



A Review of Existing Cogeneration Facilities in Canada

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Executive Summary

CIEEDAC published the original version of *A Review of Cogeneration Facilities in the Canadian Industrial Sector* in March 1999. The original purpose of the report was to identify the size (electrical capacity, kW_e), location, and thermal host of industrial cogeneration facilities in Canada. That purpose was expanded in 2002 it include data on commercial /institutional and district energy cogeneration systems. In 2003, the database was expanded again to include performance characteristics of cogeneration systems operating in Canada and more accurate data on the users of the thermal and electric products of cogeneration systems.

In the past, CIEEDAC relied on second hand data sources such as Statistics Canada, corporate websites, private consultants and electric utilities to identify cogeneration facilities and compile data on their characteristics. For the last two years, CIEEDAC has gathered data on cogeneration systems directly from the system operators. CIEEDAC sends a questionnaire to each facility seeking verification of existing data and requesting new information about each site. The resulting database is more reliable and contains data that will enhance understanding of the opportunities for and limitations of cogeneration in Canada.

The database now contains information on over 200 cogeneration systems with an operating capacity of approximately 6.8 GW_e. Currently, Alberta has 2.4 GW_e of operating cogeneration capacity and Ontario has 2.0 GW_e. Together, the two provinces account for almost 65% of total capacity in Canada. By system operator, the electric power generation industry has the most cogeneration, 3.4 GW_e or almost 51% of total operational capacity. The forest products sector has the next highest cogeneration capacity of 1.6 GW_e, which represents 23% of operating capacity.

This year we have also allocated capacity based on thermal host. Under this allocation method, the pulp and paper sector acts as thermal host to 2.2 GWe of cogeneration capacity (33%), the chemical sector to 1.7 GWe of capacity (25%) and the oil and gas sector to 1.6 GWe or 24% of the total.

The performance of cogeneration systems in Canada varies widely from a low of 37% to a high of 95%. On average, gas turbine systems are the most efficient (77%) and diesel systems are the least efficient (42%). The independent power sector is on average the least efficient of the sectors for which we have data and the defense sector is the most efficient. Fifty-nine percent of all operating cogeneration capacity (4.0 GW_e) has been installed since 1995.

The average amount of electricity generated per kW_e of installed capacity is 5,351 kWh/yr. The average heat rate¹ of systems operating in Canada is 4,764 kilojoules/kWh (4,518 BTU / kWh) for an average system efficiency of 75.6%. The average heat to power ratio of systems operating in Canada is 6.4.

This report has four appendices. The first appendix contains the questionnaire that was sent to each cogeneration facility this year. The next two show the database records for

¹ In this study, heat rate is defined as the energy content of fuel consumed in KJs, divided by the sum of the electricity output in kWhs and the thermal output in kWhs.

all cogeneration projects included in this year's review sorted by Sector (Appendix A) and Region (Appendix B). The fourth appendix describes formulas for allocating CO₂ emissions to the thermal and electrical products of cogeneration.

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A Review of Existing Cogeneration Facilities Canada

1. Introduction

Cogeneration, also referred to as combined heat and power (CHP), is the simultaneous production of electrical and thermal energy from a single fuel. By making use of the waste from one process in the production of the other, substantial gains in energy efficiency are realized compared to the independent production of both products. The efficiency of cogeneration in converting primary energy into electrical and thermal energy places the technology at the forefront of many CO₂ emission reduction strategies. National and international commitments to reducing CO₂ emissions, has increased interest in cogeneration.

Cogeneration has been widely adopted in many European countries for use in industrial, commercial and residential applications. In Denmark, Finland and The Netherlands cogeneration accounts for over 30% of national electricity generation. However, in Canada cogeneration represents 7% of national electricity generation. This low penetration rate may be attributable to low energy prices and electric utility policies on the provision of back-up power and the sale of surplus electricity. Despite these barriers, cogeneration is common in some sectors (pulp and paper and chemical products sectors) and electricity market restructuring in Alberta and Ontario is fueling a dramatic rise in utility-scale cogeneration facilities.

CIEEDAC's Cogeneration Database aims to provide a comprehensive list of cogeneration projects in Canada and present unbiased data on the performance of cogeneration systems. To date, no other comprehensive list of Canadian cogeneration projects has been identified. This task is becoming increasingly challenging as cogeneration capacity expands rapidly under deregulation. Future updates of this report will continue to refine existing data and include new additions.

This report contains the following sections:

1. Descriptions of cogeneration systems in use in Canada.
2. The methodology used to identify cogeneration projects in Canada.
3. A summary of cogeneration facilities in Canada by region and sector, system average performance characteristics and a timeline of cogeneration installations.
4. Conclusions

2. Cogeneration Systems

Cogeneration is defined as the simultaneous generation of both electricity (which includes direct drive power from steam turbines) and useful thermal energy. The thermal energy can be used in heating or cooling applications. Heating applications include generation of steam or hot water. Cooling applications require the use of absorption chillers that convert heat to cooling. A range of technologies can be used to achieve cogeneration, but the system must always include a power generator (either electric power or drive power) and a heat recovery system. The heat-to-power ratio, overall

efficiency and the characteristics of the heat output are key attributes of cogeneration systems.

The heat-to-power ratio is the ratio of the amount of useful thermal energy available to the amount of power generated usually expressed in terms of kW of heat (kW_{th}) per kW of power (kW_e).² Heat-to-power ratios vary depending on the type of prime mover (drive system) and range from 0.5:1 to 20:1.

Overall system efficiency is the percent of the fuel converted to electricity plus the percent of fuel converted to useful thermal energy. Typically, cogeneration systems have overall efficiencies of between 65% and 85%.

Heat output from cogeneration systems varies greatly depending on the system type. The output can range from high pressure, high temperature (500 to 600°C) steam to warm water (80°C or below). High pressure, high temperature steam is considered high quality thermal output because it can meet most industrial process needs. Hot water is considered a low quality thermal output because it can only be used for a limited number of thermal applications.

One classifies cogeneration systems by the type of prime mover used to drive the electrical generator. The five main types currently in use are steam turbines, gas turbines, reciprocating engines, microturbines and combined cycle gas turbines. New systems currently under development include fuel cells and stirling engines.

2.1 Steam Turbine

Steam turbines are the most common cogeneration system used in industrial applications. They range in size from a 500 kW_e to 80 MW_e . The smaller sized systems may not be economical unless the fuel used has no alternative commercial value (i.e., hog fuel). Steam turbine cogeneration systems usually produce significantly more heat than electricity per unit of fuel consumed and therefore have high heat-to-power ratios. The ratios vary from site to site and range from 3:1 to 10:1. The thermal needs of the site typically determine this ratio. The lower the quality of heat required (i.e., the lower the temperature and pressure), the greater the amount of electricity generated per unit of fuel.

Steam turbine cogeneration systems generate steam in a high-pressure steam boiler. The steam expands through a turbine to produce mechanical energy. This mechanical energy drives an electric generator.³ The output heat serves process applications such as drying wood, pulp or papermaking, etc.

Steam turbines come in two types, back-pressure turbines and condensing turbines. Back-pressure turbines exhaust steam at a pressure higher than atmosphere. Condensing turbines exhaust steam at pressures lower than atmosphere (i.e., a vacuum) and therefore require a condenser. With either type, steam can be extracted part way through at a pressure required by the thermal user. Condensing turbines produce more electricity per

² The heat-to-power ratio is the ratio of thermal energy to electricity produced by the cogeneration system. It can be expressed in different units such as Btu / kWh but in this report it is presented by the same power unit (kW).

³ The mechanical energy can also be used to drive equipment in the plant. However, this type of system is not covered in this report.

unit of fuel than back-pressure turbines because more of the energy contained in the steam is extracted by the turbine making less available for thermal applications.

Steam turbines can consume almost any fuel including the waste products of industrial processes, a key advantage in some applications.

2.2 Gas Turbine (GT)

Gas turbines act as the most common prime mover in the large cogeneration systems built recently. They range in electricity output from 250 kW_e to 200 MW_e. GT systems produce more electricity per unit of fuel than steam turbines and have an average heat-to-power ratio of 2:1. Supplemental heating through secondary firing of the exhaust gases can increase this ratio to 5:1. Steam injection, which increases the volumetric flow through the turbine, can increase the electrical output by 15%.

Gas turbine systems produce high temperature, high pressure gases in a combustion chamber. These gases expand through a turbine producing mechanical energy that drives the generator. The gases exit the turbine at temperatures of between 450 and 550°C and are used to meet the thermal requirements of the site. They can be used directly for drying, or indirectly to produce high, medium or low pressure steam or hot water.

2.3 Reciprocating Engine

Reciprocating engines are internal combustion engines operating by the same principles as a car engine. Systems range in size from 20 kW_e to 6 MW_e. The heat-to-power ratio ranges from 0.5:1 to 2.5:1. As with gas turbines, supplemental firing can be used to increase the thermal output.

It is harder to use the thermal output from reciprocating engines because it comes from two sources, the exhaust gas and the engine cooling system. The exhaust gases are of high heat (up to 400°C) but the cooling system provides only low-grade heat (below 90°C). Often one cascades the two heat sources to produce hot water. These systems produce more electrical energy per unit of fuel (35% to 53%) than either steam or gas turbines.

2.4 Combined Cycle Gas Turbine (CCGT)

CCGT cogeneration systems have a gas turbine connected in series with a steam turbine. The hot exhaust gases from the gas turbine produce steam for the steam turbine. Thermal energy remaining in the steam exhausted from the steam turbine goes to process applications. The main advantage of the CCGT is its high electrical energy efficiency compared to the other systems described above.

2.5 Microturbines

Some small industry and institutional CHP applications use microturbines. Microturbine cogeneration systems are small versions of gas turbine systems. They range in size from 20 kW_e to 250 kW_e. Microturbine systems consist of packaged high-speed generator plants with the turbine, compressor and generator all on one shaft. Microturbine cogeneration systems add a heat recovery unit to the packaged microturbine. They

typically contain power electronics to deliver electricity to the grid and can run on natural gas or other liquid fuels including landfill gas and flare gas from oil, natural gas and coal extraction. Microturbine cogeneration systems are becoming increasingly cost-effective in regions such as Alberta where electricity prices are high relative to the cost of natural gas.

Microturbines have become commercially available only in the last few years, and so successful microturbine installations are still relatively few, and total market share is limited. Some analysts predict widespread adoption of microturbine systems because of their modularity, low cost, low emissions and load flexibility.

2.6 New Technologies

Fuel cells and stirling engines are emerging technologies to supply combined heat and power.

2.6.1 Fuel Cells

A fuel cell captures the chemical energy released by the electrochemical reaction between hydrogen and oxygen and converts it to electrical energy. Fuel cells use an electrolyte to combine hydrogen (the fuel) with oxygen from the air to produce hot water or steam, depending on the type of fuel cell, and an electrical current. Hydrogen can be obtained directly from fossil fuels (natural gas or coal) or from renewable sources such as biomass or via electrolysis of water powered by renewable electricity.

Typical fuel cells produce only a small voltage (~1 volt). Combined in series (a “stack”), they produce enough power for distributed generation applications. One can apply the hot water or steam to thermal applications. Fuel cell systems for use in residential cogeneration applications could range from about 1 kW_e to 5 kW_e.⁴ They have high efficiencies even at small sizes and low load conditions, have no moving parts which reduces interruptions in service, generate no or low emissions (they use pure hydrogen or natural gas), are quiet and can be sited almost anywhere.

Fuels cells are classified according to the material used for the electrolyte. The five types currently under development are phosphoric acid fuel cells (PAFCs), molten carbonate fuel cells (MCFCs), solid oxide fuel cells (SOFCs), alkaline fuel cells (AFCs), and proton exchange membrane (also called polymer electrolyte membrane) fuel cells (PEMFCs). PEMFCs operate below 200°C, while all other fuel cells operate at higher temperatures. This has several important implications. First, because they operate at low temperatures, the exhaust heat temperature in PEMFCs is low, and can only be used where there is demand for low quality heat (e.g., hot water). Other types of fuel cells can provide higher quality thermal output. Second, operating at high temperature enables fuel cells to internally reform natural gas into hydrogen and carbon dioxide, meaning that an external reformer is not required. In contrast, PEMFCs require an external reformer if they are to use a hydrocarbon fuel. Third, the lower temperatures of PEMFCs mean that materials do not have to be as temperature resistant in this type of fuel cell compared to the others.

⁴ Fuel cell systems can be even smaller than 1 kW but these systems would not be used for cogeneration.

2.6.2 Stirling Engines

Stirling engines are *external combustion* engines in which a fuel is burned outside of the cylinder containing the engine's working fluid. This allows the fuel to be burned continuously, rather than in a series of discrete firings as in the internal combustion engine. It also allows for fuel flexibility – any type of fuel that can be used in a conventional boiler can also be used in a Stirling engine. Finally, it enables good heat recovery – the thermal efficiency of a Stirling engine is close to that of an equivalently sized conventional boiler. The gasses used inside a Stirling engine never leave the engine, so there is no need for exhaust valves and the engine runs very quietly. Stirling engines have relatively high heat to power ratios, which makes them suitable for the load requirements of the residential sector.

Stirling engines are currently being developed for combined heat and power application in the residential housing market, primarily in Europe and Japan.

2.7 Efficiencies, Heat-to-Power Ratios and Thermal Quality

Table 1 summarizes the efficiencies, heat-to-power ratios and the quality of the thermal output for cogeneration systems according to system type.

Table 1: Efficiencies, Heat-to-Power Ratios and Thermal Quality

| Cogeneration System | Electrical Energy Output (% of fuel input) | Overall Efficiency (%) | Heat-to-Power ratio | Thermal Qualities |
|-----------------------------|--------------------------------------------|------------------------|---------------------|-------------------|
| Back-pressure steam turbine | 14-28 | 84-92 | 4.0-22 | High |
| Condensing steam turbine | 22-40 | 60-80 | 2.0-10.0 | High |
| Gas turbines | 24-42 | 70-85 | 1.3-2.0 | High |
| Reciprocating engine | 33-53 | 75-85 | 0.5-2.5 | Low |
| Combined cycle gas turbine | 34-55 | 69-83 | 1.0-1.7 | Medium |
| Fuel Cells | 40-70 | 75-85 | 0.33-1 | Low to High |
| Microturbines | 15-33 | 60-75 | 1.3-2.0 | Medium to Low |

Source: UNESCAP and the European Association for the Promotion of Cogeneration

3. Good Quality Cogeneration

It is sometimes assumed that all CHP is good, i.e. better than the alternative stand-alone electricity and thermal energy generation both from an economic and an environmental perspective. This is not always the case, particularly in systems with high heat-to-power ratios and moderate system efficiencies or systems that operate at part load for significant portions of time. For example, a natural gas-fired steam turbine with a system efficiency of 65% and a heat to power ratio of 5 would be less efficient than using an 80% boiler

and a combined-cycle gas turbine to generate the electricity and thermal energy separately.

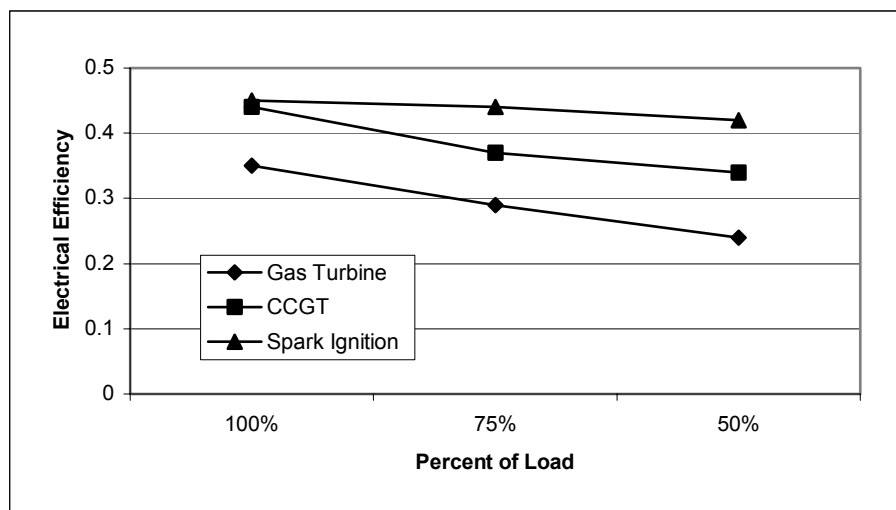
This section defines the characteristics that maximize the environmental and economic benefits of CHP systems and suggests more meaningful parameters to describe CHP systems that allow for more accurate comparisons to alternative systems.

3.1 Maximizing CHP Benefits

There are two key conditions that maximize the benefits of CHP. They are maximizing the production of electricity while closely matching the thermal load requirements in terms of both quantity and energy quality. The thermal capacity of a CHP system should be sized to meet the base thermal load required by the host facility. The quality of the thermal output should not be significantly higher than that required to meet the needs because it means the unused thermal energy could have been used to generate more electricity. The ratio of electricity production to thermal energy output and the thermal energy quality are determined by the choice of generator and auxiliary equipment.

Some CHP technologies, such as reciprocating engines, retain a high level of efficiency at part load, while others such as gas and steam turbines do not. Figure 1 compares the part load efficiencies of three major CHP system types. If a gas turbine, steam turbine or CCGT system is operated at part load for a significant portion of time, the economic and environmental advantage of using a CHP system may be lost.

Figure 1: Part Load Efficiencies of Generators



The benefits of CHP systems are correlated to the alternative electrical and thermal energy system that would have been in their place. For example, industrial thermal loads are usually met with industrial boilers with efficiencies above 80%. However, residential heating and hot water loads are served using less efficient devices. Therefore, the minimum efficiency threshold for good quality CHP in an industrial application would be higher than in a residential or district energy application.

Finally, the benefits of CHP systems that generate excess electricity are maximized if the system is located in an area of the grid that requires additional generation capacity. This location issue is of particular importance to the CHP systems being proposed in the oil sands region of Alberta. The oil sands currently hosts 1,214 MW of cogeneration capacity with an additional 245 MW under construction. However, not all of this electricity can be consumed by the projects in the immediate region. The Athabasca Regional Issues Working Group estimated that there would be roughly 1,000 MW of excess generation capacity in the oil sands region by 2010.

3.2 Alternative Parameters to Define CHP Systems

The current parameters that are used to define the characteristics of CHP systems are inadequate for assessing whether or not a CHP system is better than the alternatives. CHP systems are usually defined by their total electrical capacity and the system efficiency. These two parameters do not provide enough information to accurately assess the value of a CHP system and do not allow for direct comparison with stand-alone generation and thermal energy systems.

3.2.1 CHP System Efficiency

The current use of system efficiency to describe CHP systems is inadequate for evaluation and comparison to stand alone systems. To demonstrate this, we compare a reciprocating engine system with an efficiency of 84% and a heat to power ratio of 1.4 to a steam turbine system with an efficiency of 81% and a heat to power ratio of 14.2.⁵ The reciprocating engine system reduces GHG emissions by 67 Tonnes of CO_{2e} per GWh of total energy while the steam turbine system only reduces emissions by 11 TCO_{2e} per GWh of total energy.⁶

An alternative efficiency measure used by the US Environmental Protection Agency is Effective Electric Efficiency. Effective electric efficiency (E3) is defined as the electrical output from a CHP system divided by the total energy output from the system minus the thermal output divided by the assumed efficiency of the alternative boiler. For an alternative boiler that is 80% efficient, the effective electric efficiency would be calculated as follows:

$$E3 = (\text{CHP electrical power output}) / (\text{Total energy input to CHP system} - \text{total heat recovered} / 0.80)$$

E3 is a more informative way of comparing the efficiency of CHP systems because it makes it easier to compare CHP systems to stand-alone generators and determine their value. It also treats the CHP system as primarily a thermal energy device with electricity as the byproduct of the process.

Table 2 shows the efficiencies of several CHP systems in the Canadian Cogeneration Database and compares their system efficiency with their effective electric efficiency.

⁵ Data from the Canadian Cogeneration Database at CIEEDAC.

⁶ Strickland, C. and Nyboer, J., "Allocating GHG Emissions Among the Products of Cogeneration", November, 2003.

Table 2: Efficiencies of Canadian Cogeneration Systems

| Location | System type | Efficiency | E3 |
|--------------|----------------------|------------|-----|
| Nanaimo, BC | Steam Turbine | 74% | 45% |
| Hamilton, ON | Reciprocating Engine | 71% | 65% |
| Regina, SK | Microturbine | 67% | 51% |
| ON | Gas Turbine | 81% | 81% |

From these data we can see that the system efficiency does not correlate to the E3. In addition, we can easily see that the Nanaimo CHP system would only be advantageous when compared to electricity generated at an efficiency level below 45%. Since some CCGT systems currently exceed this efficiency level, this cogeneration system may not always result in environmental benefits. In this case, the majority of the fuel used in the Nanaimo system is hog fuel and black liquor, so there would be a reduction in GHG and other emissions.

3.2.2 Capacity Factor

Another issue not addressed by the current method of characterizing CHP systems is that CHP systems do not always have the same capacity factor as stand-alone generation systems. Base load electricity generation facilities tend to have capacity factors above 93%. This means that the generator produces electricity equal to the total electrical capacity multiplied by the total number of hours in a year (8,760) multiplied by 93%. However, the average capacity factor of electricity generation in Canada is approximately 63%.⁷ Capacity factor is affected by how many hours a system is running and at what load level. For example, a CHP system running 50% of the time at full capacity would have the same capacity factor as a CHP system running at 50% capacity full time. Because of the large variation, the capacity factor of a CHP system should be included as one of its defining parameters.

4. Methodology

For the last two years we have gathered data on Canadian cogeneration system through by means of a survey sent to all facilities listed in our database.⁸ Through this process we identified several cogeneration systems that are no longer operational, some sites that were never cogeneration facilities and some duplicate listings. In addition we are gathering new data on the performance characteristics of cogeneration systems operating in Canada. The resulting database is more reliable and contains data that will enhance understanding of the opportunities for and limitations of cogeneration in Canada. In addition, we have identified new cogeneration systems through websites, industry contacts and utility personnel.

⁷ Calculated from data for 2002 from the Canadian Electricity Association website.

⁸ The questionnaire is in Appendix A.

We feel that the Canadian Cogeneration Database is a comprehensive list of large and small cogeneration systems operating in Canada. However, a few systems may be missing because they are small or operate in remote locations. We hope to include any omissions in next year's update.

4.1 Data Sources

The key sources of data for this year's update of the Canadian Cogeneration Database are the completed questionnaires received from cogeneration facilities across Canada. New cogeneration systems were identified through websites and industry contacts. Historical sources of data for the database are:

- Canadian Gas Association (CGA): In 1996, the CGA released a listing of Canadian gas-fired cogeneration systems that were in operation on December 31, 1995. These data focus only on natural gas-fired systems, and as a result miss a large number of systems fired by other fuels (i.e., oil, hog fuel, spent pulping liquor, coke oven gas, etc.). This database has not been updated.
- Environment Canada: Environment Canada has developed a database of gas-fired cogeneration facilities and combined cycle power plants, which it updates annually.
- Consultants: Several consultants in the cogeneration business were contacted for information about existing facilities. Thermoshare Inc. and Gerald Schwinn generously shared their cogeneration databases with CIEEDAC.
- Independent Associations: A number of industrial associations such as the Independent Power Producers Society of Ontario (IPPSO) and the Independent Power Producers Society of Alberta (IPPSA) provided data on facilities in their region.
- Electric and Gas Utilities: Most electrical and gas utilities were asked to provide data on cogeneration facilities in their service area.
- Statistics Canada (STC): (catalogue no. 57-206-XPB, Electric Power Generating Stations, 1998). This publication lists the capacity of electric generating stations in Canada both utility and privately owned, by province and by type (i.e., steam turbine, internal combustion and combustion turbine plant capacities, etc.). Used as a cross-reference, it does not explicitly distinguish cogeneration systems from any other generating system. In addition, the catalogue does not explicitly identify combined cycle gas turbines facilities; rather, it lists the combustion turbine separately from the steam turbine component of the system. The publication includes, with a few exceptions, all the cogeneration systems identified by the other report references. Some inconsistencies with respect to plant names, locations and capacities were noted when compared to other sources.
- Other Sources: Additional sources of information included corporate and government websites, cogeneration manufacturers brochures and industry journals.

5. Results

The following section summarizes the results of this year's cogeneration database survey.
Regional Results

Table 3 summarizes Canadian cogeneration capacity by region for 2002 and compares it to last year's results.

Table 3: Canadian Cogeneration by Region

| Province | 2002 | | 2003 | |
|-------------------------|------------------|-------------|------------------|-------------|
| | Capacity (kW) | % of Total | Capacity (kW) | % of Total |
| Newfoundland | 17,500 | 0.2% | 17,500 | 0.3% |
| Prince Edward Island | 2,050 | 0% | 2,050 | 0.0% |
| Nova Scotia | 91,931 | 1.3% | 91,931 | 1.4% |
| New Brunswick | 164,500 | 2.4% | 177,500 | 2.6% |
| Québec | 188,840 | 2.8% | 211,840 | 3.1% |
| Ontario | 1,983,306 | 29.0% | 2,029,514 | 29.8% |
| Manitoba | 22,000 | 0.3% | 22,000 | 0.3% |
| Saskatchewan | 557,600 | 8.2% | 557,720 | 8.2% |
| Alberta | 2,584,900 | 37.8% | 2,418,502 | 35.5% |
| British Columbia | 1,204,050 | 17.6% | 1,274,050 | 18.7% |
| Territories and Nunavut | 15,400 | 0.2% | 15,460 | 0.2% |
| TOTAL | 6,832,077 | 100% | 6,818,067 | 100% |

Source: Canadian Cogeneration Database, CIEEDAC

The total operational cogeneration capacity for 2003 is slightly less than last year's total. The decrease occurred primarily because a cogeneration system in Alberta was operated in straight generation mode for the year. There were a significant number of systems added to the database this year, but most of them were small. This is the first year that microturbine cogeneration systems are included in the database.

Based on the data received this year, Alberta continues to have more operational cogeneration capacity (2.4 GWe) than any other region of Canada. Ontario is second with 2.0 GWe of operational cogeneration capacity.

5.1 Sector Results

This year we allocate cogeneration capacity by both system operator and primary thermal host. The North American Industrial Classification System (NAICS) was used to code the facilities. Table 4 shows cogeneration capacity by system operator and Table 5 shows capacity by thermal host.

Table 4: Canadian Cogeneration by System Operator

| Sector | NAICS | Amount | % of Total |
|----------------------------------|-------|------------------|----------------|
| Greenhouse Agriculture | 1114 | 3,100 | 0.0% |
| Oil Sands | 2111 | 210,000 | 3.1% |
| Non-Metallic Mineral Mining | 2123 | 69,231 | 1.0% |
| Non-Utility Generation | 2211 | 3,442,710 | 50.5% |
| District Energy | 2213 | 38,800 | 0.6% |
| Food and Beverage Manufacturing | 3111 | 232,250 | 3.4% |
| Forest Products | 3221 | 1,569,470 | 23.0% |
| Chemical Manufacturing | 3251 | 1,009,781 | 14.8% |
| Fabricated Metal Products | 3252 | 14,075 | 0.2% |
| Scientific Research | 5417 | 4,810 | 0.1% |
| Sewage Treatment | 5622 | 7,230 | 0.1% |
| Universities | 6113 | 62,730 | 0.9% |
| Hospitals | 6221 | 107,432 | 1.6% |
| Defense and Corrections Services | 9111 | 9,900 | 0.1% |
| Other | | 36,448 | 0.5% |
| Total | | 6,832,007 | 100.00% |

Source: Canadian Cogeneration Database, CIEEDAC

Table 5: Canadian Cogeneration by Thermal Host

| Sector | NAICS | Amount | % of Total |
|----------------------------------|-------|------------------|----------------|
| Greenhouse Agriculture | 1114 | 3,190 | 0.1% |
| Oil and Gas | 2111 | 1,653,600 | 24.3% |
| Non-Metallic Mineral Mining | 2123 | 329,231 | 4.8% |
| District Energy | 2213 | 38,800 | 0.6% |
| Food and Beverage Manufacturing | 3111 | 350,250 | 5.1% |
| Forest Products | 3221 | 2,174,470 | 32.9% |
| Chemical Manufacturing | 3251 | 1,682,281 | 24.7% |
| Fabricated Metal Products | 3252 | 304,575 | 4.5% |
| Scientific Research | 5417 | 8,368 | 0.1% |
| Sewage Treatment | 5622 | 7,230 | 0.1% |
| Universities | 6113 | 62,730 | 0.9% |
| Hospitals | 6221 | 130,352 | 1.9% |
| Defense and Corrections Services | 9111 | 9,900 | 0.3% |
| Other | | 55,160 | 1.3% |
| Total | | 6,832,007 | 100.00% |

Source: Canadian Cogeneration Database, CIEEDAC

5.2 Cogeneration System Performance Characteristics

This year we did not receive significant additional data on system performance. The data presented below are from last year's report and are based on data from 97 sites. We have data on average annual electricity generation from 97 sites, data on heat rate⁹ from 64 sites, and data on heat to power ratio from 77 sites.

Table 6 displays the average performance characteristics of cogeneration systems currently in operation in Canada. The average amount of electricity generated per kW_e of installed capacity is 5,351 kWh/yr. The highest rate of electricity production, 7,834 kWh/kW/yr occurs in the manufacturing sector. This high output likely occurs because manufacturing facilities operate 24 hours a day and have a demand for both heat and electricity year round. The lowest rate, 3,209 kWh/kW/yr occurs at hospitals.

Table 6: Canadian Cogeneration System Performance

| Sector | Electricity Generation | Heat Rate | Average Efficiency | Heat to Power Ratio |
|---------------------------|------------------------|--------------|--------------------|---------------------|
| | kWh/kW per year | kJ/kWh | | |
| Agriculture | 4,716 | 4,218 | 85.0% | 1.5 |
| Utilities | 4,903 | 6,307 | 57.1% | 2.0 |
| Food and Beverage | 6,055 | 4,664 | 77.2% | 3.4 |
| Forest Products | 5,494 | 4,897 | 73.5% | 10.2 |
| Manufacturing | 7,834 | n/a | n/a | n/a |
| Universities | 3,742 | 4,488 | 81.0% | 6.7 |
| Military & Corrections | 6,543 | 4,104 | 87.7% | 3.1 |
| Average for Canada | 5,351 | 4,764 | 75.6% | 6.4 |

Source: Canadian Cogeneration Database, CIEEDAC

The average heat rate of systems operating in Canada is 4,764 kJ/kWh (4,518 BTU/kWh). This translates to an average system efficiency of 75.6%. The highest efficiencies occur in the military & corrections and the agriculture sectors. The lowest efficiency is in the utility sector.

The average heat to power ratio of systems operating in Canada is 6.4. This means that for every kWh of electricity produced by cogeneration systems, 6.4 kWhs of useful thermal energy are produced. Table 6 shows that the forest products sector has the highest average heat to power ratio of all sectors. This industry demands high quality thermal energy leaving less energy available to produce electricity. The agriculture and utility sectors have low heat to power ratios. Utilities have low heat to power ratios because their systems are designed to maximize electrical output.

Table 7 shows the average system efficiency for each type of cogeneration system. It shows that gas turbine cogeneration systems have the highest average efficiency (77%)

⁹ In this study, heat rate is defined as the energy content of fuel consumed in KJs, divided by the sum of the electricity output in kWhs and the thermal output in kWhs.

while diesel systems have the lowest (42%). The second lowest is combine-cycle gas turbine cogeneration system. However, for all system types the range of efficiencies is very large and the sample size is small.

Table 7: Canadian Cogeneration System Performance

| System Type | Average Efficiency | Range | No. of Units |
|-----------------------|--------------------|------------|--------------|
| Gas Turbine | 77% | 53% to 95% | 17 |
| Steam Turbines | | | |
| BPST | 74% | 53% to 91% | 14 |
| BPEST | 72% | 58% to 88% | 9 |
| ECST | 70% | 46% to 93% | 7 |
| CCGT | 66% | 53% to 83% | 7 |
| Spark Ignition | 75% | 60% to 87% | 10 |
| Diesel | 42% | 37% to 48% | 8 |
| Microturbines | 72% | 67% to 74% | 7 |
| Total | | | 79 |

5.3 Cogeneration Installations by Date

Table 8 shows the amount of cogeneration capacity by start year to illustrate the evolution of cogeneration in Canada.¹⁰ There are two periods of significant growth in cogeneration. The first is in the 1970s and the second began in 1990 and is ongoing. The first period coincides with a dramatic increase in energy prices in Canada. Cogeneration systems may have been installed as a response to these prices and to a perceived scarcity of energy resources.

The current period of growth is likely a response to three stimuli. First, electric utilities across Canada responded to public protest over large-scale energy projects by offering to purchase power from independent power projects (IPPs). This created a market opportunity for industry to install cogeneration systems and sell excess power to the electricity grid. Second, smaller cogeneration systems are becoming increasingly cost effective expanding market opportunities beyond large-scale installations. And third, full retail access to the electricity grid in Alberta and Ontario has stimulated the development of large, grid-connected cogeneration systems. Since 1995, private utilities have installed almost 2.5 GWs of cogeneration capacity.

¹⁰ Table 5 excludes approximately 720 MW_e of operating cogeneration capacity because data on the starting year of these projects are missing.

Table 8: Cogeneration plants by start year and system operator (kW_e)

| Sector | Pre 1950 | 1950-59 | 1960-69 | 1970-79 | 1980-89 | 1990-94 | 1995-99 | 2000+ | Total |
|-------------------------------|---------------|----------------|----------------|----------------|----------------|----------------|------------------|------------------|------------------|
| Agriculture | | | | | 500 | 1,600 | 1,000 | | 3,100 |
| Mining, Oil and Gas | | 13,900 | 4,000 | | 20,000 | | 45,000 | 35,000 | 117,900 |
| Utilities | | | | | | 118,500 | 923,730 | 1,586,000 | 2,628,230 |
| Food and Textiles Man. | 2,000 | | 4,000 | | | 14,200 | | | 20,200 |
| Forest Products and Chemicals | 33,000 | 94,000 | 43,000 | 319,500 | 139,500 | 232,300 | 113,600 | 230,900 | 1,205,800 |
| Metal Manufacturing | | | | | | | 7,760 | 815 | 8,575 |
| Scientific Research | | | | | | | 810 | | 810 |
| Universities | | | | | 600 | 6,000 | 6,500 | | 13,100 |
| Hospitals | | | 1,200 | | 550 | 3,200 | | | 4,950 |
| Military | | | | | | | 3,400 | 4,070 | 7,470 |
| Unclassified | 10,000 | 86,150 | 56,500 | 335,800 | 153,881 | 435,120 | 455,060 | 567,540 | 2,100,051 |
| Total | 45,000 | 194,050 | 108,700 | 655,300 | 315,031 | 810,920 | 1,556,860 | 2,424,325 | 6,110,186 |

Source: Canadian Cogeneration Database, CIEEDAC

5.4 Data Tables

The database is published in two appendices of this report.

- Appendix B is a list of operating cogeneration systems and their characteristics by province or territory.
- Appendix C is a list of operating cogeneration systems and their characteristics by industry.

The following characteristics are provided for each site (if available):¹¹

System Operator: The company that is responsible for operation of the cogeneration system.

Type of Business: A description of the type of business activity conducted by the company operating the system.

NAICS: The North American Industrial Classification System (NAICS) code for the system operator.

City: The city nearest to the site.

Province: The province in which the system is located.

Start Year: The in-service date of the cogeneration unit.

System Owner: The company that owns the cogeneration system, if different from the system operator.

¹¹ Only data that have been authorized for publication by the system operator are listed.

Primary Thermal Host: The facility that consumes most of the thermal energy produced by the cogeneration system.

Thermal Capacity: The thermal capacity of the system in kW.

Electric 1: The primary consumer of the electricity produced by the system.

Total Elec Capacity (kW): The electrical capacity of the cogeneration system in kW.

Annual Elec Gen (MWh): The average amount of electricity generated annually in MWh.

All Elec Sold to Grid?: Yes/No

Some Elec Sold to Grid: Yes/No

Cogen1 and Cogen2: Type of generation equipment. Selected from the following:

- ST - Steam turbine.
- GT - Gas turbine.
- BPST – Back-pressure steam turbine.
- BPEST – Back-pressure extraction steam turbine.
- ECST – Extraction steam turbine
- CST – Condensing steam turbine.
- D – Diesel engine.
- SI – Spark ignition engine.
- FC – Fuel cell.

Total No. of Units: Number of individual generating units (steam turbine, gas turbine, etc.) within the facility.

Heat Rate (KJ/kWh): The KJs of fuel consumed divided by the sum of the kWhs of power generated and the kWhs of thermal energy used.

System Efficiency: The thermal performance of the system.

Heat to Power Ratio: The ratio of the thermal output to the power output.

Fuel1: The primary fuel consumed by the system.

Fuel2: The secondary fuel consumed.

Fuel3: The tertiary fuel consumed.

6. Conclusions

This is CIEEDAC's sixth annual review of cogeneration in Canada. The database contains information on 6.82 GW_e of cogeneration capacity in Canada.

Currently, Alberta has the largest cogeneration capacity of 2.4 GW_e, ahead of Ontario at 2.0 GW_e of operating cogeneration capacity. Together, the two provinces account for 65% of total capacity in Canada. When classed by system operator, the electric power generation industry has the most cogeneration, 3.4 GW_e or almost 51% of total operational capacity. The forest products sector has the next highest cogeneration capacity of 1.6 GW_e, which represents 23% of operating capacity.

When allocated by thermal host sector, the results are very different. The pulp and paper sector acts as thermal host to 2.2 GWe of cogeneration capacity (33%), the chemical sector hosts 1.7 GWe of capacity (25%) and the oil and gas sector hosts 1.6 GWe or 24% of the total.

The performance of cogeneration systems in Canada varies widely from a low of 37% to a high of 95%. On average, gas turbine systems are the most efficient (77%) and diesel systems are the least efficient (42%). The independent power sector is on average the least efficient of the sectors for which we have data and the defense sector is the most efficient.

Canadian cogeneration capacity is concentrated in regions with high electricity prices, access to the electricity grid and robust industries with high simultaneous demand for electricity and thermal energy. In particular, retail access in Alberta and Ontario has stimulated the development of over 1.5 GWe of large-scale, utility-owned cogeneration since 2000.

CIEEDAC will continue to track and update this database with the objective of improving and refining the accuracy of the data. A revised report will be released annually. As with all reports published by CIEEDAC, we encourage and appreciate any feedback from our readers.

7. References

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Appendix A

Canadian Cogeneration Database

Update Survey Questionnaire



Canadian Industrial Energy End-use Data and Analysis Centre
School of Resource and Environmental Management
Simon Fraser University
Burnaby, BC V5A 1S6
P (604) 291-3068 F (604) 291-4968
E-mail: cieedac@sfu.ca Internet: www.cieedac.sfu.ca

Canadian Cogeneration Database Update 2004

Conducted for Natural Resources Canada (NRCan)

by the
Canadian Industrial Energy End Use Data and Analysis Centre
(CIEEDAC).

Survey of Canadian Cogeneration Facilities



Part I: Introduction

The purpose of this survey is to update data contained in the Canadian Cogeneration Database. The Canadian Cogeneration Database was developed by CIEEDAC to be a single source of data on all cogeneration projects operating in Canada. Cogeneration is the simultaneous production of electricity and thermal energy from a single fuel. Cogeneration is an important component of Canada's strategy to improve energy efficiency, increase industrial competitiveness and reduce greenhouse gas emissions. This database is used by government agencies, industry and non-governmental organizations to support the growth of cogeneration in Canada.

The **cogeneration plant manager** or the company **energy manager** should complete this survey. The results of the survey will be incorporated into the Canadian Cogeneration Database. Your participation in this survey will ensure that the Canadian Cogeneration Database has accurate and complete data on your facility. Accurate data will assist policymakers to better understand the scope and opportunity for cogeneration in Canada and to develop effective policies and programs to support increased cogeneration capacity.

CIEEDAC will produce a report summarizing the results of this year's survey. Each participant will receive a copy of the report in late spring.

Thank you for your participation.

Part II: Instructions

This survey consists of 4 sections:

- Section I: Operator / Owner Information
- Section II: System Users
- Section III: Capacity and Equipment
- Section IV: Plant Operation

Please answer all the questions, even if you have to enter "DON'T KNOW". Most questions can be answered by ticking one box, all relevant boxes, or by providing short answers. Please print your responses in the spaces provided, but if your answer cannot be accommodated, please answer the question on the back of the sheet. If you have difficulties answering a question please contact Catherine Strickland at (604) 980-1239 or email cstrickland@shaw.ca.

When you have completed the form, please return it by fax to (604) 980-1283, email or by mail to:

Catherine Strickland
1395 Paisley Road
North Vancouver, BC
V7R 1C2



Part III: Survey

Section I: System Operator / Owner Information

Please provide the contact information for the cogeneration facility. If the system owner is a different company, please note below.

Company Information

Type of Business _____

North American Industry Classification System (NAICS) code (if known): _____

Contact Information for the Cogeneration Facility

Company Name _____

Contact Name _____

Title _____

Mailing Address: Street/Box: _____

City: _____

Province: _____

Postal code: _____

Phone: () _____

Fax: _____

E-mail: _____

Contact Information for the Cogeneration System Owner (if different from above)

Company Name: _____

Contact Name: _____

Phone: () _____



Section II: Energy Users

Electricity

1) List the company name and type of business for each electricity user. Please list in order of size (i.e. biggest to smallest user), if known.

- Don't know, all cogenerated electricity is sold to the grid.
- Cogenerated electricity is consumed by (Please include your company if applicable):

| <u>Company Name</u> | <u>Type of Business</u> |
|---------------------|-------------------------|
| i | |
| ii | |
| iii | |

- Some cogenerated electricity is sold to the grid.

2) If electricity is sold to the grid, is it sold wholesale or retail? _____
(Wholesale means that it is sold to a power pool or an electric utility, retail means it is sold to the user directly).

3) Does the prime electricity user require additional electricity from the grid? _____

4) Can the facility be isolated from the grid in the case of a general outage? _____

Thermal Energy

5) What is the thermal product of the cogeneration system?

- High pressure steam (greater than 30 psi)
- Low pressure steam (less than 30 psi)
- High temperature water (greater than 80°C)
- Low temperature water (less than 80°C)

6) List the company name and type of business for each user of steam or hot water produced by the cogeneration system. If known, please list in order of size of thermal load.

- i. _____
- ii. _____
- iii. _____



7) What is the thermal energy used for (if known)?

- Process Heat
- Process Steam
- Space Heat
- Preheat
- Refrigeration/Cooling
- Other (please specify) _____

Greenhouse Gas Emissions

8) Which company is allocated the greenhouse gas emissions from the facility? If more than one, please identify each company and the proportion of emissions it is responsible for.

| <u>Company Name</u> | <u>Percentage</u> |
|---------------------|-------------------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Section III: Capacity and Equipment

- 1) What is the electrical capacity of the cogeneration system? _____ MW
- 2) What is the average annual electricity production? _____ MWh/yr
- 3) What is the average annual amount of thermal energy produced by the cogeneration system? (i.e., lbs of steam/yr, MMBTUs/yr, GJ/yr) _____

4) What type of generator(s) are in operation? Please specify the type (see below), capacity, year installed and number of each for a given capacity. If you have two generators of the same type but different capacities, please list them separately.

| <u>Type of generator</u> | <u>Capacity</u> | <u>Year Installed</u> | <u>No. of this size</u> |
|--------------------------|-----------------|-----------------------|-------------------------|
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |

Please use the following codes:
 Back-pressure Steam Turbine (BPST), Back-pressure Extraction Steam Turbine (BPEST),
 Extraction Condensing Steam Turbine (ECST), Gas Turbine (GT), Diesel Engine (D), Spark-
 ignition Engine (SI), Fuel Cells (FC)



5) Is this a combined cycle plant? _____

6) What additional components does the system have? (Check all that apply)

- Regenerative Feedwater Heating
- Duct Burners
- Steam Injection

7) List the fuels consumed by the cogeneration system, with the approximate annual percentage (e.g., natural gas, 30%; hog fuel, 30%; black liquor, 40%) and the annual amounts (include units, i.e. tonnes, MMBtu, m³ or GJ).

| <u>Fuel Type</u> | <u>Percentage</u> | <u>Annual Amount</u> |
|------------------|-------------------|----------------------|
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

Appendix B

Operating Cogeneration Facilities In Canada

By Sector

Cogeneration Facilities by Sector 2003

NAICS 0

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|----------|------------------|----------------------|----------------|------------|------|
| ON | 2002 | NRCan | Research | Health Canada | 58 | MT | NG |

NAICS 1114

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|----------------------------|------------------|----------------------------|----------------|------------|------|
| ON | 1989 | WestbrookFloral | Flower Grower | Westbrook Greenhouses Ltd. | 500 | IC | NG |
| ON | 1992 | Rosa Flora Ltd | Greenhouse | Rosa Flora Ltd. | 1600 | SI | NG |
| ON | 1995 | Westbrook Greenhouses Ltd. | Flower Grower | Westbrook Greenhouses Ltd. | 1000 | IC | NG |

NAICS 2111

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|---------------------------|--------------------------|----------------------|----------------|------------|------|
| AB | 1961 | Keyspan Energy Canada Inc | Gas Plant | Rimby Gas Plant | 4000 | ST | |
| AB | 1975 | Syncrude | Mining Heavy Oil Upgradi | Syncrude | 45000 | GT | |

NAICS 2123

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|------------------------|----------------------------|-------------------------|----------------|------------|----------|
| AB | 1958/ 1964 | Canadian Salt Co. Ltd. | Mining | Canadian Salt Co. Ltd. | 13900 | BPST | |
| NS | 1980 | Canadian Salt Co. Ltd. | Salt Mining and Processing | Canadian Salt Co. | 35 | BPST | Bunker C |
| NS | 1987 | Canadian Salt Co. Ltd. | Salt Mining and Processing | Canadian Salt Co. | 52 | BPST | Bunker C |
| NS | 1998 | Canadian Salt Co. Ltd. | Salt Mining and Processing | Canadian Salt Co. | 244 | BPST | Bunker C |
| SK | 1981 | IMC Canada Ltd. | Potash Mine | IMC Potash Belle Plaine | 20000 | BPST | NG |
| SK | 2001 | IMC Canada Ltd. | Potash Mine | IMC Potash Belle Plaine | 35000 | BPST | NG |

NAICS 2211

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|---------------------------------|---------------------------|-----------------------------------|----------------|------------|--------|
| AB | 1998 | ATCO/Canadian Natural Resour | Non-Utility Generator | CNRL | 85000 | GT | NG |
| AB | 1999 | Husky Oil | Non-Utility Generator | Husky Oil | 45000 | GT | NG |
| AB | 1999 | Fort Saskatchewan Cogeneration | Non-Utility Generator | Dow Chemical Canada Inc. | 124000 | GT | NG |
| AB | 2000 | Joffre Cogeneration | Non-Utility Generator | NOVA Chemicals | 480000 | GT | NG |
| AB | 2001 | Transalta Energy Corpoation | Non-Utility Generator | Suncor Energy | 365000 | GT | NG |
| AB | 2001 | TransCanada Energy | IPP | Agrium | 80000 | GT | NG |
| AB | 2001 | Mariah Energy Corp | IPP | Walker Court Condominiums | 30 | MT | NG |
| AB | 2001 | ATCO Power | Non-Utility Generator | Husky Oil | 45000 | GT | NG |
| AB | 2001 | TransCanada Energy Ltd. | IPP | Williams Energy Redwater Fraction | 40000 | GT | NG |
| AB | 2001 | TransCanada Energy | IPP | Cancarb Thermal Carbon Black pla | 40000 | ECST | NG |
| AB | 2002 | Muskeg River Cogeneration | Non-Utility Generator | Muskeg River Mine/ Athabasca Oil | 170000 | GT | NG |
| AB | 2003 | Mariah Energy Corp | IPP | Suntec Greenhouses | 90 | MT | NG |
| AB | 2003 | TransCanada Energy | IPP | Petro-Canada Oil Sands | 165000 | GT | NG |
| BC | 1968 | BC Hydro | Electric Utility | Imperial Oil | 157500 | CST | NG |
| BC | 1993 | Duke Energy/ATCO | Gas Processing | Duke Energy | 120000 | GT | NG |
| BC | 1999 | Calpine Island Cogeneration LP | Independent Power Produce | Norske Skogindustrier, Elk Falls | 290000 | GT | NG |
| BC | 2000 | BC Hydro | Utility | Fort Nelson Gas Processing plant | 47000 | GT | |
| NB | 1964 | NB Power | Electric Utility | Irving Pulp and Paper | 13000 | BPST | #6 Oil |
| NS | 1995 | Brooklyn Power Corporation | Non-utility generator | Bowater Mersey Paper Co. | 30000 | ECST | Hog |
| NW | 2002 | Northwest Territories Power Cor | IPP | Midnight Sun Recreation Centre | 60 | MT | NG |
| ON | | Sudbury District Energy | IPP | | 5000 | GT | NG |
| ON | | Imperial Oil | Gas refinery | Imperial Oil, Nanticoke Refinery | 20000 | ST | |

| | | | | | | | |
|----|------|-----------------------------------|---------------------------|--------------------------------------|--------|------|-----|
| ON | 1990 | Abitibi Consolidated Canada | IPP | Abitibi Consolidated (Fort Frances) | 112000 | GT | NG |
| ON | 1995 | West Windsor Power | Non-Utility Generator | Canadian Salt Co. | 118000 | GT | NG |
| ON | 1995 | AES Kingston Inc. | Non-Utility Generator | Kosa Canada | 110000 | GT | NG |
| ON | 1996 | Iroquois Falls Power Corp. / Nort | Independent Power Produce | Abitibi Consolidated Inc. (Iroquois) | 110000 | GT | NG |
| ON | 1996 | Transalta Energy/Windsor Essex | Non-Utility Generator | DailmerChrysler Canada | 68000 | GT | NG |
| ON | 1998 | Whitby Cogeneration Limited Pa | Non-utility generator | Atlantic Packaging Products Ltd. | 58000 | GT | NG |
| PE | 1986 | Northeast Energy | Utility | | 850 | IC | |
| PQ | 1992 | Boralex Inc. | Thermal Utility | Cascades Inc. (Papier Kingsey Falls) | 31000 | GT | NG |
| PQ | 2003 | CHI Canada Inc. | IPP | Alliance Forest Products | 23000 | BPST | Hog |
| SK | 1999 | Meridian Cogeneration Project | Non-Utility Generator | Husky Oil Lloydminster | 220000 | GT | NG |
| SK | 2002 | ATCO Power/Sask Power Int'l | Non-Utility Generator | Cory Potash Mine | 260000 | GT | NG |

NAICS 2212

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-----------|-------------------------|----------------------------------|----------------|------------|------|
| ON | 1990 | Union Gas | Gas Utility | Union Gas Halton Division Office | 60 | IC | |
| ON | 1994 | Union Gas | Natural Gas Distributor | Union Gas Head Office | 6000 | GT | |

NAICS 2213

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|---------------------------------|-----------------------|-----------------------|----------------|------------|------------|
| BC | 1998 | Greater Vanc. Regional District | Water Treatment Plant | Iona Island WWT plant | 3750 | SI | Digester g |
| NU | 1979 | Nunavut Power Corp | District Energy | District Energy | 600 | D | Diesel |
| NU | 1981 | Nunavut Power Corp | District Energy | District Energy | 540 | D | Diesel |
| NU | 1989 | Nunavut Power Corp | District Energy | District Energy | 720 | D | Diesel |
| NU | 1993 | Nunavut Power Corp | District Energy | District Energy | 720 | D | Diesel |
| NU | 1994 | Nunavut Power Corp | District Energy | District Energy | 960 | D | Diesel |

| | | | | | | | |
|----|------|---------------------------|------------------------|------------------------------------|------|-------|----------|
| NU | 1994 | Nunavut Power Corp | District Energy | District Energy | 300 | D | Diesel |
| NU | 1995 | Nunavut Power Corp | District Energy | District Energy | 480 | D | Diesel |
| NU | 1995 | Nunavut Power Corp | District Energy | District Energy | 800 | D | Diesel |
| NU | 1995 | Nunavut Power Corp | District Energy | District Energy | 1680 | D | Diesel |
| NU | 1996 | Nunavut Power Corp | District Energy | District Energy | 600 | D | Diesel |
| NU | 2001 | Nunavut Power Corp | District Energy | District Energy | 900 | D | Diesel |
| NW | | DND Alert, NWT | District heating | DND Alert, NWT | 6600 | IC | |
| NW | | Eureka | District heating | Eureka | 500 | IC | |
| NW | 1997 | Fort McPherson | District Energy | Fort McPherson District Energy | | IC | |
| ON | 1993 | City of Barrie | Wastewater Treatment | Barrie Waste Water Treatment Plant | 500 | SI | Digester |
| ON | 1995 | CDH District Heating Ltd. | District Heating | Institutional and Commercial | 5000 | SI | NG |
| ON | 1995 | City of Guelph | Wastewater Treatment | Wastewater Treatment plant | 580 | SI | Digester |
| ON | 1996 | Core Energy | Municipality | Trigen | 3500 | GT,ST | |
| ON | 2001 | Markham District Energy | Commercial/residential | IBM Canada | 3500 | SI | NG |
| ON | 2001 | Sudbury District Energy | IPP | Sudbury Regional Hospital | 6700 | SI | NG |
| ON | 2003 | Hamilton Community Energy | District Energy | City of Hamilton | 3500 | SI | NG |
| PE | 1997 | PEI Energy Systems | District Energy | District Energy (80+ Customers) | 1200 | BPST | Wood |
| SK | 2002 | Regina General Hospital | Hospital | Regina General Hospital | 120 | MT | ng |

NAICS 3111

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|------------|------------------|----------------------|----------------|------------|------|
| ON | 1994 | Casco Inc. | Feed Industry | Casco Inc. | 10000 | GT | NG |

NAICS 3112

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|------------|-----------------------|----------------------|----------------|------------|------|
| ON | 1995 | Casco Inc. | Corn-based Sweeteners | Casco Inc. | 15000 | GT | NG |

NAICS 3113

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|--------------------|-----------------------------|----------------------|----------------|------------|------|
| AB | 1949 | Rogers Sugar Ltd. | Sugar Beet Processing Plant | Rogers Sugar Ltd. | 2000 | BPST | NG |
| AB | 1967 | Rogers Sugar Ltd. | Sugar Beet Processing Plant | Rogers Sugar Ltd. | 4000 | BPST | NG |
| BC | 1973 | Rogers Sugar | Food Manufacturer | Rogers Sugar | 3000 | BPST | NG |
| ON | 1996 | Redpath Sugar Ltd. | Sugar Refining, Packaging | Redpath Sugar Ltd. | 5600 | BPST | NG |

NAICS 3116

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-------------------|------------------|----------------------|----------------|------------|------|
| ON | 1999 | Maple Lodge Farms | Food Processing | Maple Lodge Farms | 4750 | GT | NG |

NAICS 3119

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|---------------------------------|--------------------|----------------------------------|----------------|------------|------|
| ON | 1990 | H.J. Heinz Company Of Canada | Food Manufacturing | H.J. Heinz Company Of Canada Ltd | 8600 | GT | NG |
| ON | 1994 | Cardinal Power Of Canada Inc. C | Food Industry | Casco Inc./ Benson Public School | 156000 | CCGT | |
| ON | 2001 | Jungbunzlauer | Food Manufacturer | Jungbunzlauer | 10000 | GT | NG |

NAICS 3121

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-------------------------|--------------------|-----------------------|----------------|------------|------|
| AB | 1996 | Black Velvet Distillers | Distillery Process | Palliser Distillers | 450 | IC | |
| ON | 1955 | Hiram Walker And Sons | Distiller | Hiram Walker And Sons | 2500 | BPEST | NG |
| ON | 1969 | Hiram Walker And Sons | Distiller | Hiram Walker And Sons | 5000 | BPST | NG |

| | | | | | | | |
|----|------|-------------------------|-----------|-----------------------|------|----|--------|
| ON | 1985 | Hiram Walker And Sons | Distiller | Hiram Walker And Sons | 350 | D | Deisel |
| ON | 1993 | Labatt Brewing Co. Ltd. | Brewery | Labatts | 5000 | GT | NG |

NAICS 3151

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|--------------------|----------------------|----------------------|----------------|------------|------|
| ON | 1994 | Phantom Industries | Hoisery and Swimwear | Phantom Industries | 600 | SI | NG |

NAICS 3211

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|---------------------------|------------------|---------------------------|----------------|------------|------|
| BC | 1985 | Riverside Forest Products | Wood Products | Riverside Forest Products | 5000 | CST | Hog |
| BC | 2000 | Riverside Forest Products | Wood Products | Riverside Forest Products | 7000 | CST | Hog |

NAICS 3212

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-------------------|------------------|----------------------|----------------|------------|------|
| BC | 1936 | Louisiana Pacific | Wood Products | Louisiana Pacific | 7500 | ECST | Hog |

NAICS 3221

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-----------------------------------|------------------|-----------------------------------|----------------|------------|------|
| AB | 1957 | Weldwood Of Canada Ltd. | Pulp and Paper | Weldwood Of Canada Ltd. (Hinton | 23000 | ECST | SPL |
| AB | 1973 | Weyerhauser Canada Ltd. | Pulp and Paper | Weyerhauser Canada Ltd. (Alberta | 34500 | ST | |
| AB | 1989 | Weldwood Of Canada Ltd. | Pulp and Paper | Weldwood Of Canada Ltd. (Hinton | 28000 | BPST | SPL |
| AB | 1989 | Daishowa - Marubeni Internation | Pulp and Paper | Daishowa- Marubeni International | 40000 | BPEST | SPL |
| AB | 1992 | Alberta Pacific Forest Industries | Pulp and Paper | Alberta Pacific Forest Industries | 92000 | ST | SPL |
| BC | | NorskeCanada | Pulp and Paper | Powell River Division | 40000 | BPEST | Hog |
| BC | 1945 | Western Pulp Ltd. | Pulp and Paper | Squamish Pulp Operations | 8000 | ST | |
| BC | 1949 | Western Pulp Ltd. | Pulp and Paper | Port Alice Operations | 3500 | BPST | SPL |
| BC | 1950 | Skeena Cellulose Inc. | Pulp Mill | Skeena Cellulose Inc. | 10000 | BPEST | SPL |

| | | | | | | | |
|----|------|--------------------------------|----------------|-----------------------------------|-------|-------|----------|
| BC | 1956 | Western Pulp Ltd. | Pulp and Paper | Port Alice Operations | 7500 | ECST | SPL |
| BC | 1963 | Pope and Talbot Inc. | Pulp and Paper | Pope and Talbot Harmac Pulp | 30000 | BPST | SPL |
| BC | 1964 | Norske Canada | Pulp and Paper | Port Alberni P&P Division | 26000 | BPEST | Hog |
| BC | 1968 | Skeena Cellulose Inc. | Pulp Mill | Skeena Cellulose Inc. | 32000 | BPEST | SPL |
| BC | 1968 | Tembec Industries Inc. | Pulp and Paper | Crestbrook Forest Ind. | 17500 | ST | |
| BC | 1972 | Weyerhaeuser Canada Ltd. | Pulp and Paper | Weyerhaeuser Canada Ltd. | 46000 | BPST | SPL |
| BC | 1972 | Cariboo Pulp and Paper | Pulp and Paper | Cariboo Pulp & Paper | 32000 | BPEST | SPL |
| BC | 1973 | Canadian Forest Products | Pulp and Paper | CANFOR-Northwood | 27400 | BPEST | SPL |
| BC | 1977 | Western Pulp Ltd. | Pulp and Paper | Port Alice Operations | 16500 | BPST | SPL |
| BC | 1979 | Pope and Talbot Ltd. | Pulp and Paper | Mackenzie Pulp Operation | 20000 | BPEST | SPL |
| BC | 1981 | Norske Skogindustrier | Pulp and Paper | Crofton Pulp & Paper | 38000 | ST | |
| BC | 1981 | Canadian Forest Products | Pulp and Paper | CANFOR-Northwood | 28000 | BPEST | SPL |
| BC | 1989 | Howe Sound Pulp And Paper | Pulp and Paper | Howe Sound Pulp And Paper | 62500 | BPEST | SPL |
| BC | 1992 | Howe Sound Pulp And Paper | Pulp and Paper | Howe Sound Pulp And Paper | 50000 | ECST | SPL |
| BC | 1993 | Celgar Pulp Co. | Pulp and Paper | Celgar Pulp Co. | 52000 | BPEST | SPL |
| BC | 1996 | Abitibi Consolidated | Pulp and Paper | Mackenzie Paper Division | 13900 | BPEST | HOG |
| BC | 2001 | Tembec Industries | Pulp and paper | Tembec Industries | 43500 | ECST | SPL |
| BC | 2003 | Weyerhaeuser Canada Ltd. | Pulp and Paper | Weyerhaeuser Canada Ltd. | 29000 | CST | SPL |
| MB | 2002 | Tolko Manitoba Inc. | Pulp and Paper | Tolko Manitoba Inc. - Formerly Re | 22000 | BPEST | SPL |
| NB | 1956 | Irving Pulp And Paper Ltd. | Pulp and Paper | Irving Pulp And Paper Inc. | 32500 | BPEST | SPL |
| NB | 1965 | UPM-Kymmene Mirsmichi Inc. | Pulp and Paper | UPM-Kymmene Miramichi Inc. | 17000 | BPEST | SPL |
| NB | 1972 | Ste. Anne-Nackawic Pulp Co. Lt | Pulp and Paper | Ste. Anne-Nackawic Pulp Co. Ltd. | 25000 | BPEST | SPL |
| NB | 1983 | AVCell | Pulp and Paper | Av Cell | 21000 | BPEST | Red Liqu |
| NB | 1989 | UPM-Kymmene Mirsmichi Inc. | Pulp and Paper | UPM-Kymmene Miramichi Inc. | 23000 | BPST | SPL |

| | | | | | | | |
|----|------|---------------------------------|-----------------|---------------------------------------|-------|-------|----------|
| NB | 1996 | Fraser Papers Inc. | Pulp and Paper | Nexfor/Fraser Papers | 46000 | BPEST | Hog |
| NF | 2003 | Cornerbrook Pulp and Paper | Pulp and Paper | Corner Brook Pulp and Paper Ltd | 17500 | BPEST | Hog |
| NS | | Minas Basin Pulp And Paper Ltd | Pulp and Paper | Minas Basin Pulp And Paper Ltd. | 6400 | ST | |
| NS | | Stora Forest Industries Ltd. | Pulp and Paper | Stora Forest Industries Ltd. | 29500 | ST | |
| NS | 1967 | Kimberly Clark Nova Scotia Inc. | Pulp and Paper | Kimberly Clark Nova Scotia Inc. (F | 25700 | ECST | SPL |
| ON | | Bowater | Pulp and Paper | Bowater | 76570 | ST | |
| ON | | Bowater Thunder Bay | Paper Mill | Bowater Thunder Bay | 67000 | ST | |
| ON | | Kimberly-Clark Inc. | Pulp and Paper | Kimberly-Clark Inc. Terrace Bay | 20000 | ST | |
| ON | 1944 | Marathon Pulp Inc. | Pulp and Paper | Marathon Pulp Inc. | 9500 | BPEST | SPL |
| ON | 1946 | Marathon Pulp Inc. | Pulp and Paper | Marathon Pulp Inc. | 4500 | BPEST | SPL |
| ON | 1958 | Tembec Industries Inc. | Pulp and Paper | Spruce Falls Inc. (Kapusksasing Mill | 21600 | ST | |
| ON | 1975 | Tembec Industries Inc. | Pulp and Paper | Tembec Industries Inc. | 12500 | BPEST | Hog Fuel |
| ON | 1985 | Tembec Industries Inc. | Pulp and Paper | Tembec Industries Inc. | 12500 | ECST | Hog Fuel |
| ON | 1989 | Domtar Inc. | Pulp and Paper | Domtar | 24000 | ST | |
| ON | 1993 | Sonoco Ltd. | Paper Products | Sonoco Ltd. (Branford Mill) | 4000 | GT | |
| ON | 2000 | Sonoco | Paper Products | Sonoco Paper Mill | 7800 | GT | NG |
| PQ | | La Compagnie Gaspesia Ltee | Pulp and Paper | La Compagnie Gaspesia Ltee | 6000 | ST | |
| PQ | 1993 | Tembec Industries Inc. | Pulp and Paper | Tembec Inc. (Specialty Cellulose Di | 9500 | ST | |
| PQ | 1996 | Donohue Inc. | Pulp and Paper | Abitibi Consolidated Inc. (St. Felici | 28600 | ST | |
| PQ | 1997 | Bowater Forest Products | Pulp and Paper | Bowater Forest Products | 28000 | ECST | Hog |
| PQ | 1998 | Domtar Inc. | Pulp and Paper | Domtar (Norkraft Quevillon Inc.) | 48500 | BPST | SPL |
| PQ | 2001 | Domtar Inc. | Pulp and Paper | Domtar Inc | 32000 | BPEST | SPL |
| SK | 1968 | Weyerhaeuser Canada | Forest Products | Weyerhaeuser Canada Ltd. | 21000 | ST | |

NAICS 3241

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|----------------------------|----------------------|----------------------|----------------|------------|------|
| AB | 2002 | Imperial Oil Resources Ltd | Heavy Oil Production | Imperial Oil | 165100 | GT | NG |

NAICS 3251

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|--------------------------|---------------------|-------------------------------|----------------|------------|------|
| AB | 1954 | Celanese Canada | Chemical | Celanese Canada | 21000 | ECST | NG |
| AB | 1979 | Dow Chemical Canada Inc. | Chemical | Dow Chemical Canada Inc. | 180000 | CCGT | NG |
| ON | | General Chemical | Chemical Processing | General Chemical | 10950 | ST | |
| ON | | Terra International | Chemicals | Terra International | 15500 | GT | |
| ON | 1972 | TransAlta | Chemical Processing | Dow Chemical | 161000 | CCGT | |
| ON | 1983 | TransAlta | Chemical processing | Bayer Rubber | 51031 | ST | |
| ON | 1997 | Commercial Alcohols Inc. | Ethanol Production | Commercial Alcohols Inc. | 5000 | GT | NG |
| ON | 2003 | TransAlta- Sarnia Cogen | Chemical Processing | Bayer, Dow and NOVA Chemicals | 440000 | GT | |

NAICS 3252

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-------------|---------------------|----------------------|----------------|------------|------|
| AB | 2000 | Air Liquide | Chemical Processing | Shell Chemical | 84000 | GT | |
| ON | 1992 | Dupont | Chemical plant | Dupont | 38300 | GT | NG |

NAICS 3254

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|----------------------|---------------------------|----------------------|----------------|------------|------|
| ON | 1994 | Aventis Pasteur Ltd. | Pharmaceutical Manufactur | Aventis Pasteur Ltd. | 3000 | GT | |

NAICS 3312

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|----------|--------------------|----------------------|----------------|------------|------|
| ON | 1930 | Stelco | Steel Manufacturer | Stelco | 10000 | ST | |

NAICS 3328

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|----------------------|------------------|----------------------|----------------|------------|------|
| ON | 1997 | Kuntz Electroplating | Metals | Kuntz Electroplating | 2445 | SI | NG |
| ON | 1999 | Kuntz Electroplating | Metals | Kuntz Electroplating | 815 | SI | NG |
| ON | 2000 | Kuntz Electroplating | Metals | Kuntz Electroplating | 815 | SI | NG |

NAICS 3332

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-----------------|------------------|----------------------|----------------|------------|------|
| PQ | 2000 | Pratt & Whitney | | Pratt & Whitney | 1840 | GT | |

NAICS 3361

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|------------------------------|-------------------------|----------------------|----------------|------------|------|
| ON | 1995 | Ford Motor Company Of Canada | Automobile Manufacturer | Ford Motor Company | 28000 | ECST | NG |

NAICS 3399

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-------------------|--------------------------|----------------------|----------------|------------|------|
| ON | 1995 | Kodak Canada Inc. | Photo Equipment Manufact | Kodak Canada Inc. | 4500 | GT | NG |

NAICS 5417

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|---------------------------------|-------------------|-----------------------------------|----------------|------------|------|
| ON | 1994 | NRCC | Government Agency | NRCC | 4000 | GT | |
| ON | 1996 | Canada Centre for Inland Waterw | Research facility | Canada Centre for Inland Waterway | 810 | IC | NG |

NAICS 5622

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|--------------------------------------|-----------------------|-----------------------------------|----------------|------------|----------|
| ON | 1997 | Ottawa-Carlton Regional Municipality | Waste Water Treatment | Robert Pickard Environment Centre | 2400 | SI | Digester |

NAICS 6112

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|----------------|-------------------------|-----------------------|----------------|------------|------|
| ON | | Mohawk College | College | Mohawk College | 810 | IC | |
| SK | 1993 | Saskenergy | Educational Institution | Saskatchewan Hospital | 800 | IC | |

NAICS 6113

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|-----------------------|------------------|-----------------------|----------------|------------|------|
| AB | | University of Alberta | University | University of Alberta | 13300 | GT | |
| ON | | Brock University | University | Brock University | 6560 | IC | |
| ON | 1986 | University of Ottawa | University | University of Ottawa | 600 | SI | NG |
| ON | 1992 | University of Toronto | University | University of Toronto | 6000 | GT | NG |
| ON | 1993 | University of Windsor | University | University of Windsor | 3800 | GT | NG |
| ON | 1994 | Centra Gas | University | Orillia Soldiers | 13300 | ST | |
| ON | 1995 | University of Ottawa | University | University of Ottawa | 1500 | BPST | NG |
| ON | 1997 | York University | University | York University | 5000 | GT | NG |

NAICS 6115

| Province | Start Year | Operator | Type of Business | Primary Thermal Host | Elec Cap. (kw) | Cogen type | Fuel |
|----------|------------|------------------------------------------|-----------------------|----------------------|----------------|------------|------|
| AB | 1998 | Southern Alberta Institute of Technology | Educational Institute | SAIT | 3000 | BPST | NG |
| AB | 2003 | SAIT | College | SAIT | 60 | MT | NG |

Appendix C

Operating Cogeneration Facilities in Canada

By Province or Territory

Cogeneration by Province 2003

| Province | | AB | | | | | |
|----------|------------|-----------------------------|-----------------------------|---------------------------------------|---------------|-----------------|----|
| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type Fuel | |
| 2111 | 1961 | Keyspan Energy Canada Inc | Gas Plant | Rimby Gas Plant | 4,000 | ST | |
| 2111 | 1975 | Syncrude | Mining Heavy Oil Upgrading | Syncrude | 45,000 | GT | |
| 2123 | 1958/ 1964 | Canadian Salt Co. Ltd. | Mining | Canadian Salt Co. Ltd. | 13,900 | BPEST | |
| 2211 | 1998 | ATCO/Canadian Natural Re | Non-Utility Generator | CNRL | 85,000 | GT | NG |
| 2211 | 1999 | Husky Oil | Non-Utility Generator | Husky Oil | 45,000 | GT | NG |
| 2211 | 1999 | Fort Saskatchewan Cogenera | Non-Utility Generator | Dow Chemical Canada Inc. | 124,000 | GT | NG |
| 2211 | 2000 | Joffre Cogeneration | Non-Utility Generator | NOVA Chemicals | 480,000 | GT | NG |
| 2211 | 2001 | TransCanada Energy | IPP | Cancarb Thermal Carbon Black plant | 40,000 | ECST | NG |
| 2211 | 2001 | TransCanada Energy Ltd. | IPP | Williams Energy Redwater Fractionatio | 40,000 | GT | NG |
| 2211 | 2001 | TransCanada Energy | IPP | Agrium | 80,000 | GT | NG |
| 2211 | 2001 | Mariah Energy Corp | IPP | Walker Court Condominiums | 30 | MT | NG |
| 2211 | 2001 | Transalta Energy Corpoation | Non-Utility Generator | Suncor Energy | 365,000 | GT | NG |
| 2211 | 2001 | ATCO Power | Non-Utility Generator | Husky Oil | 45,000 | GT | NG |
| 2211 | 2002 | Muskeg River Cogeneration | Non-Utility Generator | Muskeg River Mine/ Athabasca Oil San | 170,000 | GT | NG |
| 2211 | 2003 | Mariah Energy Corp | IPP | Suntec Greenhouses | 90 | MT | NG |
| 2211 | 2003 | TransCanada Energy | IPP | Petro-Canada Oil Sands | 165,000 | GT | NG |
| 3113 | 1949 | Rogers Sugar Ltd. | Sugar Beet Processing Plant | Rogers Sugar Ltd. | 2,000 | BPST | NG |

| | | | | | | | |
|------|------|-------------------------------|-----------------------------|----------------------------------------|---------|-------|-----|
| 3113 | 1967 | Rogers Sugar Ltd. | Sugar Beet Processing Plant | Rogers Sugar Ltd. | 4,000 | BPST | NG |
| 3121 | 1996 | Black Velvet Distillers | Distillery Process | Palliser Distillers | 450 | IC | |
| 3221 | 1957 | Weldwood Of Canada Ltd. | Pulp and Paper | Weldwood Of Canada Ltd. (Hinton Div | 23,000 | ECST | SPL |
| 3221 | 1973 | Weyerhaeuser Canada Ltd. | Pulp and Paper | Weyerhaeuser Canada Ltd. (Alberta Divi | 34,500 | ST | |
| 3221 | 1989 | Weldwood Of Canada Ltd. | Pulp and Paper | Weldwood Of Canada Ltd. (Hinton Div | 28,000 | BPST | SPL |
| 3221 | 1989 | Daishowa - Marubeni Intern | Pulp and Paper | Daishowa- Marubeni International Ltd. | 40,000 | BPEST | SPL |
| 3221 | 1992 | Alberta Pacific Forest Indust | Pulp and Paper | Alberta Pacific Forest Industries | 92,000 | ST | SPL |
| 3241 | 2002 | Imperial Oil Resources Ltd | Heavy Oil Production | Imperial Oil | 165,100 | GT | NG |
| 3251 | 1954 | Celanese Canada | Chemical | Celanese Canada | 21,000 | ECST | NG |
| 3251 | 1979 | Dow Chemical Canada Inc. | Chemical | Dow Chemical Canada Inc. | 180,000 | CCGT | NG |
| 3252 | 2000 | Air Liquide | Chemical Processing | Shell Chemical | 84,000 | GT | |
| 6113 | | University of Alberta | University | University of Alberta | 13,300 | GT | |
| 6115 | 1998 | Southern Alberta Institute of | Educational Institute | SAIT | 3,000 | BPST | NG |
| 6115 | 2003 | SAIT | College | SAIT | 60 | MT | NG |
| 6221 | 1960 | Alberta Hospital Ponoka | Hospital | Alberta Hospital Ponoka Site | 1,200 | BPST | NG |
| 6221 | 1964 | Calgary Health Region | Hospital | Foothills Hospital | 18,000 | ST | |
| 6221 | 1969 | Alberta Hospital | Hospital | Alberta Hospital, Edmonton | 3,000 | ST | |
| 6221 | 1980 | Alberta Hospital Ponoka | Hospital | Alberta Hospital Ponoka Site | 550 | BPST | NG |
| 6221 | 1992 | Chinook Health Region | Hospital | Lethbridge Regional Hospital | 2,750 | SI | NG |
| 6221 | 1994 | Chinook Health Region | Hospital | Lethbridge Regional Hospital | 450 | SI | NG |
| 6221 | 1996 | David Thompson Health Re | Hospital | Red Deer Hospital | 2 | SI | NG |
| 7139 | 2003 | Medicine Hat Family Leisur | Recreation Facility | Medicine Hat Family Leisure Centre | 120 | MT | NG |

Summary for 'Province' = AB (39 detail records)

Electrical Capacity for Province

2,418,502

Province BC

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|-----------------------------|----------------------------|----------------------------------|---------------|------------|----------|
| 2211 | 1968 | BC Hydro | Electric Utility | Imperial Oil | 157,500 | CST | NG |
| 2211 | 1993 | Duke Energy/ATCO | Gas Processing | Duke Energy | 120,000 | GT | NG |
| 2211 | 1999 | Calpine Island Cogeneration | Independent Power Producer | Norske Skogindustrier, Elk Falls | 290,000 | GT | NG |
| 2211 | 2000 | BC Hydro | Utility | Fort Nelson Gas Processing plant | 47,000 | GT | |
| 2213 | 1998 | Greater Vanc. Regional Dist | Water Treatment Plant | Iona Island WWT plant | 3,750 | SI | Digester |
| 3113 | 1973 | Rogers Sugar | Food Manufacturer | Rogers Sugar | 3,000 | BPST | NG |
| 3211 | 1985 | Riverside Forest Products | Wood Products | Riverside Forest Products | 5,000 | CST | Hog |
| 3211 | 2000 | Riverside Forest Products | Wood Products | Riverside Forest Products | 7,000 | CST | Hog |
| 3212 | 1936 | Louisiana Pacific | Wood Products | Louisiana Pacific | 7,500 | ECST | Hog |
| 3221 | | NorskeCanada | Pulp and Paper | Powell River Division | 40,000 | BPEST | Hog |
| 3221 | 1945 | Western Pulp Ltd. | Pulp and Paper | Squamish Pulp Operations | 8,000 | ST | |
| 3221 | 1949 | Western Pulp Ltd. | Pulp and Paper | Port Alice Operations | 3,500 | BPST | SPL |
| 3221 | 1950 | Skeena Cellulose Inc. | Pulp Mill | Skeena Cellulose Inc. | 10,000 | BPEST | SPL |
| 3221 | 1956 | Western Pulp Ltd. | Pulp and Paper | Port Alice Operations | 7,500 | ECST | SPL |
| 3221 | 1963 | Pope and Talbot Inc. | Pulp and Paper | Pope and Talbot Harmac Pulp | 30,000 | BPST | SPL |
| 3221 | 1964 | Norske Canada | Pulp and Paper | Port Alberni P&P Division | 26,000 | BPEST | Hog |
| 3221 | 1968 | Skeena Cellulose Inc. | Pulp Mill | Skeena Cellulose Inc. | 32,000 | BPEST | SPL |
| 3221 | 1968 | Tembec Industries Inc. | Pulp and Paper | Crestbrook Forest Ind. | 17,500 | ST | |
| 3221 | 1972 | Weyerhaeuser Canada Ltd. | Pulp and Paper | Weyerhaeuser Canada Ltd. | 46,000 | BPST | SPL |

| | | | | | | | |
|------|------|--------------------------|----------------|---------------------------|--------|-------|-----|
| 3221 | 1972 | Cariboo Pulp and Paper | Pulp and Paper | Cariboo Pulp & Paper | 32,000 | BPEST | SPL |
| 3221 | 1973 | Canadian Forest Products | Pulp and Paper | CANFOR-Northwood | 27,400 | BPEST | SPL |
| 3221 | 1977 | Western Pulp Ltd. | Pulp and Paper | Port Alice Operations | 16,500 | BPST | SPL |
| 3221 | 1979 | Pope and Talbot Ltd. | Pulp and Paper | Mackenzie Pulp Operation | 20,000 | BPEST | SPL |
| 3221 | 1981 | Norske Skogindustrier | Pulp and Paper | Crofton Pulp & Paper | 38,000 | ST | |
| 3221 | 1981 | Canadian Forest Products | Pulp and Paper | CANFOR-Northwood | 28,000 | BPEST | SPL |
| 3221 | 1989 | Howe Sound Pulp And Pape | Pulp and Paper | Howe Sound Pulp And Paper | 62,500 | BPEST | SPL |
| 3221 | 1992 | Howe Sound Pulp And Pape | Pulp and Paper | Howe Sound Pulp And Paper | 50,000 | ECST | SPL |
| 3221 | 1993 | Celgar Pulp Co. | Pulp and Paper | Celgar Pulp Co. | 52,000 | BPEST | SPL |
| 3221 | 1996 | Abitibi Consolidated | Pulp and Paper | Mackenzie Paper Division | 13,900 | BPEST | HOG |
| 3221 | 2001 | Tembec Industries | Pulp and paper | Tembec Industries | 43,500 | ECST | SPL |
| 3221 | 2003 | Weyerhaeuser Canada Ltd. | Pulp and Paper | Weyerhaeuser Canada Ltd. | 29,000 | CST | SPL |

Summary for 'Province' = BC (31 detail records)

Electrical Capacity for Province 1,274,050

Province MB

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|---------------------|------------------|--------------------------------------|---------------|------------|------|
| 3221 | 2002 | Tolko Manitoba Inc. | Pulp and Paper | Tolko Manatoba Inc. - Formerly Repap | 22,000 | BPEST | SPL |

Summary for 'Province' = MB (1 detail record)

Electrical Capacity for Province 22,000

Province NB

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|----------------------------|------------------|----------------------------|---------------|------------|--------|
| 2211 | 1964 | NB Power | Electric Utility | Irving Pulp and Paper | 13,000 | BPST | #6 Oil |
| 3221 | 1956 | Irving Pulp And Paper Ltd. | Pulp and Paper | Irving Pulp And Paper Inc. | 32,500 | BPEST | SPL |

| | | | | | | | |
|------|------|---------------------------|----------------|----------------------------------|--------|-------|----------|
| 3221 | 1965 | UPM-Kymmene Mirsmichi I | Pulp and Paper | UPM-Kymmene Miramichi Inc. | 17,000 | BPEST | SPL |
| 3221 | 1972 | Ste. Anne-Nackawic Pulp C | Pulp and Paper | Ste. Anne-Nackawic Pulp Co. Ltd. | 25,000 | BPEST | SPL |
| 3221 | 1983 | AVCell | Pulp and Paper | Av Cell | 21,000 | BPEST | Red Liqu |
| 3221 | 1989 | UPM-Kymmene Mirsmichi I | Pulp and Paper | UPM-Kymmene Miramichi Inc. | 23,000 | BPST | SPL |
| 3221 | 1996 | Fraser Papers Inc. | Pulp and Paper | Nexfor/Fraser Papers | 46,000 | BPEST | Hog |

Summary for 'Province' = NB (7 detail records)

Electrical Capacity for Province 177,500

Province NF

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|----------------------------|------------------|---------------------------------|---------------|------------|------|
| 3221 | 2003 | Cornerbrook Pulp and Paper | Pulp and Paper | Corner Brook Pulp and Paper Ltd | 17,500 | BPEST | Hog |

Summary for 'Province' = NF (1 detail record)

Electrical Capacity for Province 17,500

Province NS

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|------------------------------|----------------------------|---------------------------------------|---------------|------------|--------|
| 2123 | 1980 | Canadian Salt Co. Ltd. | Salt Mining and Processing | Canadian Salt Co. | 35 | BPST | Bunker |
| 2123 | 1987 | Canadian Salt Co. Ltd. | Salt Mining and Processing | Canadian Salt Co. | 52 | BPST | Bunker |
| 2123 | 1998 | Canadian Salt Co. Ltd. | Salt Mining and Processing | Canadian Salt Co. | 244 | BPST | Bunker |
| 2211 | 1995 | Brooklyn Power Corporation | Non-utility generator | Bowater Mersey Paper Co. | 30,000 | ECST | Hog |
| 3221 | | Minas Basin Pulp And Paper | Pulp and Paper | Minas Basin Pulp And Paper Ltd. | 6,400 | ST | |
| 3221 | | Stora Forest Industries Ltd. | Pulp and Paper | Stora Forest Industries Ltd. | 29,500 | ST | |
| 3221 | 1967 | Kimberly Clark Nova Scotia | Pulp and Paper | Kimberly Clark Nova Scotia Inc. (Form | 25,700 | ECST | SPL |

Summary for 'Province' = NS (7 detail records)

Electrical Capacity for Province 91,931

Province NU

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|--------------------|------------------|--------------------|---------------|------------|--------|
| 2213 | 1979 | Nunavut Power Corp | District Energy | District Energy | 600 | D | Diesel |
| 2213 | 1981 | Nunavut Power Corp | District Energy | District Energy | 540 | D | Diesel |
| 2213 | 1989 | Nunavut Power Corp | District Energy | District Energy | 720 | D | Diesel |
| 2213 | 1993 | Nunavut Power Corp | District Energy | District Energy | 720 | D | Diesel |
| 2213 | 1994 | Nunavut Power Corp | District Energy | District Energy | 960 | D | Diesel |
| 2213 | 1994 | Nunavut Power Corp | District Energy | District Energy | 300 | D | Diesel |
| 2213 | 1995 | Nunavut Power Corp | District Energy | District Energy | 800 | D | Diesel |
| 2213 | 1995 | Nunavut Power Corp | District Energy | District Energy | 1,680 | D | Diesel |
| 2213 | 1995 | Nunavut Power Corp | District Energy | District Energy | 480 | D | Diesel |
| 2213 | 1996 | Nunavut Power Corp | District Energy | District Energy | 600 | D | Diesel |
| 2213 | 2001 | Nunavut Power Corp | District Energy | District Energy | 900 | D | Diesel |

Summary for 'Province' = NU (11 detail records)

Electrical Capacity for Province 8,300

Province NW

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|-----------------------------|------------------|--------------------------------|---------------|------------|------|
| 2211 | 2002 | Northwest Territories Power | IPP | Midnight Sun Recreation Centre | 60 | MT | NG |
| 2213 | | DND Alert, NWT | District heating | DND Alert, NWT | 6,600 | IC | |
| 2213 | | Eureka | District heating | Eureka | 500 | IC | |
| 2213 | 1997 | Fort McPherson | District Energy | Fort McPherson District Energy | | IC | |

Summary for 'Province' = NW (4 detail records)

Electrical Capacity for Province 7,160

Province

ON

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|------------------------------|----------------------------|------------------------------------------|---------------|------------|----------|
| 0 | 2002 | NRCan | Research | Health Canada | 58 | MT | NG |
| 1114 | 1989 | WestbrookFloral | Flower Grower | Westbrook Greenhouses Ltd. | 500 | IC | NG |
| 1114 | 1992 | Rosa Flora Ltd | Greenhouse | Rosa Flora Ltd. | 1,600 | SI | NG |
| 1114 | 1995 | Westbrook Greenhouses Ltd. | Flower Grower | Westbrook Greenhouses Ltd. | 1,000 | IC | NG |
| 2211 | | Sudbury District Energy | IPP | | 5,000 | GT | NG |
| 2211 | | Imperial Oil | Gas refinery | Imperial Oil, Nanticoke Refinery | 20,000 | ST | |
| 2211 | 1990 | Abitibi Consolidated Canad | IPP | Abitibi Consolidated (Fort Frances) | 112,000 | GT | NG |
| 2211 | 1995 | West Windsor Power | Non-Utility Generator | Canadian Salt Co. | 118,000 | GT | NG |
| 2211 | 1995 | AES Kingston Inc. | Non-Utility Generator | Kosa Canada | 110,000 | GT | NG |
| 2211 | 1996 | Transalta Energy/Windsor E | Non-Utility Generator | DailmerChrysler Canada | 68,000 | GT | NG |
| 2211 | 1996 | Iroquois Falls Power Corp. / | Independent Power Producer | Abitibi Consolidated Inc. (Iroquois Fall | 110,000 | GT | NG |
| 2211 | 1998 | Whitby Cogeneration Limite | Non-utility generator | Atlantic Packaging Products Ltd. | 58,000 | GT | NG |
| 2212 | 1990 | Union Gas | Gas Utility | Union Gas Halton Division Office | 60 | IC | |
| 2212 | 1994 | Union Gas | Natural Gas Distributor | Union Gas Head Office | 6,000 | GT | |
| 2213 | 1993 | City of Barrie | Wastewater Treatment | Barrie Waste Water Treatment Plant1 | 500 | SI | Digester |
| 2213 | 1995 | CDH District Heating Ltd. | District Heating | Institutional and Commercial | 5,000 | SI | NG |
| 2213 | 1995 | City of Guelph | Wastewater Treatment | Wastewater Treatment plant | 580 | SI | Digester |
| 2213 | 1996 | Core Energy | Municipality | Trigen | 3,500 | GT,ST | |
| 2213 | 2001 | Sudbury District Energy | IPP | Sudbury Regional Hospital | 6,700 | SI | NG |
| 2213 | 2001 | Markham District Energy | Commercial/residential | IBM Canada | 3,500 | SI | NG |

| | | | | | | | |
|------|------|----------------------------|---------------------------|--------------------------------------|---------|-------|----------|
| 2213 | 2003 | Hamilton Community Energ | District Energy | City of Hamilton | 3,500 | SI | NG |
| 3111 | 1994 | Casco Inc. | Feed Industry | Casco Inc. | 10,000 | GT | NG |
| 3112 | 1995 | Casco Inc. | Corn-based Sweeteners | Casco Inc. | 15,000 | GT | NG |
| 3113 | 1996 | Redpath Sugar Ltd. | Sugar Refining, Packaging | Redpath Sugar Ltd. | 5,600 | BPST | NG |
| 3116 | 1999 | Maple Lodge Farms | Food Processing | Maple Lodge Farms | 4,750 | GT | NG |
| 3119 | 1990 | H.J. Heinz Company Of Can | Food Manufacturing | H.J. Heinz Company Of Canada Ltd. | 8,600 | GT | NG |
| 3119 | 1994 | Cardinal Power Of Canada I | Food Industry | Casco Inc./ Benson Public School | 156,000 | CCGT | |
| 3119 | 2001 | Jungbunzlauer | Food Manufacturer | Jungbunzlauer | 10,000 | GT | NG |
| 3121 | 1955 | Hiram Walker And Sons | Distiller | Hiram Walker And Sons | 2,500 | BPEST | NG |
| 3121 | 1969 | Hiram Walker And Sons | Distiller | Hiram Walker And Sons | 5,000 | BPST | NG |
| 3121 | 1985 | Hiram Walker And Sons | Distiller | Hiram Walker And Sons | 350 | D | Deisel |
| 3121 | 1993 | Labatt Brewing Co. Ltd. | Brewery | Labatts | 5,000 | GT | NG |
| 3151 | 1994 | Phantom Industries | Hoisery and Swimwear | Phantom Industries | 600 | SI | NG |
| 3221 | | Bowater | Pulp and Paper | Bowater | 76,570 | ST | |
| 3221 | | Kimberly-Clark Inc. | Pulp and Paper | Kimberly-Clark Inc. Terrace Bay | 20,000 | ST | |
| 3221 | | Bowater Thunder Bay | Paper Mill | Bowater Thunder Bay | 67,000 | ST | |
| 3221 | 1944 | Marathon Pulp Inc. | Pulp and Paper | Marathon Pulp Inc. | 9,500 | BPEST | SPL |
| 3221 | 1946 | Marathon Pulp Inc. | Pulp and Paper | Marathon Pulp Inc. | 4,500 | BPEST | SPL |
| 3221 | 1958 | Tembec Industries Inc. | Pulp and Paper | Spruce Falls Inc. (KapusKasing Mill) | 21,600 | ST | |
| 3221 | 1975 | Tembec Industries Inc. | Pulp and Paper | Tembec Industries Inc. | 12,500 | BPEST | Hog Fuel |
| 3221 | 1985 | Tembec Industries Inc. | Pulp and Paper | Tembec Industries Inc. | 12,500 | ECST | Hog Fuel |
| 3221 | 1989 | Domtar Inc. | Pulp and Paper | Domtar | 24,000 | ST | |

| | | | | | | | |
|------|------|----------------------------|------------------------------|------------------------------------|---------|------|----------|
| 3221 | 1993 | Sonoco Ltd. | Paper Products | Sonoco Ltd. (Branford Mill) | 4,000 | GT | |
| 3221 | 2000 | Sonoco | Paper Products | Sonoco Paper Mill | 7,800 | GT | NG |
| 3251 | | Terra International | Chemicals | Terra International | 15,500 | GT | |
| 3251 | | General Chemical | Chemical Processing | General Chemical | 10,950 | ST | |
| 3251 | 1972 | TransAlta | Chemical Processing | Dow Chemical | 161,000 | CCGT | |
| 3251 | 1983 | TransAlta | Chemical processing | Bayer Rubber | 51,031 | ST | |
| 3251 | 1997 | Commercial Alcohols Inc. | Ethanol Production | Commercial Alcohols Inc. | 5,000 | GT | NG |
| 3251 | 2003 | TransAlta- Sarnia Cogen | Chemical Processing | Bayer, Dow and NOVA Chemicals | 440,000 | GT | |
| 3252 | 1992 | Dupont | Chemical plant | Dupont | 38,300 | GT | NG |
| 3254 | 1994 | Aventis Pasteur Ltd. | Pharmaceutical Manufacturer | Aventis Pasteur Ltd. | 3,000 | GT | |
| 3312 | 1930 | Stelco | Steel Manufacturer | Stelco | 10,000 | ST | |
| 3328 | 1997 | Kuntz Electroplating | Metals | Kuntz Electroplating | 2,445 | SI | NG |
| 3328 | 1999 | Kuntz Electroplating | Metals | Kuntz Electroplating | 815 | SI | NG |
| 3328 | 2000 | Kuntz Electroplating | Metals | Kuntz Electroplating | 815 | SI | NG |
| 3361 | 1995 | Ford Motor Company Of Ca | Automobile Manufacturer | Ford Motor Company | 28,000 | ECST | NG |
| 3399 | 1995 | Kodak Canada Inc. | Photo Equipment Manufacturer | Kodak Canada Inc. | 4,500 | GT | NG |
| 5417 | 1994 | NRCC | Government Agency | NRCC | 4,000 | GT | |
| 5417 | 1996 | Canada Centre for Inland W | Research facility | Canada Centre for Inland Waterways | 810 | IC | NG |
| 5622 | 1997 | Ottawa-Carlton Regional M | Waste Water Treatment | Robert Pickard Environment Centre | 2,400 | SI | Digester |
| 6112 | | Mohawk College | College | Mohawk College | 810 | IC | |
| 6113 | | Brock University | University | Brock University | 6,560 | IC | |
| 6113 | 1986 | University of Ottawa | University | University of Ottawa | 600 | SI | NG |

| | | | | | | | |
|------|------------|-----------------------------|------------------------|----------------------------------------|--------|------|--------|
| 6113 | 1992 | University of Toronto | University | University of Toronto | 6,000 | GT | NG |
| 6113 | 1993 | University of Windsor | University | University of Windsor | 3,800 | GT | NG |
| 6113 | 1994 | Centra Gas | University | Orillia Soldiers | 13,300 | ST | |
| 6113 | 1995 | University of Ottawa | University | University of Ottawa | 1,500 | BPST | NG |
| 6113 | 1997 | York University | University | York University | 5,000 | GT | NG |
| 6221 | | St. Vincent Hospital | Hospital | St. Vincent Hospital | 420 | IC | NG |
| 6221 | | St. Catharine's Hospital | Hospital | St. Catharines Hospital | 250 | IC | |
| 6221 | 1972/ 1999 | London Health Sciences Cen | Hospital | University Hospital/ Victoria Hospital | 11,000 | ST | |
| 6221 | 1992 | TransAlta Energy Corp. / Co | Health | Ottawa Health Science Centre | 68,000 | CCGT | |
| 6221 | 1994 | Union Gas | University | Union Gas Halton Div. Office | 6,000 | IC | |
| 6221 | 1994 | Orillia Soldiers Hospital | Hospital | Orillia Soldiers | 760 | IC | |
| 6221 | 1997 | Royal Victoria Hospital | Hospital | Royal Victoria Hospital | 250 | SI | NG |
| 6222 | | Union Gas | | Lutherwood Childrens Mental Health C | 2,000 | ST | |
| 9111 | 1992 | Canadian Forces | National Defense | Canadian Forces Station Alert | 3,000 | D | Deisel |
| 9111 | 2000 | Department of National Defe | Military | CFB Petawawa | 3,500 | GT | NG |
| 9112 | 1997 | Corrections Canada | Correctional facility | Corrections Canada | 760 | IC | |
| 9112 | 2002 | Correctional Services Canad | Corrections/Government | Warkworth Institute | 570 | D | NG |

Summary for 'Province' = ON (81 detail records)

Electrical Capacity for Province

2,029,514

Province

PE

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|--------------------|------------------|---------------------------------|---------------|------------|------|
| 2211 | 1986 | Northeast Energy | Utility | | 850 | IC | |
| 2213 | 1997 | PEI Energy Systems | District Energy | District Energy (80+ Customers) | 1,200 | BPST | Wood |

Summary for 'Province' = PE (2 detail records)

Electrical Capacity for Province

2,050

Province PQ

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|-----------------------------|------------------|------------------------------------------|---------------|------------|------|
| 2211 | 1992 | Borex Inc. | Thermal Utility | Cascades Inc. (Papier Kingsey Falls Inc. | 31,000 | GT | NG |
| 2211 | 2003 | CHI Canada Inc. | IPP | Alliance Forest Products | 23,000 | BPST | Hog |
| 3221 | | La Compagnie Gaspesia Ltee | Pulp and Paper | La Compagnie Gaspesia Ltee | 6,000 | ST | |
| 3221 | 1993 | Tembec Industries Inc. | Pulp and Paper | Tembec Inc. (Specialty Cellulose Div.) | 9,500 | ST | |
| 3221 | 1996 | Donohue Inc. | Pulp and Paper | Abitibi Consolidated Inc. (St. Felicien | 28,600 | ST | |
| 3221 | 1997 | Bowater Forest Products | Pulp and Paper | Bowater Forest Products | 28,000 | ECST | Hog |
| 3221 | 1998 | Domtar Inc. | Pulp and Paper | Domtar (Norkraft Quevillon Inc.) | 48,500 | BPST | SPL |
| 3221 | 2001 | Domtar Inc. | Pulp and Paper | Domtar Inc | 32,000 | BPEST | SPL |
| 3332 | 2000 | Pratt & Whitney | | Pratt & Whitney | 1,840 | GT | |
| 9111 | 1999 | Department of National Defe | Military | CFB Valcartier | 3,400 | GT | NG |

Summary for 'Province' = PQ (10 detail records)

Electrical Capacity for Province

211,840

Province SK

| NAICS | Start Year | Operator | Type of Business | Primary Thermal Ho | Capacity (kw) | Cogen type | Fuel |
|-------|------------|-----------------------------|-----------------------|-------------------------|---------------|------------|------|
| 2123 | 1981 | IMC Canada Ltd. | Potash Mine | IMC Potash Belle Plaine | 20,000 | BPST | NG |
| 2123 | 2001 | IMC Canada Ltd. | Potash Mine | IMC Potash Belle Plaine | 35,000 | BPST | NG |
| 2211 | 1999 | Meridian Cogeneration Proje | Non-Utility Generator | Husky Oil Lloydminster | 220,000 | GT | NG |
| 2211 | 2002 | ATCO Power/Sask Power In | Non-Utility Generator | Cory Potash Mine | 260,000 | GT | NG |
| 2213 | 2002 | Regina General Hospital | Hospital | Regina General Hospital | 120 | MT | ng |

| | | | | | | |
|------|------|---------------------|-------------------------|--------------------------|--------|----|
| 3221 | 1968 | Weyerhaeuser Canada | Forest Products | Weyerhaeuser Canada Ltd. | 21,000 | ST |
| 6112 | 1993 | Saskenergy | Educational Institution | Saskatchewan Hospital | 800 | IC |
| 6221 | 1951 | SaskEnergy | Hospital | Saskatchewan Hospital | 800 | ST |

Summary for 'Province' = SK (8 detail records)

| | |
|-----------------------------------------|-----------|
| Electrical Capacity for Province | 557,720 |
| Total Electrical Capacity | 6,818,067 |

Appendix D

Allocation of CO₂ Emissions from Cogeneration

Allocation of CO₂ Emissions from Cogeneration

This appendix summarizes seven methods that can be used to allocate the CO₂ emissions generated by cogeneration systems to the electrical and thermal products. When the owner / operator, the thermal host and the electricity consumer are not the same, the allocation of emissions to each product is necessary to ensure that each stakeholder is credited with their share of the CO₂ emissions produced by the system.

The following adapts six calculations of fuel allocation to the thermal and electrical products of a cogeneration system¹². The fuel allocation is multiplied by the appropriate CO₂ emission factor to calculate the share of emissions for each product.

Allocation based on energy content of the products

This is a simple method of allocation of CO₂ emissions. The main criticism is that it does not account for the *quality* of the energy produced and its ability to do useful work.

Therefore, it underrates the electricity share of energy and emissions.

$$C_E = \left(\frac{E}{E + H} \right) F \phi \qquad C_H = \left(\frac{H}{E + H} \right) F \phi$$

Where:

C_E = amount of CO₂ emissions allocated to electrical production;

C_H = amount of CO₂ emissions allocated to heat production;

E = net electricity production of the cogeneration system

H = net heat production of the cogeneration system

F = primary fuel consumed by the cogeneration system; and,

ϕ = CO₂ emission coefficient (i.e., unit of CO₂ produced per unit of primary fuel consumed)

Allocation based on exergy content of the products

Allocation based on exergy¹³ content accounts for the quality the energy form. As a result, the allocation of fuel and emissions is lower for the thermal product than the allocation based on energy content.

$$C_E = \left(\frac{E}{E + \beta H} \right) F \phi \qquad C_H = \left(\frac{\beta H}{E + \beta H} \right) F \phi$$

Where:

β = ratio of exergy to energy content of heat produced. The ratio for electricity is 1.0, 0.6 for steam at 600 degrees C and 0.2 for water at 90 degrees C (*Wall, G., Energy, Society and Morals, 1997*).

¹² Phylipsen, et.al, Handbook of International Comparisons of Energy Efficiency in the Manufacturing Sector, 1996.

¹³ Exergy is defined as the maximum amount of work (work here being the physics definition of work) that can be obtained from an energy carrier.

Allocation based on economic value of the products

This method may have some advantages for owner / operators that sells the electrical and thermal products independently.

$$C_E = \left(\frac{C_e E}{c_e E + c_h H} \right) F \phi \qquad C_H = \left(\frac{C_h H}{c_e E + c_h H} \right) F \phi$$

Where:

c_e = the economic value of electricity produced

c_h = the economic value of thermal energy produced

Allocation of incremental fuel consumption to electrical production

This method considers electricity to be a byproduct of the thermal process and is consistent with the “Fuel Charged to Power” (FCP) calculation done by many consultants in the cogeneration field. The FCP calculation nets out the fuel consumed by the reference boiler (i.e., an independent boiler providing the same steam as the cogeneration system) from the total fuel consumed by the cogeneration system.

$$C_E = \left[F - \left(\frac{H}{\eta_b} \right) \right] \phi \qquad C_H = \frac{H}{\eta_b} \phi$$

Where:

η_b = efficiency of the boiler that would have been used in the production of the same amount of heat energy as produced by the cogeneration system (i.e., reference boiler).

Allocation of incremental fuel consumption to the heat production

In contrast to the previous method, this calculation nets out the fuel used by an independent generator / power plant needed to provide the same amount of electricity.

$$C_E = \frac{E}{\eta_{pp}} \phi \qquad C_H = \left[F - \left(\frac{E}{\eta_{pp}} \right) \right] \phi$$

Where:

η_{pp} = efficiency of the power plant that would have been used in the production of the same amount of electricity as produced by the cogeneration system (i.e., reference power plant).

Allocation based on a shared emission savings between heat and electricity

A shared-savings approach may be a compromise to allocating all savings to either the electrical or thermal products.

$$C_E = \left(\frac{\frac{E}{\eta_{pp}}}{\frac{E}{\eta_{pp}} + \frac{H}{\eta_b}} \right) F \phi \qquad C_H = \left(\frac{\frac{H}{\eta_b}}{\frac{E}{\eta_{pp}} + \frac{H}{\eta_b}} \right) F \phi$$

Allocation by agreement

In some cases, the allocation of CO₂ emissions to each product of cogeneration will be determined by a contractual agreement between the various parties to the project.

Allocation of CO₂ emissions associated with transmission and distribution

One of the advantages of cogeneration systems is that they are typically located close to the thermal load and the electricity user(s). Under these conditions, the losses associated with transmission and distribution of electricity are reduced or eliminated. However, accounting for these reductions would be on a case-by-case basis. If the electricity is sold to the grid, this spatial advantage of cogeneration is lost.