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# Combined Heat and Power Backgrounder

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Energy, the foundation for today's modern society, is the focus of Guelph's Community Energy Initiative and is front and centre in the City's quest to build a resilient, sustainable city for future generations.

The Guelph Community Energy Plan, a Municipal Energy Plan that was endorsed by Guelph City Council in 2006, sets out ambitious goals for reductions in energy use and greenhouse gas emissions by 2031. In order to achieve these goals, electricity and thermal energy used to heat and cool communities must be produced and used much more efficiently.

Combined heat and power (also called CHP or cogeneration) is an efficient way to generate electricity and thermal energy. By using combined heat and power units which simultaneously generate electricity and thermal energy from one fuel source, communities are extracting more useful energy output from each unit of fuel input, resulting in efficiencies of up to or greater than 80 per cent; this is substantially greater than the 30-45 per cent efficiencies of conventional electricity production facilities.

By increasing efficiency, less fuel is used to generate the same amount of electricity and thermal energy making it cheaper and cleaner than buying electricity from the power grid or burning fuels in a boiler to produce thermal energy.

## Guelph's Community Energy Initiative and Combined Heat and Power

The Guelph Community Energy Initiative identified the fact that local, small-scale highly efficient combined heat and power facilities, especially when paired with district energy thermal grids, have an important role to play in helping the Guelph community achieve its energy and environmental goals.

Specifically, Guelph's Community Energy Plan calls for at least 30 per cent of the municipality's anticipated electricity requirements be associated with combined heat and power by 2031. The Plan recommends the City proactively seek combined heat and power projects with a total electric capacity in the 100-megawatt range with a comparable level of heat recovery.

Guelph's energy strategy promoting combined heat and power and district energy directly addresses a number of the municipality's strategic priorities including:

- Increasing energy efficiency
- Reducing greenhouse gas emissions
- Strengthening the resiliency of the City's energy infrastructure
- Improving energy security
- Growing the local economy – Attracting jobs
- Improving the competitiveness of local industries

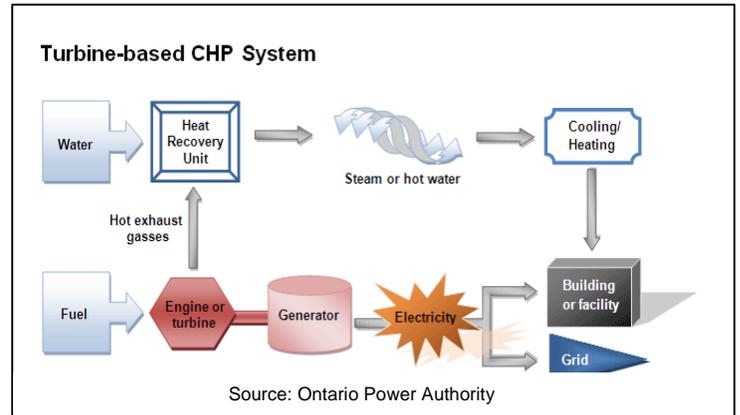
By generating much more useful energy from a single fuel input, combined heat and power offers tremendous economic and environmental benefits to direct users of the system, the local community and society as a whole.

## Frequently Asked Questions

### What is Combined Heat and Power?

Combined heat and power (also called CHP or cogeneration) is one of the most efficient ways to generate electricity and thermal energy.

In a combined heat and power system electricity and thermal energy are generated simultaneously from a single fuel source. Waste heat from the generation of electricity can be used directly as hot air for heating buildings, for drying purposes, or to produce steam, hot water or chilled water for heating, cooling or industrial processes.



Combined heat and power is a type of distributed generation, which means that the electricity generation facility is located at or near the point where the electricity is consumed. This is unlike traditional centralized power stations which are typically located far from where the electricity is actually used.

### How Does a Combined Heat and Power Facility Work?

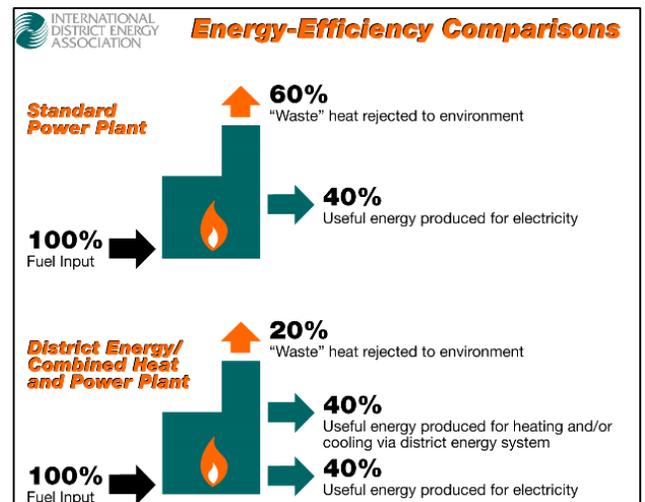
#### Combined heat and power captures and uses energy that would normally be lost

In a combined heat and power facility, electricity is generated by burning fuel to drive a reciprocating engine or turbine that is hooked up to a generator. Waste heat from this process - that normally would be exhausted into the atmosphere - is captured and put to productive use. By capturing more of the fuel's energy content, combined heat and power systems generate energy that is far more cost-effective and cleaner than systems that solely generate electricity or produce thermal energy.

#### Combined heat and power as a heat source for district energy systems

One application particularly relevant to the Guelph community is to use the waste heat from the combined heat and power facility to heat water for use in a district energy system. District energy systems distribute hot or chilled water for space and domestic water heating and/or cooling to surrounding buildings through a series of underground pipes (otherwise known as a "thermal grid").

When small combined heat and power units serve as a heat source for a district energy thermal grid, operational efficiency is optimized.



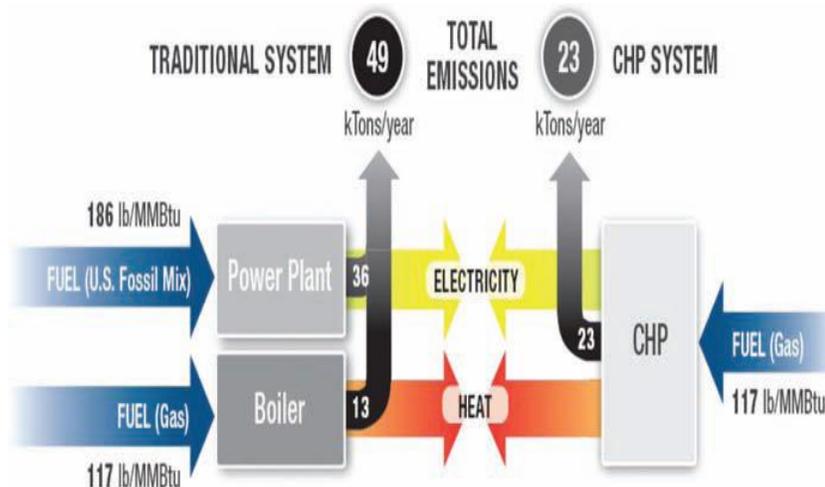
The 2013 Ontario Power Authority’s Long Term Energy Plan (LTEP), cites the experiences in Markham, Windsor and Oshawa, where combined heat and power facilities feed waste heat to district energy systems and achieve overall efficiencies up to 80 per cent compared to the 30-45 per cent efficiencies with conventional electricity production.

This means that pairing combined heat and power facilities with district energy thermal grids is one of the most efficient ways to use fossil fuels while generating electricity.

## What are the Benefits of Combined Heat and Power?

### 1. Reduces energy consumption and greenhouse gases

When one input fuel is used to produce two types of outputs (heat and power), this translates directly into reduced energy consumption, fewer greenhouse gas emissions and a smaller carbon footprint than traditional forms of power generation as illustrated on the diagram below.



Source: IDEA White Paper: "Combined Heat and Power (CHP): Essential for a Cost Effective Clean Energy Standard" (<http://www.districtenergy.org/assets/pdfs/White-Papers/WhitepaperIDEACleanEnergy4-4-11.pdf>)

### 2. Enhances resiliency of community infrastructure

Generating electricity and heat locally, near the point of consumption, reduces the vulnerability of the electricity system to severe weather impacts and other causes of power outages. Because systems can function on multiple fuels, risks of supply interruptions from single fuel dependency are also reduced.

In the event of a catastrophic failure of the electricity grid, combined heat and power systems with certain technical capabilities can function in "island mode," disconnecting from the grid and providing electricity (as well as heating and cooling) to buildings to which they are directly connected.

Recent extreme weather events have highlighted the reliability benefits of combined heat and power. After Superstorm Sandy, combined heat and power systems were lauded for their ability to keep facilities operating and people safe, warm, fed, and – in the case of hospitals – alive.

([National Electrical Manufacturers Association website](#))

### **3. Encourages economic development – Brings jobs to Guelph**

Combined heat and power projects will further the City’s objective of distinguishing itself as an attractive, healthy and progressive “green” community within which to live and work. Companies interested in sustainable business practices - as well as those that depend on a continuous supply of reliable, high quality power such as data centres, hospitals, financial institutions and high-technology industries - will find the benefits of local electricity generation and a thermal grid an incentive to locate in the community.

### **4. Keeps Energy Dollars in the Community**

Envida Community Energy Inc. is owned by Guelph Municipal Holdings Inc. which is 100 per cent owned by the City of Guelph.

Guelph Municipal Holdings Inc. is guided by the community vision and strategic objectives of Guelph City Council. The Board of Guelph Municipal Holdings Inc. reports directly to Council and, thus, to Guelph citizens. As such, since generation takes place locally, not only are energy dollars kept in the community, but also Guelph energy consumers become direct stakeholders in their energy supply.

### **5. Provides fuel flexibility**

Combined heat and power systems are fuel flexible providing the ability to use a variety of renewable and fossil fuels.

Natural gas is the most common fuel for combined heat and power systems. While natural gas will continue to be an important fuel, the ability of combined heat and power systems to operate on diverse fuels makes them an important part of a balanced and sustainable energy portfolio.

Locally sourced renewable fuels can include landfill or digester biogas, biomass including clean construction by-products and surplus urban forest material, and waste heat from municipal, commercial and industrial facilities.

As an added benefit, combined heat and power systems can be adapted or changed over time to new, more advantageous energy sources as they become available.

In some cases, systems may be developed to use one fuel, and then retooled to respond to changing fuel supply and price conditions, such as local biomass resources as they come available or shifts in the cost of various fuels.

### **6. Provides indirect environmental and economic benefits**

Local, centralized combined heat and power facilities connected to a district energy system will reduce the amount of heating and cooling equipment required by companies that locate in the area

and connect to the system. Users will also benefit from reduced energy costs and are protected from the volatility of fuel costs and electricity prices.

### Is Combined Heat and Power a New Concept?

No.

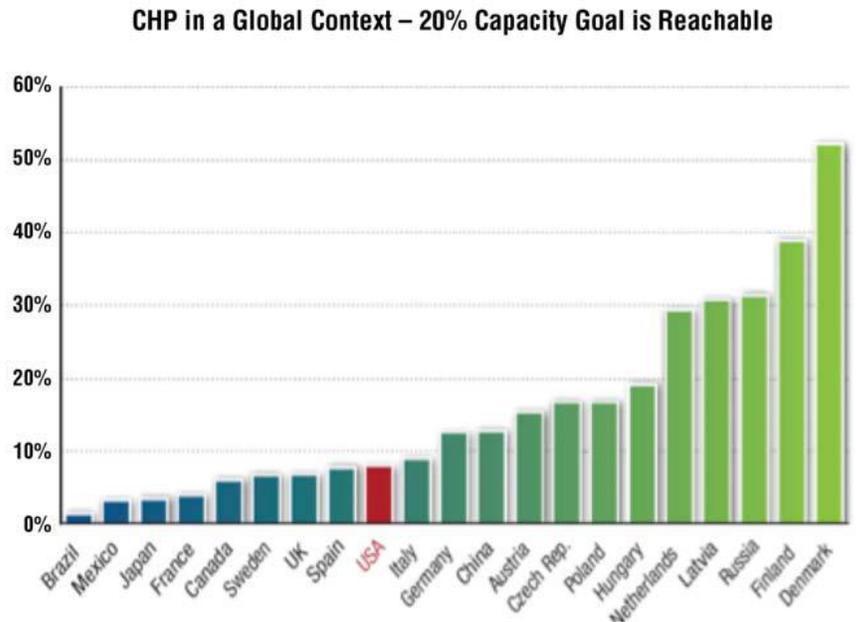
Combined heat and power is a proven technology, the principles of which have been around since the late 1800s when Thomas Edison used it to power the world’s first commercial power plant. However, when the Ontario electricity system was constructed, the focus was put on the development of centralized generation facilities to produce electricity which was delivered to communities via high voltage transmission lines and local distribution systems.

Combined heat and power systems have been employed for many years, mostly in industrial, large commercial and institutional applications. Combined heat and power is not well understood outside of these circles but, for decades, it has quietly been providing highly efficient electricity and process heat to some of the most vital industries, largest employers, urban centres and campuses in North America - and elsewhere.

### How Widely Accepted is Combined Heat and Power?

Numerous countries produce between 15 per cent and 50 per cent of electricity from combined heat and power, with the largest combined heat and power penetration occurring in countries like Denmark where district energy systems are also widely used.

In Canada, combined heat and power represents an estimated seven per cent of national electricity generation.<sup>i</sup>



Source: IDEA White Paper: "Combined Heat and Power (CHP): Essential for a Cost Effective Clean Energy Standard

<http://www.districtenergy.org/assets/pdfs/White-Papers/WhitepaperIDEACleanEnergy4-4-11.pdf>

## What is Guelph's Position on Combined Heat and Power Plants?

Guelph's Community Energy Plan calls for at least 30 per cent of the municipality's anticipated electricity requirements be associated with combined heat and power by 2031 and recommends the City proactively seek combined heat and power projects with a total electric capacity in the 100-megawatt range with a comparable level of heat recovery.

Guelph's leadership in focusing on combined heat and power is supported by the conclusions reached by governments in Ontario and the United States.

- Ontario's Long-Term Energy Plan notes: *"Combined heat and power can be an efficient way to use natural gas to generate electricity as well as useable heat or steam. Given the right circumstances, combined heat and power can help support regional economic development, and local energy needs, while reducing carbon dioxide emissions at a competitive cost."*
- In the United States, President Barack Obama signed an executive order in 2012 that set a national goal of 40 gigawatts (GW) of new combined heat and power by the end of 2020, in addition to the 80 GW capacity that currently exists in the U.S. The purpose is to accelerate investments in industrial energy efficiency to improve manufacturing competitiveness and create jobs in the US while improving the energy system and reducing harmful emissions.

## What Types of Industries Can Benefit Most from Combined Heat and Power?

Combined heat and power is unique among electricity-producing technologies and methods because it generates more than one output (or type of energy). For most industrial and district energy applications, thermal energy is the most valued output; electricity is considered a secondary, yet beneficial, by-product.

Combined heat and power is especially useful in applications that have significant electric and thermal loads, specifically:

- Hospitals and nursing homes (e.g. Ottawa and London Health Sciences Centres)
- Colleges and universities (e.g. University of Guelph; University of Ontario Institute of Technology, Oshawa; Queen's University; University of Toronto)
- Hotels
- Chemical industries, pulp and paper mills, refineries, food processing facilities and metals manufacturing (e.g. Imperial Oil refinery, Sarnia)
- Commercial facilities, office buildings, apartment complexes
- Government facilities, landfills and sewage treatment plants
- Greenhouses
- Health clubs, recreational facilities, swimming pools, arenas
- District heating and cooling systems (e.g. Markham, Windsor and London District Energy)

Combined heat and power facilities currently feeding 414 megawatts of electricity into the Ontario grid are listed on the [Ontario Power Authority website](#).

## How big is a Combined Heat and Power Facility?

Combined heat and power facilities come in a variety of sizes. The Guelph Community Energy Initiative calls for the use of small-scale (5-10 megawatt) combined heat and power facilities that could fit within an existing building, such as at the West End Community Centre pictured at right, or a newly constructed building like the ones pictured below of the Sudbury District Energy Cogeneration Facility (left) or Hamilton Community Energy (right).



## What are the Environmental Impacts of a Combined Heat and Power Plant?

Combined heat and power facilities do not present the same challenges with aesthetics, noise or environmental impact that would be typical of larger power plants. Typically, these are under 20-megawatt facilities, much smaller than a conventional power generating plant.

### Aesthetics

Small combined heat and power facilities like the ones above can be constructed to blend in with their surroundings. They can also be housed within buildings so that they are not seen from the street.

### Noise

While combined heat and power systems do generate some ambient and exhaust noise, the noise level is comparably low for an energy generation facility. A combined heat and power facility emits approximately 80 decibels(A) (dB(A)) of noise, which is slightly more than typical office building noise (55-65 dB(A)) and akin to a typical passing road vehicle (75 – 90 dB(A))<sup>ii</sup>.

The installation of a combined heat and power facility often involves investigating the effects of the plant on the existing local noise profile and taking mitigation measures such as sound barriers, silencers and other devices. When designed appropriately, noise from a facility should blend in with the existing background noise and not cause a noticeable difference.

## Emissions

Because these plants are at a much smaller scale than large central plants, there is far less fuel used in the generation process to begin with. In addition, combined heat and power facilities use one unit of fuel to generate two outputs, both heat and power. This is unlike other typical forms of generation where only one output is created. By displacing forms of generation that only produce one output, less greenhouse gas and other air emissions are produced.

Greenhouse gas emissions are further reduced in the community when a combined heat and power facility serves as a heat source for a district energy system since clients of the district energy system do not burn fuel in on-site furnaces or boilers to produce thermal energy.

## Water

Combined heat and power and district energy facilities consume minimal water resources and produce effectively zero effluents in generating electricity and thermal energy in a closed loop system.

## What Permitting is Required to Build a Combined Heat and Power Facility?

Envida Community Energy will not proceed on a project unless all mandatory environmental, safety and municipal approvals and permits are in place. These include:

- Ministry of Environment - Environmental Compliance Approval for Air/Noise
- Grand River Conservation Authority Permit/Approval
- City of Guelph - Building Permit and Street Occupancy Permit
- Ministry of Transportation - Building and Land Use Permit/Entrance Permit
- Ministry of Labour - Notice of Project
- Technical Standards and Safety Authority Approval
- Electrical Safety Authority - Electrical Interconnection Approval
- Ministry of Environment - Preparation of an Environmental Review on Screening Process under Regulation 116/01 of the *Environmental Assessment Act*
- Approval under the *Canadian Environmental Assessment Act*

Sources of information for this backgrounder included:

- Combined Heat & Power: Effective Energy Solutions for a Sustainable Future, <http://www.districtenergy.org/assets/pdfs/ORNLCCHPreport12-08.pdf>
- EEA, Inc. CHP Installation Database. ii Combined Heat & Power: Effective Energy Solutions for a Sustainable Future
- Gilmour, B., & Warren, J. (2008, January). The New District Energy: Building Block for Sustainable Community Development. Canadian District Energy Association. Toronto: Urban Energy Solutions
- Chittum, Anna, & Farley, Kate. (2013, July). Utilities and the CHP Value Proposition: Report Number IE134: American Council for an Energy-Efficient Economy

<sup>i</sup> Source: CHP facilities in Canada. Canadian Industrial Energy End-use Data and Analysis Centre (CIEEDAC), Simon Fraser University, Burnaby, BC, April, 2013 [http://www2.cieedac.sfu.ca/media/publications/Cogeneration\\_Report\\_2013\\_2012\\_data\\_Final\\_-\\_May\\_3.pdf](http://www2.cieedac.sfu.ca/media/publications/Cogeneration_Report_2013_2012_data_Final_-_May_3.pdf)

<sup>ii</sup> Source: UK Department of Energy and Climate Change, <http://chp.decc.gov.uk/cms/noise/>