 while others terminate much later. Many of the incentives were created or are supported by the adoption of recent Acts, such as the Energy Independence and Security Act of 2007 (EISA) and the Energy Policy Act of 2005 (EPACT). The Internal Revenue Service, Department of Energy and the Department of Agriculture all administer funds for various types of programs. For a more detailed description of individual grants and incentives offered for CHP systems, please refer to Appendix F.

CHP incentive and funding opportunities are offered by various government entities throughout the country, many at the state and federal level. These opportunities take a variety of forms, including:

- Financial incentives, such as grants, tax credits, low-interest loans, favorable partial load rates (e.g., standby rates), and tradable allowances.
- CHP or biomass project development can be expedited with regulatory treatment, such as standard interconnection requirements, net metering, and output-based regulations that remove unintended barriers.

6.1 FEDERAL INCENTIVES FOR DEVELOPING COMBINED HEAT AND POWER PROJECTS

In 2008 and early 2009, two key federal bills were passed that include provisions that support CHP:

- The Energy Improvement and Extension Act of 2008 (EIEA) passed by Congress on October 3, 2008, significantly expanded federal energy tax incentives and introduced the CHP investment tax credit.
- The American Recovery and Reinvestment Act of 2009 (ARRA), passed in February 2009, expands and revises tax incentives for CHP and provides funding opportunities for CHP and waste energy recovery.

Note that many of the programs authorized in EIEA or ARRA are still under development.

6.2 TAX PROVISIONS

6.2.1 CHP Investment Tax Credit (ITC)

EIEA created a 10% investment tax credit (ITC) for the costs of the first 15 MW of CHP property. To qualify for the tax credit, the CHP system must:

- Produce at least 20% of its useful energy as electricity and 20% as thermal energy;
- Be smaller than 50 MW;
- Be constructed by the taxpayer or have the original use of the equipment begin with the taxpayer;
- Be placed in service after October 3, 2008 and before January 1, 2017; and

- Be 60% efficient on a lower heating value basis.

The 60% efficiency requirement does not apply to CHP systems that use biomass for at least 90% of the system's energy source. The ITC may be used to offset the alternative minimum tax and the CHP system must be operational in the year in which the credit is first taken.

ARRA allows taxpayers eligible for the CHP ITC to receive a grant from the U.S. Department of the Treasury instead of taking the ITC for new installations. For eligible CHP projects, Treasury will make payments to qualified applicants in an amount equal to 10% of the system cost. The Treasury Department is now accepting applications for the grant program. For more information including the guidance document (PDF), terms and conditions (PDF), and a sample application (PDF), please visit the U.S. Department of Treasury's Web site. To apply for a grant in lieu of the tax credit, please visit the application web site.

The CHP ITC is claimed through IRS Form 3468, available on the IRS's Web site. Facility owners who claim the ITC can not claim the production tax credit (PTC).

6.2.2 Investment Tax Credits for Micro-Turbines and Fuel Cells

The EIEA extended the ITC to micro-turbines and fuel cells. For micro-turbines, the credit is equal to 10% of expenditures, with no maximum limit stated (explicitly), but it is capped at $200 per kW of capacity. Eligible property includes micro-turbines up to two MW that have an electricity-only generation efficiency of 26% or higher.

For fuel cells, the credit is equal to 30% of expenditures, with no maximum credit. However, the credit for fuel cells is capped at $1,500 per 0.5 kW of capacity. Eligible property includes fuel cells with a minimum capacity of 0.5 kW that have an electricity-only generation efficiency of 30% or higher. (The credit for property placed in service before October 4, 2008, is capped at $500 per 0.5 kW.)

The ITC for both micro-turbines and fuel cells is available for eligible systems placed in service on or before December 31, 2016. As with the CHP ITC, facility owners can choose to receive a one-time grant equal to 30% of the construction and installation costs for the facility, as long as the facility is depreciable or amortizable. To be eligible, the facility must be placed in service in 2009 or 2010, or construction must begin in either of those years and be completed prior to the end of 2013. For more information including the guidance document, terms and conditions and a sample application, please visit the U.S. Department of Treasury's Web site. To apply for a grant in lieu of the tax credit, please visit the application web site.

The ITC for micro-turbines and fuel cells is claimed through IRS Form 3468, available on the IRS's Web site. Facility owners who claim the ITC can not claim the production tax credit (PTC).

6.2.3 Renewable Electricity Production Tax Credit

The EIEA extended the PTC for biomass, geothermal, hydropower, landfill gas, waste-to-energy, and marine facilities and other forms of renewable energy through 2010, and the ARRA further extended the tax credit through 2013. The renewable electricity PTC is a per kWh federal tax credit included under Section 45 of the U.S. tax code for electricity generated by qualified energy resources. The PTC provides a corporate tax credit of 1.0 cents/kWh for landfill gas, open-loop biomass, municipal solid waste resources, qualified hydropower, and marine and hydrokinetic (150 kW or larger). Electricity from wind, closed-loop biomass, and geothermal resources receive 2.1 cents/kWh. Projects that receive other government grants or subsidies receive a discounted tax credit.

The ARRA allows taxpayers eligible for the federal PTC to take the federal business energy investment tax credit (ITC) or to receive a grant from the U.S. Treasury Department instead of taking the PTC for new installations. The Treasury Department issued Notice 2009-52 in June 2009, giving limited guidance on how to take the federal business energy investment tax credit instead of the federal renewable electricity production tax credit. The Treasury Department is now accepting applications for the grant program. For more information including the guidance document, terms and conditions and a sample application, please visit the U.S. Department of Treasury's Web site.

The Renewable Energy PTC is claimed through IRS Form 8835 and IRS Form 3800.

6.2.4 Bonus Depreciation

Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain property through depreciation deductions. The MACRS establishes a set of class lives for various types of property, ranging from three to 50 years, over which the property may be depreciated. The ARRA extended the five-year bonus depreciation schedule through 2010 and includes CHP, thereby allowing 50% of the depreciation value to be taken in the first year and the remainder over the following four years.

To qualify for bonus depreciation, a project must satisfy these criteria:

- The property must have a recovery period of 20 years or less under normal federal tax depreciation rules;
- The original use of the property must commence with the taxpayer claiming the deduction;
- The property generally must have been acquired during 2009 or 2010; and
- The property must have been placed in service during 2009 or 2010.

The bonus depreciation rules do not override the depreciation limit applicable to projects qualifying for the federal business energy tax credit. Before calculating depreciation for such a project, including any bonus depreciation, the adjusted basis of the project must be reduced by one-half of the amount of the energy credit for which the project qualifies.

For more information on the federal MACRS, see IRS Publication 946, IRS Form 4562: Depreciation and Amortization, and Instructions for Form 4562.

6.2.5 Advanced Energy Manufacturing Tax Credit

ARRA established the advanced energy manufacturing tax credit to encourage the development of a U.S.-based renewable energy manufacturing sector. ARRA authorizes the Department of the Treasury to issue $2.3 billion of credits under the program. In any taxable year, the investment tax credit is equal to 30% of the qualified investment required for an advanced energy project that establishes, re-equips, or expands a manufacturing facility that produces any of the following:

- Equipment and/or technologies used to produce energy from solar, wind, geothermal, or other renewable resources;
- Fuel cells, micro-turbines, or energy-storage systems for use with electric or hybrid-electric motor vehicles;
- Equipment used to refine or blend renewable fuels; or

- Equipment and/or technologies to produce energy-conservation technologies (including energy-conserving lighting technologies and smart grid technologies).

Qualified investments generally include personal tangible property that is depreciable and required for the production process. Other tangible property may be considered a qualified investment only if it is an essential part of the facility, excluding buildings and structural components.

To be eligible for the tax credit, a project must be certified by the Department of the Treasury. In determining which projects to certify, ARRA directs the Department of the Treasury to consider those projects that most likely will:

- Be commercially viable;
- Provide the greatest domestic job creation;
- Provide the greatest net reduction of air pollution and/or greenhouse gases;
- Have the greatest potential for technological innovation and commercial deployment;
- Have the lowest levelized cost of generated (or stored) energy or the lowest levelized cost of reduction in energy consumption or greenhouse gas emissions; and
- Have the shortest project time from certification to completion.

After certification is granted, the taxpayer has up to one year to provide additional evidence that the requirements of the certification have been met and three years to put the project in service.

On August 13, 2009, the Department of the Treasury announced the availability of funds under the program and preliminary applications were due to DOE September 16, 2009, followed by final applications being due to DOE and IRS on October 16, 2009. By January 15, 2010, the IRS certified or rejected applications, and notified the certified projects with the approved amount of their tax credit. Awardees received acceptance agreements from the IRS by April 16, 2010. Credits will be allocated until the program funding is exhausted. Subsequent allocation periods will depend on remaining funds.

6.2.6 Clean Renewable Energy Bonds

The 2005 Energy Policy Act created Clean Renewable Energy Bonds (CREBs) within Section 54 of the U.S. tax code. Unlike traditional bonds that pay interest, tax credit bonds pay the bondholders by providing a credit against their federal income tax. In effect, CREBs provide interest-free financing for clean energy projects.

In 2008, EIEA provided authority for the issuance of an additional $800 million in "new" CREBs, and in 2009, ARRA allocated an additional $1.6 billion for CREBs. The 2008 legislation also extended the deadline by which bonds must be issued for previous allocations to December 31, 2009.

The types of projects for which bonds can be issued include renewable energy projects utilizing landfill gas, wind, biomass, geothermal, solar, municipal solid waste, small hydroelectric, marine, and hydrokinetic. The IRS has determined that facilities "functionally related and subordinate" to the generation facility itself are also eligible for CREB financing. Examples of these auxiliary components include transmission lines and interconnection upgrades.

The EIEA directs the IRS to allocate the bonding authority equally among electric cooperatives, government entities, and public power producers. Other changes for "new" CREBs are as follows:

- The federal tax credit is reduced to 70% of the interest payment;
- The bond holder can transfer the tax credit to another party;
- Taxpayers can carry forward unused credits into future years; and
- Bond proceeds must be used within three years or a request for an extension must be made.

6.2.7 Qualified Energy Conservation Bonds

The EIEA created a new funding mechanism called Qualified Energy Conservation Bonds (QECBs), similar to the CREB model in which a bondholder receives tax credits in lieu of interest. The act authorizes state, local, and tribal governments to issue energy conservation bonds to finance qualified projects. The 2008 legislation allows the IRS to distribute up to $800 million in bond authorizations. In 2009, ARRA provided an additional $2.4 billion in bonding authority. The bond proceeds can be used to finance capital expenditures that achieve one of the following goals:

- Reduction of energy consumption by at least 20%;
- Implementation of a green community program; or
- Electricity generation from renewable resources in rural areas.

An IRS notice contains more details about the bond program, including an outline for the bond cap for each state. The IRS is expected to issue further guidance on how the program will work soon.

6.3 GRANTS/PRODUCTION INCENTIVES

6.3.1 Deployment of CHP Systems, District Energy Systems, Waste Energy Recovery Systems, and Efficient Industrial Equipment

On June 1, 2009 the DOE announced plans to provide $156 million from ARRA to support projects that deploy efficient technologies in the following four areas of interest:

- CHP;
- District energy systems;
- Industrial waste energy recovery; and
- Efficient industrial equipment.

Applications were due by July 15, 2009.

On November 3, 2009, the DOE announced its award of more than $155 million to 41 industrial energy efficiency projects across the country. The nine largest projects, totaling $150 million and leveraged with $634 million in private industry support, will promote the use of CHP, district energy systems, waste energy recovery systems, and energy efficiency initiatives at hospitals, utilities, and industrial sites.

A full list of recipients is available on the DOE's Industrial Technology Program Web site.

6.3.2 Combined Heat and Power Systems Technology Development Demonstration

The Combined Heat and Power Systems Technology Development Demonstration aims to accelerate the development and deployment of CHP technologies and systems to work towards a goal of increasing U.S. electricity generation capacity from CHP. Applications for CHP technology development and demonstration will be considered for three areas of interest. The areas of interest are based on the output range of the CHP system and are as follows:

- Large CHP systems (greater than or equal to 20 MW);
- Medium CHP systems (greater than or equal to 1 MW to less than 20 MW); and
- Small CHP systems (greater than or equal to 5 kW to less than 1 MW).

All three areas sought applicants that can perform research, development, and demonstration of technologies that increase the efficiency and reduce the cost of CHP systems. Applications were due by August 4, 2009.

The large CHP systems have an estimated total budget of $30 million – $15 million from the DOE. The medium systems have an estimated budget of $30 million – $15 million from the DOE. Small CHP systems have an estimated budget of $20 million – $10 from the DOE.

Funded demonstration projects are aimed at accelerating the project development process through collaborative partnerships with key industry partners. Key technologies are those capable of sizable energy savings and corresponding greenhouse gas emissions reductions while providing a least cost approach to compliance with relevant emissions regulations. All technologies have a defined pathway to commercialization.

6.3.3 Waste Energy Recovery Registry and Grant Program

Title IV of the Energy Independence and Security Act of 2007 contains extensive new provisions designed to save energy in buildings and industries. Subtitle D of the Act focuses on industrial energy efficiency and contains new provisions designed to improve energy efficiency by promoting CHP, waste energy recovery, and district energy systems. EPA is required under EIEA Subtitle D, Part E to establish a recoverable waste energy inventory program.

Subject to appropriations, the EIEA also directs the DOE to develop a waste energy recovery incentive grant program to provide incentive grants to:

- Owners and operators of projects that successfully produce electricity or incremental useful thermal energy from waste energy recovery;
- Utilities purchasing or distributing the electricity; and
- States that have achieved 80% or more of recoverable waste heat recovery opportunities.

US EPA's obligation under EISA is to develop an ongoing survey of major domestic industrial and large commercial sources, as well as the sites at which the sources are located, and to conduct a review of each source for the quantity and quality of potential waste energy produced. This survey is a necessary first step to gather the data needed to establish the Registry of Recoverable Waste Energy Sources (Registry). The purposes of the survey and Registry are to:

- Provide a list of the economically feasible existing waste energy recovery opportunities in the US, based on a survey of major industrial and large commercial sources.

- Provide state and national totals of the existing waste energy recovery opportunities, as well as the potential criteria pollutant and greenhouse gas emissions reductions that could be achieved with the capture and use of the waste energy recovery opportunities listed in the Registry.

- Serve as the basis for potential waste energy recovery projects to qualify for financial and regulatory incentives as described in Energy Policy and Conservation Act (EPCA) Sections 373 "Waste Energy Recovery Incentive Grant Program" and 374 "Additional Incentives for Recovery, Use, and Prevention of Industrial Waste Energy," as added by EISA.

On July 16, 2009, the US EPA Administrator signed a draft rule which proposes to establish the criteria for including sources or sites in the Registry, as required by EISA. The draft rule also proposes the survey processes by which US EPA will collect data and populate the Registry. The proposed rule would apply to major industrial and large commercial sources as defined by US EPA in the rulemaking. The proposed rule would not require the installation of new monitoring equipment, rather it would require only that sources above certain threshold levels that wish to be included in the Registry enter specific already-monitored data points into the survey. The survey is a software tool that will calculate the quantity and quality of potentially recoverable waste energy.

The proposed rule and relevant background information can be accessed on the Waste Energy Recovery Registry Web site. Public comments were accepted through September 21, 2009. For general questions about the proposed rule, contact Katrina Pielli.

6.3.4 EPA Clean Water and Drinking Water State Revolving Funds

ARRA provides funding for states to finance high-priority infrastructure projects needed to ensure clean water and safe drinking water. It provided $4 billion for the Clean Water State Revolving Fund (CWSRF) program, in place since 1987, including funds for Water Quality Management Planning Grants. ARRA also provided $2 billion for the Drinking Water State Revolving Fund (DWSRF) program, in place since 1997. States must provide at least 20% of their grants for green projects, including green infrastructure, energy or water efficiency, and environmentally innovative activities. CHP projects at wastewater treatment facilities qualify for grants under the 20% set-aside.

The CWSRF program is available to fund a wide variety of water quality projects, including all types of nonpoint source, watershed protection or restoration, and estuary management projects, as well as more traditional municipal wastewater treatment projects. Through the CWSRF program, each state and Puerto Rico maintain revolving loan funds to provide independent and permanent sources of low-cost financing for a wide range of water quality infrastructure projects. Funds to establish or capitalize the CWSRF programs are provided through federal government grants and state matching funds (equal to 20% of federal government grants).

The DWSRF program provides public water systems with affordable financing for infrastructure improvements which enable them to comply with national primary drinking water standards and protect public health. States use federal capitalization grant money awarded to them under this program to set up an infrastructure funding account from which assistance is made available to public water systems. Loans made under the program can have interest rates between 0% and market rate and repayment terms of up to 20 years. Loan repayments to the state provide a continuing source of infrastructure financing.

More information and program guidance, including grant allocations to each of the states is available through the Clean Water and Drinking Water State Revolving Funds Web site.

6.3.5 Renewable Energy Production Incentive

The Renewable Energy Production Incentive (REPI) Program was created by the Energy Policy Act of 1992 and reauthorized by the Energy Policy Act of 2005 to extend through 2026. REPI provides financial incentives for renewable energy electricity produced and sold by qualified renewable energy generation facilities, which include not-for-profit electrical cooperatives, public utilities, state governments, U.S. territories, the District of Columbia, and Indian tribal governments. The facilities are eligible for annual incentive payments of approximately 2 cents/kWh for:

- Landfill Gas
- Solar
- Wind
- Geothermal
- Biomass
- Livestock Methane
- Ocean
- Fuel cells using hydrogen derived from eligible biomass facilities

To be eligible, qualified renewable energy facilities must be operational before October 1, 2016. Funding is subject to annual appropriation, and the program has historically been under-funded. During years in which there is a funding shortfall, legislation requires DOE to allocate 60% of REPI funds to solar, wind, ocean, geothermal, or closed-loop biomass technologies and the remainder to landfill gas, livestock methane, and open-loop biomass projects. If funds are not sufficient to make full payments to all qualifying facilities, payments are made to those facilities on a pro rata basis.

To assist DOE in its budget planning, DOE requests that the owner or operator of a qualified renewable energy facility provide notification at least six months in advance of electricity generation. To receive payment, qualified facility owners and operators submit information, such as monthly electricity generation, to DOE during the first quarter (i.e., October 1 through December 31) of the next fiscal year.

More information and details about the application procedures are provided on the REPI Web site and in the Partnership's funding database.

6.3.6 Energy Efficiency and Conservation Block Grant Program

The Energy Efficiency and Conservation Block Grant (EECBG) Program provides grants to local governments, tribal governments, states, and U.S. territories to reduce energy use and fossil fuel emissions, and to implement energy efficiency improvements. Through formula and competitive grants, the Program empowers local communities to make strategic investments to meet the nation's long-term goals for energy independence and leadership on climate change.

The EECBG Program is intended to help U.S. cities, counties, states, territories, and Indian tribes to develop, promote, implement, and manage energy efficiency and conservation projects and programs designed to:

- Reduce fossil fuel emissions;
- Reduce the total energy use of the eligible entities;

- Improve energy efficiency in the transportation, building, and other appropriate sectors; and
- Create and retain jobs.

Funding for the EECBG Program under ARRA totals $3.2 billion. Of this amount, approximately $2.7 billion will be awarded through formula grants. In addition, approximately $454 million will be allocated through competitive grants.

All states are eligible to apply for direct formula grants and competitive grants from DOE. Depending on population, cities and counties are eligible for EECBG Program funds either directly from DOE or from the state in which they are located.

To date, DOE has awarded more than 1,200 EECBGs, totaling over $1.4 billion. The first EECBG formula grant awards were made on July 24, 2009, and continue to be made each week.

On October 19, 2009, DOE issued its competitive EECBG funding opportunity announcement. The announcement seeks innovative state and local government and Indian tribe programs, and will use up to $454 million in ARRA EECBG funds for these competitive grants awarded in the two topic areas described below. Applications were due to DOE by December 14, 2009, and the voluntary letters of intent were due by November 19, 2009.

- **Topic 1: Retrofit Ramp-Up, $390 million.** The first topic area will award funds for innovative programs that are structured to provide whole-neighborhood building energy retrofits. These will be projects that demonstrate a sustainable business model for providing cost-effective energy upgrades for a large percentage of the residential, commercial, and public buildings in a specific community. DOE expects to make 8 to 20 awards under this topic area, with award size ranging from $5-75 million. Eligible entities include states, formula-eligible local and tribal governments, entities eligible under Topic 2, and nonprofit organizations authorized by the preceding entities.
- **Topic 2: General Innovation Fund, $64 million.** The second topic area will award up to $64 million to help expand local energy efficiency efforts and reduce energy use in the commercial, residential, transportation, manufacturing, or industrial sectors. DOE expects to make 15 to 60 awards, with award size ranging from $1-5 million. Eligible entities include local and tribal governments that were not eligible to receive population-based formula grant allocations from DOE under the EECBG program; a governmental, quasi-governmental, or non-governmental, nonprofit organization authorized by and on behalf of a unit of local government (or Indian tribe) that was not an eligible entity; or a consortia of units of local governments (or tribes) that were not eligible entities.

For complete details on the availability of funds please visit the EECBG Web site, or the Partnership's funding database.

6.3.7 State Energy Program

The State Energy Program (SEP) provides grants to states to address their energy priorities in the areas of energy efficiency and development of renewable energy technologies. The ARRA appropriated $3.1 billion for the program for fiscal year 2009. In order for a state to be eligible for these funds, it must commit to all three of the following:

- Instituting policies at state-regulated utilities that support energy efficiency;
- Adopting energy efficient building codes; and
- Prioritizing grants toward funding energy efficiency and renewable energy programs.

States will have discretion over how the money is distributed. Local governments and others interested in developing CHP projects should contact their State Energy Office to learn more about their state's process for distributing grants. DOE has posted the list of State Energy Offices. In Maine, SEP funds are directed to Efficiency Maine and starting July 1, 2010 will be directed to the Efficiency Maine Trust.

The Weatherization and Intergovernmental Program in the DOE Office of Energy Efficiency and Renewable Energy manages SEP. More information about SEP can be viewed on the SEP Web site.

6.4 LOAN GUARANTEES

6.4.1 Innovative Energy Efficiency, Renewable Energy, and Advanced Transmission and Distribution Loan Guarantees

The Energy Policy Act of 2005 authorized the U.S. Department of Energy to issue loan guarantees to eligible projects that avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases. The projects need to employ new or significantly improved technologies when compared to technologies in service in the United States at the time the guarantee is issued. Under the solicitation that closed in February 2009, the minimum application fee was $75,000, which indicates that the program has historically been designed to support larger scale renewable energy and bio-fuel projects. DOE periodically publishes requests for applications for loan guarantees, which can target specific technologies or be general.

ARRA expanded the loan guarantee program with $6 billion for renewable energy systems, bio-fuel, and electric power transmission projects. "Renewable energy systems" include those that generate electricity or thermal energy (or manufacture component parts of such systems). Bio-fuel projects are limited to those that are likely to become commercial technologies and will produce transportation fuels that substantially reduce life-cycle greenhouse gas emissions compared to other transportation fuels. The 2009 funds are limited to projects that commence construction by September 30, 2011.

More information about DOE's loan guarantee program, including solicitation announcements, is available on the program's Web site.

6.5 COMMUNITY BASED RENEWABLE ENERGY PILOT PROGRAM

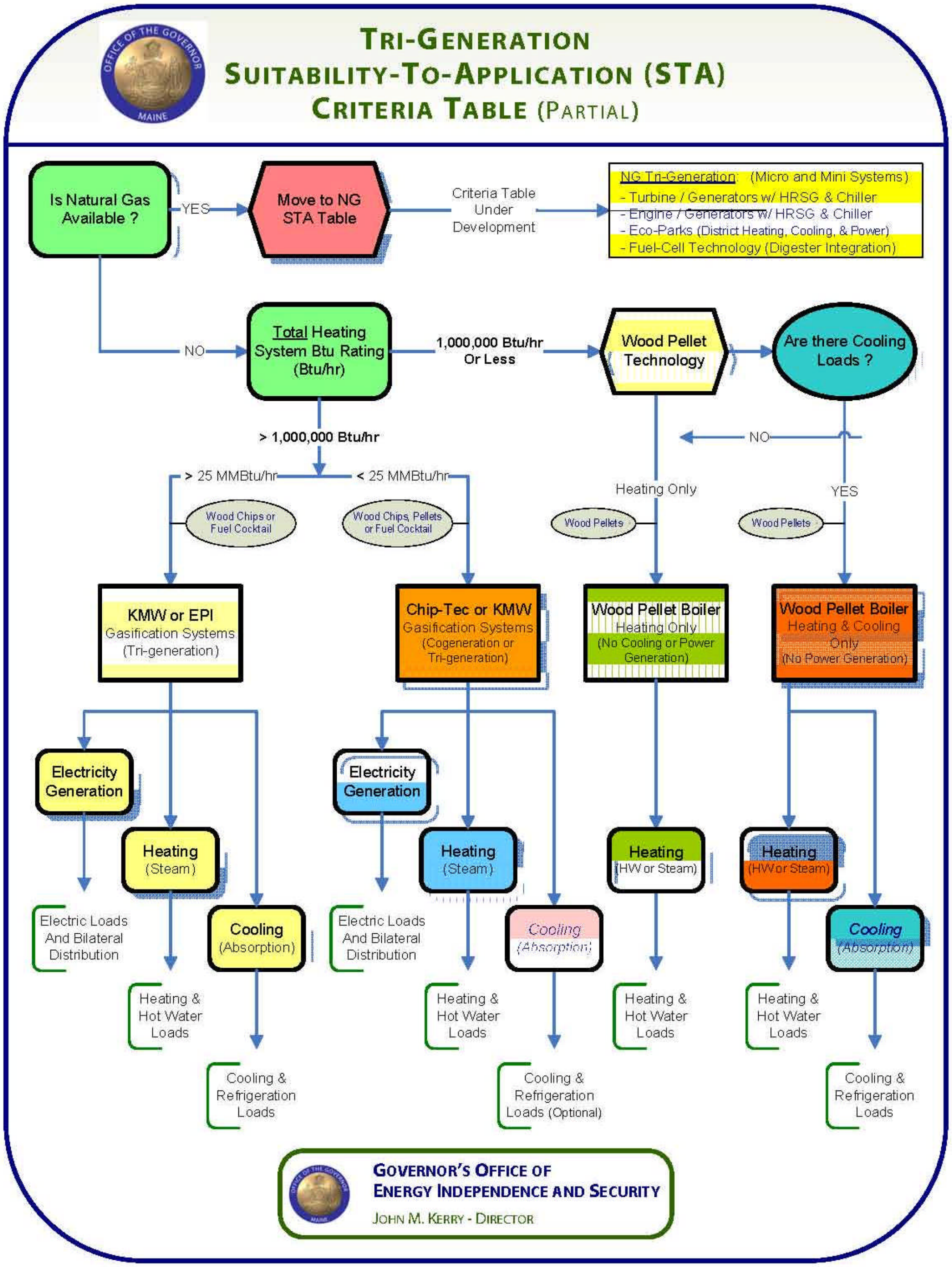
In response to legislative direction, the MPUC established a community-based renewable energy pilot program to encourage the sustainable development of community-based renewable energy in the State. The program is not to exceed 50 megawatts (MW) in capacity and eligible projects must include qualifying owners, community support, grid-connection, and capacity not to exceed 10 MW. One of two incentives can be applied to projects, either long-term contracts or a set renewable energy credit multiplier set at 150% of the amount of the electricity. The State may give purchasing preference to electricity generated by community-based renewable projects, the MPUC can incorporate into the supply of the standard-offer service and shall arrange for a green power offer composed of green power supply and will incorporate green power supply from community-based renewable energy projects to the maximum extent possible.

7. BEST APPLICATIONS IN MAINE

7.1 BEST APPLICATION FOR CHP

As demonstrated in the previous sections in this report, CHP systems have been designed and built for many different applications and various types of facilities, such as commercial applications, hospitals, heath care, education and industrial sites.

In Maine, there are numerous opportunities for CHP application, and many facilities are in various stages of implementing CHP systems. In general terms, the best applications for CHP reside with Energy Eco-Parks, high density housing, health care facilities, hospitals, colleges and universities, food and/or seafood processors, wood product manufacturers, sawmills and any facility or business near natural gas transmission lines. Any facility that has 24/7 operations with heating and cooling needs is perfect for CHP. Facilities with intense thermal loads, such as pulp and paper manufacturers, are also particularly well suited for CHP. Cost-effective and efficient location of CHP at locations with significant thermal loads is encouraged, whether at industrial sites, high-density housing or other facilities. Many facilities and businesses are able to easily take advantage of the environmental and economic benefits that CHP systems offer once an energy model has been created for the site.


TRI-GENERATION
SUITABILITY-TO-APPLICATION (STA)
CRITERIA TABLE (PARTIAL)
Is Natural Gas Available ?
YES
Move to NG STA Table
Criteria Table Under Development
NG Tri-Generation: (Micro and Mini Systems)
- Turbine / Generators w/ HRSG & Chiller
- Engine / Generators w/ HRSG & Chiller
- Eco-Parks (District Heating, Cooling, & Power)
- Fuel-Cell Technology (Digester Integration)
NO
Total Heating System Btu Rating (Btu/hr)
1,000,000 Btu/hr Or Less
Wood Pellet Technology
Are there Cooling Loads ?
> 1,000,000 Btu/hr
NO
> 25 MMBtu/hr
< 25 MMBtu/hr
Heating Only
YES
Wood Chips or Fuel Cocktail
Wood Chips, Pellets or Fuel Cocktail
Wood Pellets
Wood Pellets
KMW or EPI Gasification Systems (Tri-generation)
Chip-Tec or KMW Gasification Systems (Cogeneration or Tri-generation)
Wood Pellet Boiler Heating Only (No Cooling or Power Generation)
Wood Pellet Boiler Heating & Cooling Only (No Power Generation)
Electricity Generation
Heating (Steam)
Cooling (Absorption)
Electric Loads And Bilateral Distribution
Heating & Hot Water Loads
Cooling & Refrigeration Loads
Electricity Generation
Heating (Steam)
Cooling (Absorption)
Electric Loads And Bilateral Distribution
Heating & Hot Water Loads
Cooling & Refrigeration Loads (Optional)
Heating (HW or Steam)
Heating & Hot Water Loads
Heating (HW or Steam)
Cooling (Absorption)
Heating & Hot Water Loads
Cooling & Refrigeration Loads
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JOHN M. KERRY - DIRECTOR

TRI-GENERATION
SUITABILITY-TO-APPLICATION (STA)
DATA TABLE (PARTIAL)

Sample - State System Sizes:

East Campus Capacity:	=	66,782,000 Btu/hr	(3 Boilers Total Capacity)
State House:	=	35,005,600 Btu/hr	(3 Boilers Total Capacity)
Service Garage:	=	2,900,000 Btu/hr	(1 Boiler Total Capacity)
Maine PUC Building:	=	1,089,000 Btu/hr	(1 Boiler Total Capacity)

Note: *Final systems should be sized based on thermal usage profiles, not capacity.*

Basic Conversions:

1 Boiler HP	=	33,465 Btu/hr
1 Boiler HP	=	9.8 $kW_{(Boiler)}$
1 lb Steam	=	1004 Btu
# 2 Fuel Oil	=	139,000 Btu / Gallon
Natural Gas	=	100,000 Btu / Therm.
1 Therm.	=	100,000 Btu
1 kWh	=	3,412 Btu
MMBtu	=	1,000,000 Btu
1 Refrigeration Ton	=	0.58 kW (Consumption)
1 Refrigeration Ton	=	12,000 Btu

Chip-Tec Gasification Systems:

Series A:
12 to 22 Boiler HP = (401,580 Btu/hr to 736,230 Btu/hr)

Series C:
23 to 300 Boiler HP = (769,695 Btu/hr to 10,039,500 Btu/hr)

Series B:
100 to 1,500 Boiler HP = (3,346,500 Btu/hr to 50,197,500 Btu/hr)

KMW Gasification Systems:

Range:
250 to 4,000 Boiler HP = (8,366,250 Btu/hr to 133,860,000 Btu/hr)

EPI Gasification Systems:

Magnitude *(13 MW Biomass Cogeneration or Tri-generation)*:
Up to 40,000 Boiler HP = (up to 1,305,200,000 Btu/hr)

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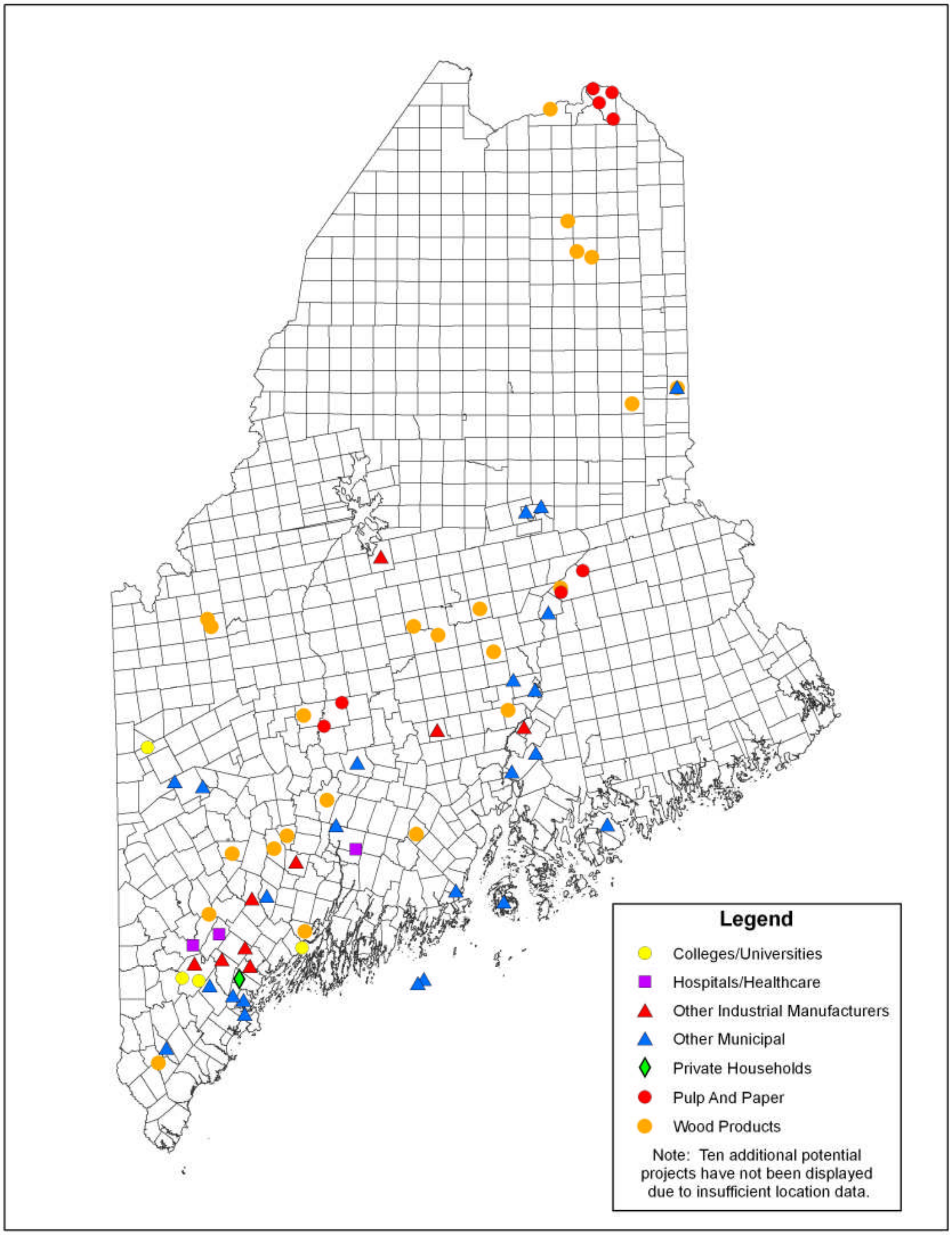
As part of the proposed Maine Energy Independence Fund (MEIF) initiative, OEIS examined potential "shovel-ready" projects throughout Maine that could benefit from positive CHP policies and incentives. OEIS identified more than 60 projects, consisting of a variety of different CHP applications totaling over $750 million.

Figure 7-1 is an illustrative map of potential CHP projects throughout the State of Maine. It does not reflect the full range of projects that may be available, but provides an initial snapshot of the extent to which CHP systems could penetrate the market given favorable incentives and funding opportunities.

Figure 7-1: Map of Shovel Ready Projects in Maine



Source: Map provided by Woodard & Curran

8. POTENTIAL LEGISLATIVE & POLICY RECOMMENDATIONS

Legislative and regulatory policy should recognize the valuable energy, economic development and environmental benefits of CHP and provide a hospitable market for CHP to compete with other energy resources. Maine is already playing an important role through inclusion of CHP as an eligible resource in its renewable portfolio standard and other initiatives. The Maine Legislature and Governor should review and consider the full toolbox of policy options to promote financial and policy incentives for CHP development, including public financing, tax incentives, loan and financing programs, utility and/or regulatory incentives and market-based approaches. CHP is an important part of a comprehensive, integrated energy plan. Policies must be in place to remove barriers to and stimulate CHP projects throughout the state.

OEIS recommends consideration of the following policies, initiatives and action items:

8.1 INTERCONNECTIONS TASKFORCE

In January 2010, the Maine Public Utilities Commission adopted a final rule, Chapter 324 Small Generator Interconnection Procedures, responding to a legislative resolve to "review and make a determination regarding the establishment of statewide standards for the interconnection of small renewable energy facilities to the energy grid." The MPUC concluded that statewide interconnection procedures for Maine's utilities should be created to increase the efficiency of the interconnection process, encourage the increased use of renewable energy and other distributed generation resources like combined heat and power systems and foster a market for companies that sell and install small generation systems.

OEIS commends the MPUC for its rulemaking and recommends that an interconnection stakeholder taskforce be formed to review and further explore how to streamline the technical and economic guidelines or requirements in order to quickly move CHP projects forward throughout the State of Maine.

Standardized interconnection requirements support the development of clean distributed generation by providing clear, concise rules for connecting CHP systems to the utility grid. These rules specify how to purchase power from the grid when supplemental power is needed and sell excess power to the grid. Uniform requirements can ensure that the costs of interconnection are the same throughout the state and are commensurate with the nature, size and scope of the project and that the project interconnection meets the safety and reliability needs of the utility and energy end-user.

The interconnection stakeholder taskforce should include electric utilities, MPUC commissioners, developers of CHP systems and projects, third-party technical organizations, other state agencies (e.g., OEIS), and NGOs.

Areas of exploration and collaboration may include:

- Specific issues faced by different project sizes and types, fuel sources and facilities;
- Appropriate CHP types and technologies;
- Strategies for reducing time and cost of interconnection process;
- Application process, purchase agreements, technical requirements, appropriate fees, insurance, liability issues;
- Existing federal and national organization model rules and requirements and other state experiences;

- Process to monitor effectiveness and ability to update rules; and
- Collaborative process for dispute resolution.

8.2 COST SHIFTING ANALYSIS

There is a concern that different rates and charges may apply to combined heat and power projects to recover utilities' reduced or lost revenue. If customers purchase less electricity due to on-site distributed energy projects, it is possible that utilities will have less income to cover fixed costs and these additional costs could be shifted to other ratepayers. If not properly designed, the additional rates may create unnecessary economic barriers to the use of renewable energy and CHP. Appropriate rate design is critical to ensure utility cost recovery, appropriate price signals for energy efficiency and renewable energy and reasonable and fair prices for rate payers.

OEIS recommends that the MPUC review and further explore cost shifting to ratepayers associated with utilities' potential lost revenue from CHP projects. This analysis should quantify the cost shifting, explore whether these rates and charges are creating unwarranted barriers to the use of renewable CHP projects, examine alternative rate designs and quantify and compare the system-wide benefits that CHP may provide.

A customer who shifts to CHP for the bulk of their electricity needs, but remains connected to transmission and distribution networks and relies upon the T&D network for backup service, should bear its fair share of the utility's costs, but this fair share is often less than 100% of the T&D costs that they would have otherwise paid. The case of Eastern Maine Medical Center demonstrates that "exit fees" or other rate designs that significantly seek to shift T&D rate recovery to allocation based on peak demand, as opposed to volumetric billing, can exert a significant chilling effect on CHP implementation in Maine. To use an analogy, it does not make sense to make a customer pay for a full fare buffet daily when the customer merely needs a snack now and then.

8.3 PURSUE MAINE ENERGY INDEPENDENCE FUND

The Maine Energy Independence Fund (MEIF) is a proposed public-private partnership that would match a potential DOE grant or loan one-to-one with private investments. Funds would be invested in small-to-medium sized clean energy projects and companies located in Maine. These funds would also help with the project development costs. The MEIF would create green jobs in the state, reduce dependence on imported sources of energy and lower energy costs. When fully leveraged with private investments, the MEIF could generate as much as $1 billion of much needed investment in renewable energy and energy efficiency infrastructure in Maine, including CHP projects.

8.4 COGENERATION ENERGY ZONES

The concept of cogeneration energy zones has merit but needs to be characterized. A cogeneration energy zone, as defined in LD 1044, is a "designated geographic area that includes a sawmill that has an on-site cogeneration facility." Deregulation allows CHP models to bilaterally distribute excess electricity supply to remote locations. For example, if Hancock Lumber installed a local CHP faculty in Bethel, any excess electricity from that site could be bi-laterally distributed to their other mills and retail stores in Maine via a wholesale energy account established with ISO-NE. The low-cost electricity supply would help reduce energy costs at the remote sites and the host CHP site in Bethel would realize the benefits of low cost electricity and thermal energy from the CHP plant.

Energy Eco-Parks for sawmill operations could be part of "Cogeneration Energy Zones" for sawmills. Cogeneration Energy Zones could have incentives that help advance CHP models for sawmills, such as streamlining the interconnection process or restricting utility standby fees and/or cost shifting. The energy zones could also benefit from guaranteed cost or access for biomass feedstock sources. Cogeneration Energy Zones could have access to low interest project funding and economic development resources to solicit potential complementary energy eco-park tenants. Hydroponic greenhouse operations or cold storage facilities would offer good year round thermal and electric tenants for such parks. Also, the co-location of bio-fuels production facilities should be considered as 24/7 energy hosts and a fiber enhancement business.

8.5 PLAN TO REDUCE PEAK POWER CONSUMPTION IN GOVERNMENT BUILDINGS

The State of Maine has made significant strides towards reducing the consumption and the cost of energy at the state-owned and operated facilities of executive branch departments and agencies (BGS, Jan. 2010, p. 6). Statewide heating oil use has decreased by an estimated 30% and electricity use decreased by an estimated 5% across these facilities during the FY05 - FY09 period (BGS, Jan. 2010, p. 6). Maine has been using 100% renewable electricity for state facilities since 2007 pursuant to MRSA Title 5, Section 1766-A (BGS, Jan. 2010, p. 4). Energy efficiency, conservation, and independence at the executive branch facilities of state Government can be improved, and the following four points summarize ways in which the State of Maine can reduce peak-load energy consumption in the existing and new state government buildings.

8.5.1 Demand Response Programs

Since the time of the 2007 Resolve, Chapter 183, the State of Maine has entered into a contractual agreement to reduce peak-load energy consumption through a so-called demand response program. Maine's private-sector partner is EnerNOC, which was selected as the result of a public, competitive process. The departments and agencies have pursued demand response programs for both generator and curtailment programs to reduce electricity costs by reducing electricity consumption during peak periods (BGS, Jan. 2010, pp. 11,13). The state through a contract with EnerNOC has enrolled multiple facilities with a total demand response capacity of 2,405 kW. The West Campus of state government in Augusta, which includes the State House, is among the locations enrolled in the demand response program. (BGS, Jan. 2010, p. 60).

In addition, the Department of Corrections, in partnership with BGS, enrolled all of the Department of Corrections facilities with EnerNOC. The program provides revenue to the department for being enrolled in the program and also provides revenue when the department uses its generators in the event that a demanded response event is declared by ISO New England. The revenue will be used to offset utility costs (BGS, Jan. 2010, p. 33).

The BGS Property Management Division, which provides service to 72 buildings within the communities of Augusta, Hallowell, and Vassalboro, is also enrolled with EnerNOC. The program will pay a fee to Property Management to ensure the removal of a given amount of power demand from the grid by running the Burton Cross Office Building generator. In the last three years, Property Management Division has reduced fuel consumption by 8% and electrical consumption by 14% (BGS, Jan. 2010, p. 25).

8.5.2 State Installation of CHP on East Campus

Among state government facilities, the single largest energy consuming location is the East Campus, which is managed by BGS (BGS, Jan. 2010, p. 10). The East Campus consumes approximately 425,000 gallons of heating fuel annually. The major initiative in this area is a plan to install a cogeneration or trigeneration energy system which would capture waste heat to generate electricity. (BGS, Jan. 2010, pp. 10, 60). Several rounds of initial assessment have been completed in the 2007-2009 period and have indicated a combined heat and power application with a fuel source other than oil could payback the initial investment in less than 10 years (BGS, Jan. 2010, p. 60). A substantial and more detailed assessment is expected to be completed for BGS in early 2010 by the firm Harriman Architect + Engineers (BGS, Jan. 2010, p. 60).

8.5.3 Plan Requirements

The following energy reduction goals relevant to state facilities are outlined in the State of Maine Comprehensive Energy Action Plan 2008-2009, promulgated by OEIS (BGS, Jan. 2010, pp. 60-68).

- Work with state government to adopt an overall energy reduction goal at state facilities;
- Work with state government to adopt an overall goal of new, renewable power generation at state facilities;
- Continue to promote increased efficiency standards for all new construction;
- Reduce peak-load energy consumption in all sectors;
- Seek to develop on-site clean, renewable energy projects at appropriate state facilities;
- Assist in the development of "bio-fuel" and "biomass" energy plants using Maine renewable resources;
- Work with DOC regarding biomass and bio-oil refineries using indigenous Maine fiber;
- Increase use of bio-fuels and alternative energy in state-occupied buildings; and
- Continue "lead by example" initiatives in Maine by implementing progressive energy policies applicable to state, county, and local governments.

8.6 EXPAND NATURAL GAS IN MAINE TO HELP REDUCE MAINE DEPENDENCE ON OIL

The Maine Comprehensive Energy Action Plan establishes goals to promote natural gas as a "transitional fuel" by expanding the natural gas infrastructure to all sectors in Maine and supporting development of liquefied natural gas ("LNG") where economically, socially and environmentally feasible. Although natural gas itself is a fossil fuel, it is cleaner-burning and more efficient per btu than fuel oil and coal, and will provide a more environmentally-friendly bridge between Maine's current consumption of fossil fuels and harnessing the state's abundant renewable energy resources. In order to do that, however, projects proposing to increase natural gas availability in Maine must pass the rigorous regulatory and statutory environmental review process exercised by the Department of Environmental Protection. In addition, the support of the community in which such development is proposed is of critical importance.

The Plan recommends convening a year-long, natural gas "dialogue" with all major natural gas players in the state to define the critical challenges regarding the development of traditional natural gas and LNG in Maine and to identify opportunities for the development of traditional natural gas and LNG projects where economically, socially and environmentally feasible. The Plan also recommends facilitating opportunities for private industry and residential customers to connect with natural gas companies in Maine to explore potential natural gas expansion projects.

Natural gas is an important part of the State's energy mix. In order to successfully and cost-effectively upgrade natural gas services, transmission systems and infrastructures, Maine must continue to work with natural gas companies, regulators, potential customers, communities and other stakeholders to explore the development of natural gas policies that support CHP systems in Maine. Natural gas demand is expected to increase and domestic production from conventional natural gas resources in the United States is not expected to keep pace with this projected demand growth. While Maine must focus on cultivating indigenous, renewable resources such as on- and off-shore wind, solar, biomass and bio-fuels, geothermal and tidal energy, it must carefully examine the role of natural gas, including LNG, including its safe and efficient storage and transportation, in the state's immediate and future energy plans.

8.7 SUPPORT CONGRESSIONAL DELEGATION AND ADMINISTRATION ON FEDERAL ENERGY INITIATIVES

The U.S. Congress has made energy and climate change policy development a priority legislative issue. OEIS supports a bipartisan approach to educate, promote awareness of and develop policy on increasing and expanding energy efficiency, renewable energy, natural gas and CHP use in the nation's energy portfolio. For example, the Maine Congressional Delegation should participate in efforts to explore the ways alternative energy sources can help meet Maine's energy needs and reduce the state's dependence on foreign fossil fuels. For example, the Senate and House Natural Gas Caucuses formed in October 2009 to examine the economic, environmental and energy benefits of using domestic sources of natural gas. These types of high-profile, bipartisan groups are also investigating distributed energy, high-performance and sustainable buildings, renewable energy and energy efficiency initiatives. The Maine Governor, Legislature and state agencies should participate in these educational efforts and serve as resources in Congressional hearings, briefings and other legislative forums.

8.8 SUPPORT CURRENT LEGISLATIVE AND REGULATORY ADVOCACY FOR CHP

The CHP community is advocating on the federal and state levels for legislative and regulatory initiatives that will support their industry. On the national level, these efforts include:

- Support to expand the CHP tax credit and extend it until 2016;
- Funding for CHP and waste energy recovery programs within the DOE Industrial Technology Program;
- Inclusion of CHP in a national renewable portfolio standard; and
- Dedicated revenues from climate change legislation to fund CHP, waste energy and district energy projects.

On the state level, CHP advocacy is focused on the following:

- Implementing utility rates to allow for utility cost recovery while also providing appropriate price signals for CHP and other clean energy resources;
- Emission regulations that require air permits to reflect the added value of CHP technologies and to be designed on an output-basis; and
- Standard interconnection regulations.

Increased funding for CHP research, development, demonstration and deployment is critical to incentivize appropriate and cost-effective, environmentally beneficial projects. Funding should be allocated to the most cost-effective projects on a "bang for the buck" basis, measured in terms of grid-purchased kWh avoided or greenhouse gas emissions avoided per public dollar.

In Maine, it has been suggested that the thermal portion of an in-state CHP project should qualify in the RPS and receive renewable energy credit (REC) value in addition to any qualifying (e.g., biomass) generation that is otherwise eligible under the RPS. This change in policy would recognize the full value of CHP projects as a component of the RPS mandate and should be fully explored and modeled as appropriate for Maine.

Maine policymakers should be aware of these activities and support those federal, regional and state initiatives that encourage cost-effective CHP projects in Maine. For example, we support examination of the Northeast CHP Application Center's recommendations for mechanisms that should be considered by New England states:

- Direct funding to provide support for desirable projects.
- Investment Tax Credits (ITC) to encourage capital investment. ITCs may be tied to CHP system efficiency, and states may enact ITCs that are incremental to or separate from Federal provisions.
- Production Tax Credit (PCT) to credit the facility based on energy produced, providing an incentive for reliable operation.
- Development incentives such as tax incentives for Brownfield redevelopment investments or loan guarantees may include CHP.
- Accelerated depreciation or expensing to ease the debt burden and shorten payoff periods. Under Federal rules, depreciation periods depend on what type of business owns the facility (industrial sites typically take depreciation faster than commercial or residential).
- Tax exempt financing or tax exempt leasing to promote investment.
- Loan guarantees to reduce risk to customers installing CHP.
- Emission reduction credits for distributed generation to provide market-based incentives to reduce NOx emissions – credits may be sold in existing emission markets.
- Tariff exemptions from standby or other charges for highly efficient CHP, or other regulatory mechanisms to recognize the system benefits of CHP.

Finally, CHP initiatives should be implemented in synergy with current programs, such as RGGI, and future plans pursued by the Efficiency Maine Trust.

8.9 PURSUE DOE/MAINE MEMORANDUM OF UNDERSTANDING

Maine is seeking to create a partnership with DOE through a Memorandum of Understanding (DOE-Maine Clean Energy and Efficiency Partnership) to:

- Integrate national, regional and state energy, environmental and economic policies;
- Invest in projects in Maine that increase energy efficiency, advance renewable energy, reduce greenhouse gas emissions and promote economic development and jobs;
- Make Maine a replicable model for achievement of a clean-energy-based economy;
- Develop and diversify Maine's economy and energy supply through innovative, market-based mechanisms that allow every sector to benefit from the transition to clean energy; and
- Help Maine create educational and employment opportunities necessary to sustain a clean energy economy.

8.10 IMPLEMENT GRANTS CONNECTOR PROGRAM

ARRA provides Maine with funds for job creation, energy efficiency, renewable energy, weatherization and workforce development. As a response to ARRA, OEIS will be coordinating federal, state and local funding programs with the goal of optimizing energy assistance for Maine businesses, non-profits and government entities. OEIS will track energy efficiency, renewable and clean energy projects in need of assistance and match them with policy, financial and incentive programs, their guidelines and all applicable deadlines. Eligible projects include CHP systems.

8.11 FULLY IMPLEMENT 'AN ACT REGARDING MAINE'S ENERGY FUTURE'

On June 12, 2009, Governor Baldacci signed into law *An Act Regarding Maine's Energy Future* (LD 1485), putting Maine on a path to reduce statewide heating oil consumption 20% by 2020. The legislation establishes the new, independent Efficiency Maine Trust for the purpose of administering programs for energy efficiency and alternative energy resources to help individuals and businesses in Maine "meet their energy needs at the lowest cost." The new Trust will is governed by an independent, nine-member board representing diverse state agencies, customer classes, and environmental interests and is subject to oversight by the MPUC.

The Trust has developed a triennial plan providing program design, planning and implementation strategies for all energy efficiency and alternative energy resources, for all fuel types, across all customer classes. CHP technologies and programs should be a key consideration in the Trust's activities.

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10. ACRONYMS

A

ADSCR- Adjusted Debt Service Coverage Ratio

AFC- alkaline

ARRA- American Recovery and Reinvestment Act

B

BCAP- Biomass Crop Assistance Program

BGS- Bureau of General Services

BHE- Bangor Hydro Electric

C

C-CHP- Combined Cooling Heat and Power

CESCI- Clean Energy Solutions Capital Investment

CHP- Combined Heat and Power

CI- compression-ignition

CMP- Central Maine Power

CO_2- carbon dioxide

CON- Certificate of Need

CREBs- Clean Renewable Energy Bonds

CWSRF- Clean Water State Revolving Fund

D

DG- distributed generation

DOC- Department of Corrections

DOE- Department of Energy

DOER- Department of Energy Resources

DTE- Department of Telecommunications and Energy

DWSRF- Drinking Water State Revolving Fund

E

EAP- Energy Audit Program

ECIPP- Enhanced Commercial/Industrial Performance Program

EECBG-Energy Efficiency and Conservation Block Grant

EIEA- Energy Improvement and Extension Act

EISA-Energy Independence and Security Act

EMMC-Eastern Maine Medical Center

EMS- Energy Management Services

EPA- Environmental Protection Agency

EPACT- Energy Policy Act

EPCA-Energy Policy and Conservation Act

ERC- Energy Resource Commission

F

FERC- Federal Energy Regulatory Commission

G

GCGP- Green Communities Grant Program

GIS- Generation Information System

GWe-gigawatts electric

H

HHV- higher heating value

HRSG-heat recovery steam generator

I

IREC- Interstate Renewable Energy Council

ITC- Investment Tax Credit

K

kW-kilowatt

kWh-kilowatt-hour

L

LHV-lower heating value

LNG-Liquefied Natural Gas

M

MACRS- Modified Accelerated Cost-Recovery System

MADRI- Mid-Atlantic Demand Resources Institute

MCFC-molten carbonate

MEIF- Maine Energy Independence Fund

MNG- Maine Natural Gas

MW- megawatt

N

NECHPI- Northeast Combined Heat and Power Initiative

NECHPRAC- Northeast Combined Heat and Power Regional Application Center

NGOs- non-government organizations

NOx- nitrogen oxide

NYSERDA- New York State Energy Research and Development Authority

O

O&M- Operations and Maintenance

OEIS- Office of Energy Independence and Security

P

PAFC- phosphoric acid

PEMFC- proton exchange membrane

PLRP- Peak Load Reduction Program

PPH- pounds per hours

PTC- Production Tax Credit

PUC- Public Utilities Commission

PURPA- Public Utilities Regulatory Policy Act

Q

QECBs- Qualified Energy Conservation Bonds

R

REC- Renewable Energy Credit

REPI- Renewable Energy Production Incentive

RGGI- Regional Greenhouse Gas Initiative

S

SEP- State Energy Program

SGIP- Small Generator Interconnection Procedure

SI- spark-ignition

SO_2- sulfur dioxide

SOFC- solid oxide

T

T&D- transmissions & distributions

U

USCHPA- United States Clean Heat and Power Association

V

VAMC- Veterans Administration Medical Center

VOCs- volatile organic compounds

W

WWTP- Wastewater Treatment Plant