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IEA Industrial Energy-related Technologies and Systems

Annex XV: Industrial Excess Heat Recovery
TASK 2

COUNTRY REPORT CANADA

Canada

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1. INTRODUCTION

Canada has agreed to contribute to two sub-tasks of IETS-Annex XV including "Sub-Task 1: In-depth evaluation and inventory of excess heat levels" and "Sub-Task 3: Possible policy instruments and the influence on future use of excess heat." As part of contribution in sub-task 1, the available excess heat in Canada for "pulp and paper" and "food processing" sectors were quantified and are presented in sections 2 to 4 of this report. In parallel, as part of Canada's contribution in sub-task 3, some of the existing policy instruments in Canada that influence the use of excess heat in the country were evaluated and listed in Section 5. It should be noted that the list presented in this report is not exhaustive and some other important policy instruments and programs may not be included. The methodology that is used in sub-task 1, presented in Section 3, can be considered as Canada's input into "Sub-Task 2: Methodology on how to perform an inventory in practice."

2. OBJECTIVES

The objectives of this project were to gather and organize relevant broad information concerning the thermal waste streams' discharge, characterized by both energy content and temperature range for two Canadian manufacturing sectors: *pulp and paper* and *food manufacturing*. The project approximates the potential for thermal waste heat recovery in only the two selected sectors as Canada joined Annex XV rather late after its launch.

3. METHODOLOGY

As a starting point, the project team reviewed a study completed by Stricker Associates Inc. for CanmetENERGY in 2007. Very briefly, the 2007 study analyzed energy use in industrial processes in the 8 main industrial manufacturing sectors of Canada, including the following sectors:

1- Paper manufacturing
2- Primary metals manufacturing
3- Petroleum and coal manufacturing
4- Chemical manufacturing
5- Wood products manufacturing
6- Non-metallic manufacturing
7- Food manufacturing
8- Beverage and tobacco manufacturing

Energy use data was obtained at the 2-digit SIC code level from the Canadian Industrial Energy End-Use Data and Analysis Center (CIEEDAC) database (2003 data). The published total energy use data was divided into specific operations, by making use of 108 Industrial Processes* "models" that formed the basis for the original North American Industrial Classifications. In this way, an overview of how energy was used in Canadian industry sectors was obtained, as opposed to how much energy each specific plant site consumed.

* Energy Analysis of 108 Industrial Processes by Harry Brown, Bruce Hedman
ISBN-10: 0135769922, Prentice Hall (May 1997)

This approach had certain positive implications for the methodology of this project on thermal waste streams. For example, the Canadian and US Standard Industrial Classification (SICs) have been unified under the new North American Industry Classification System (NAICS), and the recent CIEEDAC data has been classified under this new system. Accordingly, there is an opportunity to use updated CIEEDAC data, as the code harmonizations implied that using the 108 industrial processes' models turns out to be more accurate than in the past.

For this study, the most recent CIEEDAC data for the two manufacturing sectors (2015 data) was used and the model developed by Stricker in 2007 was updated.

The waste streams or rejected thermal energy flows in the processes examined were identified and classified according to the following classes:

1. Stack Losses – defined as combustion gases and hot dryer air (150°C to 450°C)
2. Steam Losses – defined as low pressure steam (100°C to 110°C / 15 psi)
3. Process Gases and Vapours – defined as exhaust gases and moist air (80°C to 120°C)
4. Liquid Streams – defined as liquids (27°C to 120°C)
5. Other Losses – these can include miscellaneous or general process losses that were calculated in order to balance the energy input and output quantities.

The preceding classification of waste streams was established by virtue of their temperatures, amount of energy contained and nature of the media involved in the energy transport. Waste heat in the fifth classification, however, may not be easily recoverable because the losses likely involve a variety of mechanisms that are difficult to quantify or capture, such as equipment shell losses, leakage, endothermic reactions, elevated final product temperatures, etc.

It should be stated at this point that while an energy balance was attempted for each step in the 108 processes, "other losses" can include variations in the processes used by the industries represented under each sub-classification. We believe that the overall results reflect reasonable values of energy conversion and rejected thermal energy.

The methodology for determining waste heat streams of the Canadian manufacturing sector involved combining information on energy usage from the CIEEDAC database (2015 data) with the modelled industrial flow sheets for processes used in the two selected manufacturing sectors (from "Energy Analysis of 108 Industrial Processes" book). This methodology is illustrated in Figure 1 and described in the following section.

First, the project team examined the NAICS data classifications, cross referencing them to the original SICs, and finally linking them to the available analysis of the 108 Industrial Processes. Table 1 presents Cross-Reference of NAICS Industries & Process Flow-Sheets for Waste Heat, along with the total amount of energy consumed by each sub-sector.

Second, the project team defined the processes involved in each industry, identifying the energy inputs, waste streams, and their corresponding classifications, and calculating these components as a fraction of the total energy input. This fraction was then applied to the total energy reported in the corresponding industry manufacturing sector and calculating the amounts of waste energy. These steps and calculations are presented in detail in annexes 2 to 5 and the findings are summarized in Section 4. Accordingly, this step quantified the thermal waste streams by industry, and their class of waste stream.

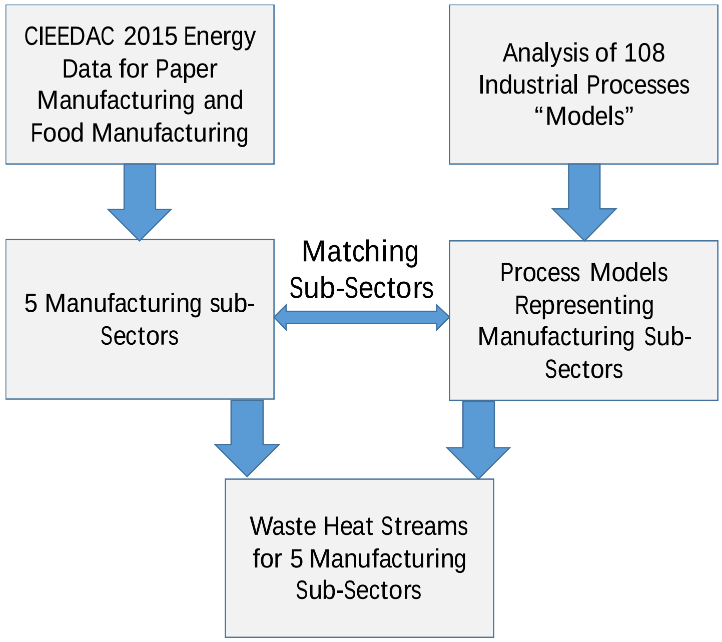


Figure 1: Methodology to Estimate Thermal Reject Heat Streams

Table 1: Cross-Referencing of NAICS Industries and 108-Industry Processes "Models"

NAICS #	Evaluated Subsector(s) Names	Sub-Sector 2015 Total Energy Usage			108 Ind. Classification	108 Ind. Process Name	108 Industrial Process Analysis Book Pages
		(TJ)	(% Mfg)				
322112	Chemical Pulp Mills [1]	277,957	13.14%		2611-1	Pulp Mills - Sulfate or Kraft Process	66-68
322121	Paper Mills Except Newsprint [1]	89,109	4.21%		2621-1	Paper Mills - Finishing Plant	75-77
322122	Newsprint Mills [1]	98,225	4.64%		2621-1	Paper Mills - Finishing Plant	75-77
3115	Dairy Products [2]	11,600	0.55%		2026	Fluid Milk	18-20
3116	Meat Products [2]	19,400	0.92%		2033-1	Meat Packing	15-17
	Subtotal	496,291	23.46%				
100001	All Manufacturing Industries	2,115,027	100.00%				

References & Notes:
[1] " Energy Use and Related Data: Canadian Paper Manufacturing Industries 1990 to 2015", Canadian Industrial Energy End-use Data and Analysis Centre (CIEEDAC), Simon Fraser University, March 2017.
[2] http://oee.rncan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_id_ca.cfm

4. PRESENTATION OF RESULTS

For each industry, comments and explanations are provided about the way the data was used. When calculating total fuel input to the industrial process, self-generated electricity was subtracted from the total amount of consumed electricity because self-generated electricity would otherwise be counted twice. Similarly, self-generated steam is a derived energy source usually from fossil fuel and was not added to the total purchased energy in order to be consistent with the way CIEEDAC data is reported. However, purchased steam (not self-generated), if shown separately, was added to the total energy to be consistent with the method of reporting in the CIEEDAC data. A summary of the results obtained in this study is presented in annex 1.

4.1 PAPER MANUFACTURING (NAICS 322)

The pulp and paper industry is one of the main pillars of Canadian economy. The forest industry (pulp and paper and lumber) employed directly and indirectly 600,000 workers in 2012, and had a contribution of over $20 billion, or roughly 2%, to Canada's annual GDP in 2011. Canada remains one of the world's largest producers of newsprint and northern bleached softwood Kraft pulp despite capacity increases in other countries.

The pulp and paper sector is a resource-intensive industry that requires great quantities of energy, water and other resources. According to Natural Resources Canada, the paper manufacturing industry accounted for 26% of the total energy consumption in the manufacturing sector in 2015, making it the largest energy-consuming manufacturing subsector in Canada*. The pulp and paper industry accounted for 7% of the greenhouse gas emissions (5.9 $MtCO_{2e}$) released by industrial manufacturing facilities in 2015 (excluding the mining, and oil & gas sectors, which are reported separately in Canada)**.

The present study focuses on two types of mills:

a) Paper Mills
b) Chemical Pulp Mills

* Total energy consumption by the manufacturing sector in 2015 was 2090 PJ http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=IC&sector=aaa&juris=ca&rn=3&page=1

Pulp and paper industry energy consumption in 2015 was 541.7 PJ http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=IC&sector=aaa&juris=ca&rn=6&page=1

**http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=HB&sector=agg&juris=00&rn=4&page=0

4.1.1 PAPER MILLS (NAICS 32212)

This section is made up of Paper Mills (NAICS 322121) and Newsprint Mills (NAICS 32122). Most paper today is made on an endless belt of wire mesh that moves horizontally. A flow of watery pulp is spread on the level belt that passes over several rolls. The water is drained off and is remixed with the pulp to salvage the fibre contained in it. Vacuum pumps beneath the belt speed up water removal from the paper. As the paper travels along the belt, it passes under a number of cylinders. These cylinders press still more water out of the web of paper and consolidate the fibre, giving the paper enough strength to continue through the machine without the support of the belt.

After pressing, the paper is fully formed; it is then carried through a series of heated cylinders that complete the drying process. The next step is calendering. The main purpose of calendering is to improve the surface properties of paper. Compaction of paper surface and its structure improves the surface properties, such as smoothness and gloss. Special papers are given additional treatments.

The process flow sheet used in this study as described in the reference "Energy Analysis of 108 Industrial Processes" (Finishing plant 2621-1) is detailed in annex 2.

The total energy used in this sub-sector is 187,334 TJ. The main contributor is electricity with 74,970 TJ (40% of total) followed by wood waste with 40,108 TJ (21%), and by spent pulping liquor with 36,676 TJ (20 %). Figure 2 provides more detail on the distribution of energy sources in paper mills.

The rejected thermal energy flows were calculated by applying the approach described in Section 3. The total thermal reject energy is summarized in the Table 2 below.

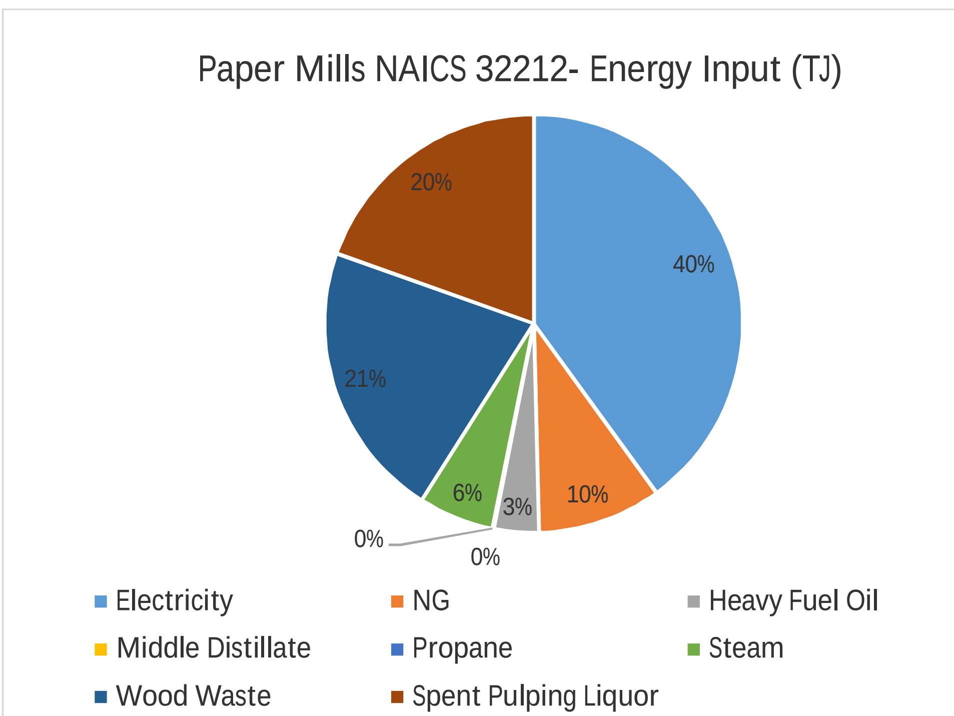


Figure 2: Distribution of Energy Sources in Paper Mills (2015 data)

Table 2: Summary of Rejected Thermal Energy Flows in Paper Mills

	Losses % or TJ	Stack Losses	Steam Losses	Process Gas	Liquid Streams	Other Losses
Rejected Energy	**% of input**	17.7%	0%	38.6%	10.5%	29.1%
	TJ	33,151	0	72,249	19,601	54,437

4.1.2 CHEMICAL PULP MILLS (NAICS 322112)

The pulp industry uses the following main production processes:

- Chemical pulp-Kraft process
- Chemical pulp-Sulfite process
- Mechanical pulping process
- Thermo-mechanical pulping
- Chemico-thermo-mechanical pulping

CIEEDAC reports that chemical pulp mills consume most of the energy in this sector, with an annual consumption of 277,957 TJ compared to only 27,697 TJ for mechanical pulp mills. In this study, the Kraft process has been used as the model for this sub-sector, since it is the most commonly used process.

In the Kraft process, high temperature is required for the lime re-calcination kiln. The wood chips are treated with steam and chemicals that remove resinous material and lignin from the wood, leaving pure fibres of cellulose. The wood is cooked or "digested" in this solution under pressure.

The flow sheet of a typical "Pulp Mill - Kraft Process" as described in the reference "Energy Analysis of 108 Industrial Processes" (Kraft Process 2611-1) is detailed in annex 3.

The total energy used in the pulp subsector (NAICS 322112) is 277,957 TJ. The main contributor is the spent pulping liquor with 163,709 TJ (59% of total), followed by wood waste with 49,208 TJ (18%) and electricity with 31,330 TJ (11%). Figure 3 provides more detail on the energy input distribution in chemical pulp mills.

The detailed calculations and the flow sheet of the processes involved are presented in annex 3. The total rejected thermal energy was calculated by applying the approach described in Section 3. The thermal waste streams are summarized in Table 3.

Canadian Kraft mills are typically 60% to 80% energy self-sufficient. With emerging energy-efficient technologies, they could eventually become fully self-sufficient. Detailed information is difficult to obtain, since most mills consider their energy consumption as confidential information.

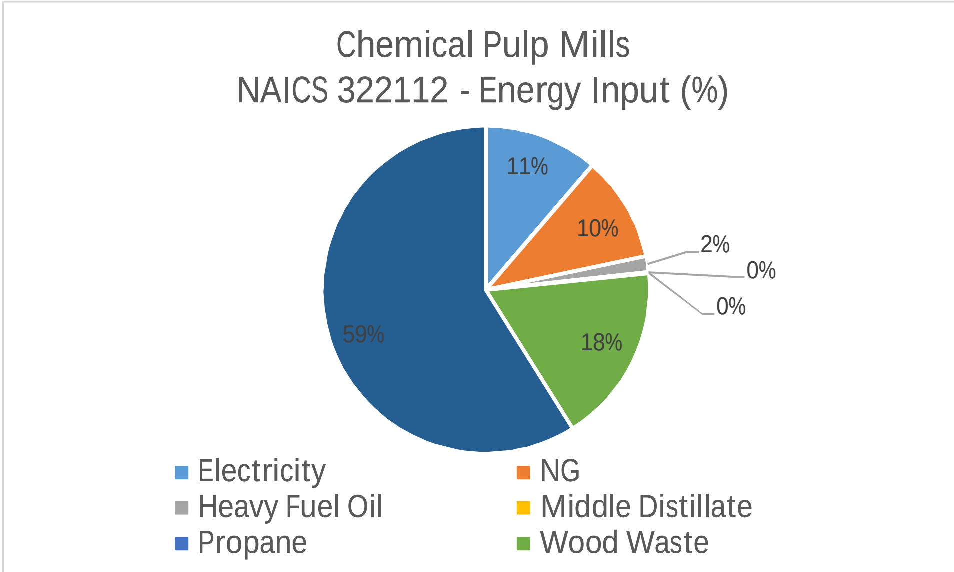


Figure 3: Input Energy Distribution in Chemical Pulp Mills (2015 data)

Table 3: Summary of Rejected Thermal Energy Flows in Chemical Pulp Mills

	Losses % or TJ	Stack Losses	Steam Losses	Process Gas	Liquid Streams	Other Losses
Rejected Energy	% of input	19.0%	7.6%	13.1%	29.8%	19.4%
	TJ	52,857	20,987	36,486	82,765	54,048

Table 4 and Table 5: Typical Electricity Consumption (kWh/t) for North America Softwood Kraft Mill

Year	1960	1980	1990 Mill A – Mill B	2000 Model Mill**
Electricity (kWh/t)	*920*	*780*	*885 - 669*	*625 - 640*

** Optimal mill design for energy efficiency.

* Energy Cost Reduction in the Pulp and paper Industry, PAPRICAN, November 1999. CPPA Annual Meeting, Tech. Sect, Montreal B323, 1998

summarize data from typical North America operating mills for softwood Kraft mills*.

Table 4: Typical Steam Consumption (GJ/t) for North America Softwood Kraft Mill

Year	1960	1980	1990	2000 Model Mill**
Energy (GJ/t)	24.5	22.10	16.96	7.8 – 9.18

** Optimal mill design for energy efficiency.

Table 5: Typical Electricity Consumption (kWh/t) for North America Softwood Kraft Mill

Year	1960	1980	1990 Mill A – Mill B	2000 Model Mill**
Electricity (kWh/t)	*920*	*780*	*885 - 669*	*625 - 640*

** Optimal mill design for energy efficiency.

* Energy Cost Reduction in the Pulp and paper Industry, PAPRICAN, November 1999. CPPA Annual Meeting, Tech. Sect, Montreal B323, 1998

4.2 FOOD MANUFACTURING (NAICS 311)

The abundance of natural resources has enabled Canada to become one the world's biggest agriculture producers and the 5th largest exporter of agricultural and agri-food products. Red meat (production and exports) dominates the food industry in Canada. This sector plays a major role in Canada's economy and accounts for a large part of Canada's agri-food sector. According to Agriculture Canada, Canada's red meat industry had annual shipments worth $20.9 billion in 2017*.

The meat industry is an energy-intensive sector that requires energy for slaughtering, processing, storage, packaging, etc. The meat industry had an energy consumption of 22,100 TJ in 2014, of which 62% was natural gas and 36% was electricity**. Energy costs are usually a small part of production costs compared to raw material and labour. Nevertheless, the meat industry is taking initiatives to improve its energy efficiency. Decreasing natural gas and electricity consumption as the main sources of energy in this sector will reduce the environmental footprint of the meat industry and help Canada reach its national targets for reducing greenhouse gas emissions.

In the Food and Beverage process diagrams, where the temperature of the product remains the same (above or below ambient) but there are losses, these losses are noted and are matched with the other energy losses indicated in the process. Steam loads indicated in the individual process sheets (108 Processes) add up to the total boiler output.

4.2.1 DAIRY PRODUCTS (NAICS 3115)

The normal processes involved in processing fluid milk are presented in annex 4. The main processing steps are:

- Separation
- Pasteurization
- Homogenization
- Cooling
- Packaging
- Storage

The total energy used in this sub-sector is 11.6 PJ. The main energy sources are natural gas with 7.3 PJ (63% of total) and electricity with 3.8 PJ (33%). Figure 4 provides more detail on the energy distribution in dairy products plants.

* http://www.agr.gc.ca/eng/industry-markets-and-trade/canadian-agri-food-sector-intelligence/red-meat-and-livestock/red-meat-and-livestock-market-information/industry-profile/?id=1415860000002

**http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=id&juris=ca&rn=19&page=0

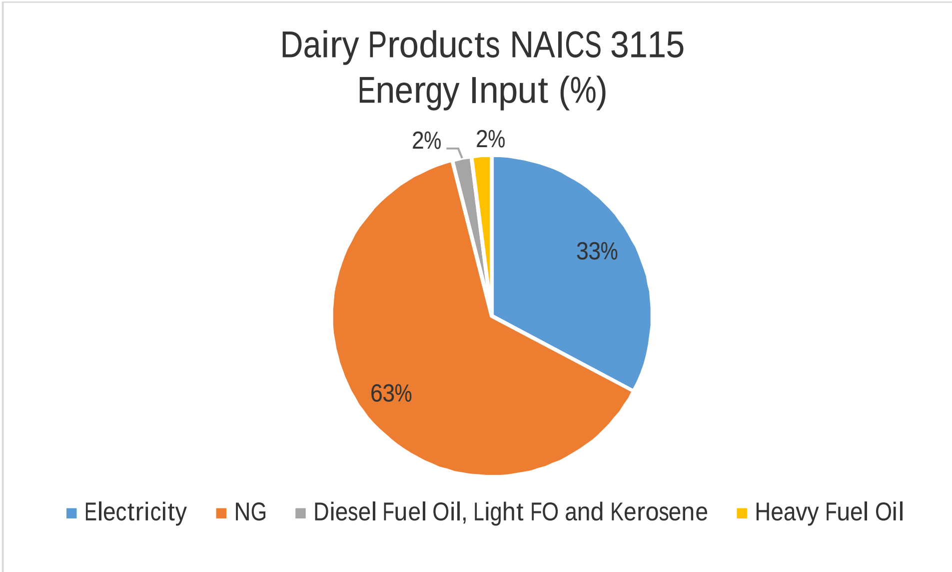


Figure 4: Input Energy Distribution in Dairy Products Plants (2015 data)

The total rejected thermal energy is shown in Table 6.

Table 6: Summary of Rejected Thermal Energy Flows in Milk production

	Losses % or PJ	Stack Losses	Steam Losses	Process Gas	Liquid Streams	Other Losses
Rejected Energy	% of input	23%	0%	0%	44%	28%
	PJ	2.7	0.0	0.0	5.1	3.3

The detailed calculations and the flow sheet of the processing steps involved are presented in annex 4.

4.2.2 Meat Products (NAICS 3116)

The Meat Packing sector includes several products and processes. The processes involved in meat packing industries are presented in annex 5. The most common processes involved are:

- Slaughtering
- Blood processing
- Trimming
- Cutting & De-boning
- Sterilizing
- Processing (curing, smoking, cooking)
- Drying
- Refrigerating
- Packaging

The total energy used in this sub-sector is 19.4 PJ. The main energy sources are natural gas at 12.4 PJ (64% of total) and electricity at 6.5 PJ (34%). Figure 5 provides more detail on the energy distribution in meat processing plants.

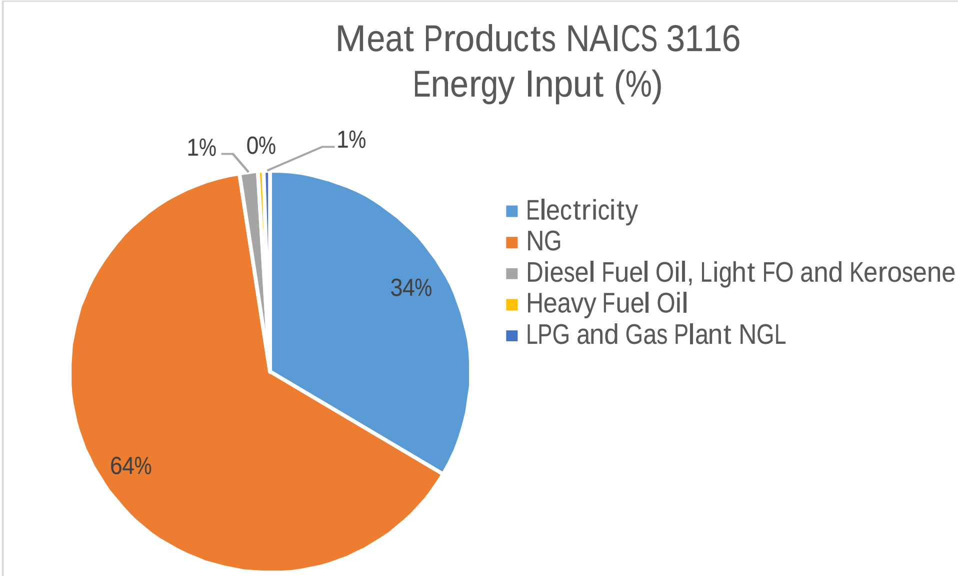


Figure 5: Input Energy Distribution in Meat Products Plants (2015 data)

The rejected thermal energy flows are shown in Table 7 below.

Table 7: Summary of Rejected Thermal Energy Flows in Meat packing Plants

	Losses % or PJ	Stack Losses	Steam Losses	Process Gas	Liquid Streams	Other Losses
Rejected Energy	% of input	28.2%	6.0%	20.7%	39.2%	13.8%
	PJ	5.5	1.2	4.0	7.6	2.7

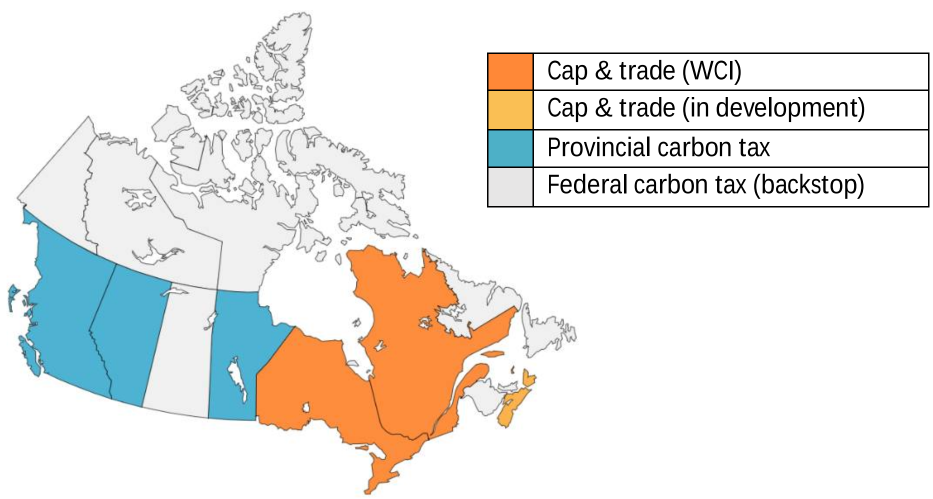
The detailed calculations and the process flow sheets are presented in annex 5.

5. POLICY INSTRUMENTS IN CANADA

Policy instruments that can influence the generation of waste heat include regulatory and economic incentives, as well as research efforts to achieve technical improvements and the diffusion of information to promote changes in behaviour. A list of some Policies and Measures in effect in Canada is available at: http://www.iea.org/policiesandmeasures/pams/canada/. The intention of this report is not to present each and every policy instrument available in Canada but rather to present an illustrative list of policies available that influence the generation of waste heat in the country. Annex 6 provides a summary table of the policy instruments in Canada that were discussed in this report.

5.1 CARBON PRICING INITIATIVES ACROSS CANADA

One of the most important policy instruments with regard to excess heat includes legislation directed towards GHG emissions, such as carbon pricing mechanisms. The CO_2 trading system and CO_2 taxes in place in most provinces of the country are summarized below:



P/T	Regime	Price per tonne
BC	Carbon tax, with the possible addition of an output-based allocation system for emissions-intensive trade-exposed (EITE) sectors	$35 in 2018, with $5 annual increases until 2021 to $50.
AB	Carbon levy and output-based allocation system (OBAS)	$30 in 2018, $50 in 2022.
SK	*	
MB	Carbon tax with output-based allocation system	$25 in 2018, stable until 2022.
ON	Effective July 3, 2018, government of Ontario cancelled the cap and trade regulation and prohibited Ontario's carbon market using a cap and trade program	Unknown
QC	Cap-and-trade (WCI)	$18 in 2018 (floor price) rising to $28 in 2022
NB	*	
NS	Cap-and-trade	In development
PEI	*	
NL	*	
YK	*	
NT	*	
NU	*	

* The Government of Canada committed to pricing carbon pollution across the country by 2018.

The federal carbon pricing backstop system consists in implementing a carbon tax of $10 in 2018 (increasing from $10/t to $50/t in 2022) in all provinces and territories that do not have a carbon pricing mechanism. This carbon levy applied to fossil fuels is combined with an output-based pricing system for certain large industrial facilities.

5.2 OTHER REGULATORY AND ECONOMIC INCENTIVES

Various other policy instruments, at the provincial and federal levels, also play a role in addressing industrial excess heat usage. A review of some federal programs influencing all Canadian provinces and territories is presented below. At the provincial level, both the provincial governments and utility companies offer some support for industrial energy-saving projects.

5.2.1 FEDERAL POLICY INSTRUMENTS

The Government of Canada contributes to the development and implementation of energy efficiency measures through a range of efforts, including direct financial incentives; funding and grants; research offices and labs; targeted legislation; and research and development (R&D) programs. Some of these are described further below.

FINANCIAL ASSISTANCE FOR ENERGY EFFICIENCY PROJECTS - NRCAN

Natural Resources Canada (NRCan) aids the adoption of an energy management standard and accelerates energy-saving investments and the exchange of best practices within Canada's industrial sector. Cost-shared financial assistance to industrial companies of 50% of eligible costs to a maximum of $40,000 can be provided for:

Natural Resources Canada   Ressources naturelles Canada

Canada

- Energy management systems projects, including CAN/CSA-ISO 50001 Energy Management Systems Standard implementations
- Process integration and computational fluid dynamics studies

As an example, this incentive can help industrial companies bear the costs of hiring a technical firm to conduct a process integration (PI) study. A PI study is a system energy analysis that looks at how an organization uses heat, where they can recover heat, and what could be the best use for that heat in their facility. The energy analysis must be site-wide and cover all heating and cooling process requirements, as well as other service or utility production systems (steam, hot water, compressed air and refrigeration). It can be combined with other incentives available at the provincial level.

POLICY INSTRUMENTS - CLASS 43 OF DEPRECIABLE PROPERTY

The Government of Canada provides an accelerated Capital Cost Allowance (CCA) rate for Class 43.1 and 43.2 properties as an incentive to encourage businesses to invest in specified clean energy generation and energy efficiency equipment. Both classes include a variety of stationary equipment that generates or conserves energy by:

- using a renewable energy source (e.g., wind, solar, small-scale hydro)
- generating fuels/heat from waste (e.g., landfill gas, wood waste, manure)
- making efficient use of *fossil fuels* (e.g., high efficiency cogeneration systems)

NRCan is responsible for advising Finance Canada, the Canada Revenue Agency and taxpayers on engineering and scientific issues related to:

- accelerated CCA for specified clean energy generation and energy conservation equipment that meet the requirements of Classes 43.1 and 43.2

- certain eligible start-up expenses that qualify as *Canadian renewable and conservation expenses* (CRCE) under the Regulations.

CANADIAN INDUSTRY PROGRAM FOR ENERGY CONSERVATION (CIPEC)

The Canadian Industry Program for Energy Conservation (CIPEC) is a partnership between private industry and the federal Government that aims to promote and improve Canada's industrial energy efficiency and reduce greenhouse gas emissions from energy use.

ENERGY STAR FOR INDUSTRY

The ENERGY STAR symbol means that a product, new home, building or industrial facility is certified as energy efficient. ENERGY STAR Canada is a voluntary partnership between the Government of Canada and organizations in the public, private and not-for-profit sectors to promote energy efficiency.

Industrial facilities located in Canada can earn ENERGY STAR certification and display the ENERGY STAR symbol, similar to those seen on appliances and electronics in the marketplace.
ENERGY STAR Energy Performance Indicators (EPIs) can be used to benchmark a facility's energy performance against similar facilities in a given industry in Canada and the United States, generating a score on a scale of 1 to 100. EPIs are currently available to Canadian integrated steel mills – EPIs for other industrial sectors are under development.

CLEAN GROWTH PROGRAM

The Clean Growth Program (CGP) will provide $155 million for clean technology research and development (R&D) and demonstration projects in Canada's energy, mining and forestry sectors.

This program covers five areas focused on pressing environmental challenges and economic opportunities facing Canada's natural resource operations:

- Reducing greenhouse gas and air-polluting emissions
- Minimizing landscape disturbances and improving waste management
- The production and use of advanced materials and bioproducts
- Efficient energy use and productivity
- Reducing water use and impacts on aquatic ecosystems

SUSTAINABLE DEVELOPMENT TECHNOLOGY CANADA

Sustainable Development Technology Canada (SDTC) funds Canadian cleantech projects and coaches the companies that lead them as they move their groundbreaking technologies to market. Since their inception in 2001, $989 million in SDTC funding was allocated to 347 cleantech projects across Canada. As of 2017, over 200 patents were held by SDTC funded cleantech entrepreneurs and an estimated annual 10.1 $MtCO_{2e}$ in emissions reduction is attributable to SDTC's projects with technologies in the market in 2016 (Ref.).
Examples of past/current projects relevant to energy efficiency/excess heat include:

- Energy Management System Development and Implementation by Pulse Energy Inc.

- Wood Fired Heat and CO_2 Recovery Plant for Use in Greenhouse Applications by SunSelect Produce (Delta) Inc.

CLEAN ENERGY INNOVATION

The Energy Innovation Program (EIP) received $49 M over 3 years from 2016 to 2019, to support clean energy innovation. Clean Energy Innovation key priority areas are: renewable, smart grid and storage systems; reducing diesel use by industrial operators in northern and remote communities; methane and VOC emission reduction; reducing greenhouse gas emissions in the building sector; carbon capture, use and storage; and, improving industrial efficiency.

CANMETENERGY – INDUSTRIAL SYSTEM OPTIMISATION

Within NRCan, CanmetENERGY works with industry to co-manage and share the costs of development and commercialization of a range of technologies, including process integration, learning-based expert systems, combustion systems and controls, manufacturing processes, and environmentally friendly and energy-efficient processes for energy-intensive industries.
CanmetENERGY disseminates technical information to encourage adoption of these techniques and practices in targeted energy intensive sectors of Canadian industry. Functionally, CanmetENERGY expertise for industry focuses on:

- Industrial Energy Systems (targeted approach): Through R&D, CanmetENERGY experts help to identify priority technologies that can reduce and/or recover energy loss in industrial energy systems, including combustion, process heating, combined heat and power, compressed air, motors, pumps and fans (*1); and

- Industrial Process Optimization (global approach): Through R&D, CanmetENERGY experts apply a global approach focused on solutions for energy-intensive processes. This method can be used to reduce energy consumption through increased heat recovery, maintaining energy performance over time or the optimal integration of new technologies.

5.2.2 Provincial Policy Instruments

British Columbia (BC)	
B.C. Ministry of Energy and Mines (and NRCan) – ISO 50001 Implementation Incentive	As part of the Ministry's Innovative Clean Energy (ICE) Fund, designed to support the B.C. government's energy, economic and environmental priorities, this program offers up to $80,000 of cost-shared assistance to B.C. industrial companies to implement energy management system (EMS) projects that help facilities pursue compliance with the CAN/CSA-ISO 50001. EMS projects can include the development of an energy baseline, energy use assessment, energy performance monitoring, etc. It has been reported that industries can save between 10% and 20% of their annual energy use within the first five years of implementing an EMS (Ref.).
FortisBC – Incentives and equipment rebates for industrial facilities	This B.C. natural gas and power provider offers funding for plant-wide audits, feasibility studies and energy-efficiency upgrades. For example, their steam trap audit and replacement rebates (50% up to $10,000 for the audit and $250 per failed steam trap replaced) is available to facilities using natural gas as an input to industrial production. It is estimated that about 20 percent of the steam leaving the central boiler plant of a typical industrial facility is lost

	through leaking steam traps, which can cost thousands of dollars a year in energy costs. This rebate aims at improving the efficiency of industrial steam systems and reducing the waste heat. Additionally, FortisBC's Industrial Optimization Program supports energy efficiency improvement projects across the full spectrum of industrial subsectors (pulp and paper, food and beverage, manufacturing, oil and gas, etc.). Incentives range from a few thousand dollars for a small plant-wide audit to $1 million for a large retrofit, facility expansion or new construction projects. The program is designed to help customers from the identification of energy-saving opportunities through to the implementation of energy conservation measures – including recovery and reuse of waste energy and using more efficient equipment.
Alberta (AB)	
Government of Alberta – Carbon Competitiveness Incentive (CCI) and Emissions Reductions Alberta (ERA)	The CCI program is a made-in-Alberta plan designed in consultation with industry to reduce greenhouse gas emissions from large industrial emitters (>100,000 tonnes of annual greenhouse gas emissions). This regulation in place since January 2018 introduces output-based allocation (OBA) of allowable carbon emissions intensity on individual industries, on a benchmarking basis, which intends decarbonization of Alberta's industry at an accelerated rate. This new regulation stimulates competition for decarbonization among large industrial emitters and avoids curbing economic expansion. Regulated facilities can purchase fund credits from the ERA agency (current rate of $30 per tonne of emissions), and this in turn funds for energy efficiency initiatives. Since 2009, ERA has provided $327M in funding to over 100 promising projects, including $24M for 25 industrial process efficiency projects, thereby reducing greenhouse gas emissions by approximately 8,000,000 tonnes of CO_{2e} (by 2020). Sample funded project: Emission-free electrical power from multiple waste energy sources. The Alberta Energy Innovation Fund ($1.4B over seven years) also has an industrial energy efficiency component. They will allocate $240 million for industrial energy-efficiency projects that help companies reduce emissions and costs by upgrading equipment or facilities to lower energy use. The support will be available for large industrial, agricultural and manufacturing operations.
Alberta Agriculture and Forestry – Farm Energy and Agri-Processing Program (FEAP)	The FEAP offers financial support (up to $250,000) to applicants who incorporate high efficiency equipment which will result in cost savings, energy conservation, and ultimately, reduced greenhouse gas emissions. For example, the program has funded energy efficiency measures on dairy farms like the installation of Refrigeration Heat Recovery Unit (RHR), which use a heat exchanger to transfer waste heat from the hot refrigerant in the main refrigeration line to water in a tank – leading to 20% to 50% energy savings (Ref.). Other eligible projects include the installation of Combined Heat and Power Units (CHP) or greenhouse CO_2 recovery systems in conjunction with heat storage.
Saskatchewan (SK)	
SaskPower – Industrial Energy Optimization Program (IEOP)	Through the IEOP, industries are provided with customized technical assistance to identify and implement energy management and capital projects. Financial assistance is contingent upon concrete action by industry to move forward with energy optimization projects and include: - 100% of the cost, up to $15,000 for the identification of capital or energy management projects

	- 50% of the cost, up to $50,000 for developing an investment-grade business case - 50% of the project cost, up to $500,000 for an energy efficiency capital project A sample project at a steelmaker's facility allowed savings of 1.7 MW of demand 12.9 GWh/y in energy – the largest project for a single customer to date (Ref.)
Manitoba (MB)	
Manitoba Hydro – Industrial Power Smart Programs	Through its Natural Gas Optimization Program, Manitoba Hydro provides its major industrial and commercial consumers with technical support and financial incentives to identify, evaluate and implement energy efficiency projects throughout their facilities. The program aims to reduce natural gas consumption and promotes the use of a system approach, considering at once the production, distribution and use of thermal energy (steam, hot water, etc.). Funding is available for energy assessments, including process integration studies, through a financial incentive covering 50% of the first $5,000 segment of study costs, and 25% of the remaining study costs, up to a maximum of $10,000. For the implementation of energy efficiency measures, available funding is calculated based on the amount of natural gas saved and can cover up to 50% of the project cost, up to a maximum of $100,000. Energy efficiency screening studies are offered at no cost to address overall energy efficiency potential and to identify specific Power Smart electric and natural gas energy-saving opportunities within an industrial facility. Through the Bioenergy Optimization Program, companies can evaluate whether converting their waste streams and by-products by installing a biomass-to-energy conversion system is feasible. Capital costs associated with the design, purchase, and installation of equipment are eligible for the incentive (up to 50%, or a maximum incentive of $1,000,000 on electrical load reductions and $250,000 on natural gas load reductions).
Ontario (ON)	
Enbridge – Energy Management Industrial Programs	This gas distributor offers custom and fixed incentives, as well as a Comprehensive Energy Management Program. Between 1995 and 2013, their energy efficiency programs have helped industrial facilities save approximately 16.5 million tonnes of CO_2 emissions, which is equivalent to taking 3.2 million cars off the road per year. Examples of project include reducing excess exhaust in a metal office furniture manufacturer's oven, with estimated 125,000 m^3 of natural gas savings, or increasing the heat transfer efficiency of a furnace in a zinc oxide plant, resulting in almost 15% reduction of natural gas per metric tonne produced.
Ontario's Ministry of Energy, Northern Development and Mines - Northern Industrial Electricity Rate Program	The Northern Industrial Electricity Rate (NIER) Program, effective as of 2017, assists Northern Ontario's largest industrial electricity consumers to reduce energy costs, sustain jobs and maintain global competitiveness. NIER program participants receive a rebate of two cents per kilowatt hour, with individual rebates capped at 2013-2016 average consumption levels, or $20 million per year per company – whichever is lower. On average, industrial electricity prices can be reduced by up to 25 percent through the program.

	Participants are required to develop and implement an energy management plan to manage their energy usage and reduce costs.
Union Gas – Process Improvement Studies	Union Gas helps fund studies to improve processes in its customer's business. Studies identify ways to optimize the energy use of a specific piece of natural gas process equipment as part of company's overall operations and practices. Industrial customers incentive is 66% up to $20,000 of the project cost. New studies can have 34% additional top-up to a maximum of $20,000.
Quebec (QC)	
Quebec's Ministry of Natural Resources / Transition Énergétique Québec (TEQ) – ÉcoPerformance	TEQ provides financial assistance for energy efficiency and conversion projects. The program aims at reducing the energy consumption and greenhouse gas emissions of companies by funding projects or measures related to energy consumption and production, as well as process improvements. For energy saving studies, the funds available may cover up to 50% of eligible expenses up to an amount of $100k per site for small and medium consumers and up to $300k per site for large consumers (≥36,000 GJ/y, excluding electricity). The program also includes a component for the implementation of projects aimed at reducing greenhouse gas emissions. The funds available can cover up to 75% of eligible expenses up to a total of $5M per request and $10M per site and per year.
Énergir – Implementation of Energy Efficiency Measures Grant	Énergir (the new Gas Métro) provides financial assistance to encourage its customers to conduct feasibility studies, including energy saving studies, and implement energy efficiency measures for a more efficient use of natural gas. Énergir's financial aid is $0.25 per cubic metre of natural gas saved for the first year following the implementation of an energy efficiency measure. The maximum amount of financial aid is $100,000 per account number serviced by natural gas.
New Brunswick (NB)	
NB Power – Energy Smart Industrial Program	The Energy Smart Industrial Program helps accelerate industry investments in energy efficiency by providing financial incentives and advice to industrial facilities. They assist facilities with the assessment and implementation of energy efficiency measures for them to better manage energy costs while improving their productivity and competitiveness. Large industry clients can obtain up to $20,000 to assess energy efficiency upgrades, up to $300,000 in incentives for implemented measures, and, if eligible, up to $150,000 in incentives for Energy Management Information System (EMIS).

The three other provinces (Nova Scotia, Prince Edward Island, and Newfoundland and Labrador), as well as the three Canadian territories (Yukon, Northwest Territories, and Nunavut) do not have provincial funding incentives targeting specifically energy optimization within the industrial sector. Most programs offered are directed at the residential and commercial sector, and include initiatives around efficient lighting, refrigeration and buildings. In fact, most industries in Canada are located in the seven provinces with sample measures tabulated above. In 2015, the seven provinces discussed in this report (Alberta, British Columbia, Manitoba, New Brunswick, Ontario, Quebec, Saskatchewan) covered 98% of the greenhouse gas emissions from heavy industries (including stationery combustion, onsite transportation, electricity and steam production, and process emissions from mining, pulp and paper mills, iron and steel mills, cement producers, lime manufacturing, and chemical plants) and 98% of the greenhouse gas emissions from the oil & gas industry.

ANNEX 1 – MAJOR MANUFACTURING SECTORS: FLOW-SHEET CROSS-REFERENCE, RESULTS SUMMARY

ANNEX 1:

TABLE 1A: Cross-Reference of NAICS Industries and Process Flow Sheets for Waste Heat

NAICS #	NAICS Name	Sector 2015 Energy Usage [1, 2, 3] (TJ)	(% Mfg)	NAICS #	Evaluated Subsector(s) Names	Sub-Sector Energy Usage [1] (TJ)	(% Mfg)	108 Ind Classification	108 Ind. Process Name [2]	108 Industrial Process Analysis Pages	Process Flow Worksheet Complete (Y/N)	Waste Heat Analysis Complete (Y/N)
322	Paper Manufacturing	541,676	25.7%	322112	Chemical Pulp Mills	277,957	13.2%	2611-1	Pulp Mills - sulfate or kraft process	66-68	Y	Y
				322121	Paper Mills except newpri	89,109	4.2%	2621-1	Paper Mills - Finishing Plant	75-77	Y	Y
				322122	Newsprint Mills	98,225	4.7%	2621-1	Paper Mills - Finishing Plant	75-77		
311	Food Mfg	108,168	5.1%	3115	Dairy Products	12,503	0.6%	2026	Fluid Milk	18-20	Y	Y
				3116	Meat Products	17,902	0.8%	2033-1	Meat Packing	15-17	Y	Y
	Subtotal	649,844	30.8%		Subtotal	495,696	23.5%					
100001	All Manuf. Industries	2,111,508	100.0%	100001	All Manuf. Industries	2,111,508	100.0%					

References & Notes:

[1] " Energy Use and Related Data: Canadian Paper Manufacturing Industries 1990 to 2015", Canadian Industrial Energy End-use Data and Analysis Centre (CIEEDAC), Simon Fraser University, March 2017.

[2] http://oee.rncan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_id_ca.cfm

[3] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002501

ANNEX 1:

TABLE 1B: Summary of Industrial Waste Heat Analysis for Canadian Industry

								Waste Heat - Eval. Sub-Sectors					Waste Heat - Est'd Sector Values				
								1	2	3	4	5	1	2	3	4	5
NAICS #	NAICS Name	Sector 2015 Energy Usage [1, 2, 3] (TJ)	(% Mfg)	NAICS #	Evaluated Subsector(s) Names	Sub-Sector Energy Usage [1] (TJ)	(% Mfg)	Stack Losses (> 150 C) (TJ)	Steam (100-250 C) (TJ)	Proc Gas (80-150 C) (TJ)	Liquid (25-90 C) (TJ)	Other Loss (TJ)	Stack Losses (> 150 C) (TJ)	Steam (100-250 C) (TJ)	Proc Gas (80-150 C) (TJ)	Liquid (25-90 C) (TJ)	Other Loss (TJ)
322	Paper Manufacturing	541,676	25.7%	322112	Chemical Pulp Mills	277,957	13.2%	52,857	20,987	36,486	82,765	54047.6	100,128	63,027	81,071	134,950	101,519
				322121	Paper Mills except newprint	89,109	4.2%	33,151	33,152	33,153	33,154	33155.4					
				322122	Newsprint Mills	98,225	4.7%										
311	Food Mfg	108,168	5.1%	3115	Dairy Products	12,503	0.6%	2,723	0	0	5,080	3284.84	29,137	4,127	14,280	45,113	21,190
				3116	Meat Products	17,902	0.8%	5,467	1,160	4,014	7,601	2671.43					
	Subtotal	649,844	30.8%		Subtotal	495,696	23.5%	94,198	55,299	73,653	128,600	93159.3	129,264	67,154	95,352	180,063	122,709
100001	All Manuf. Industries	2,111,508	100.0%	100001	All Manuf. Industries	2,111,508	100.0%										

References & Notes:

[1] " Energy Use and Related Data: Canadian Paper Manufacturing Industries 1990 to 2015", Canadian Industrial Energy End-use Data and Analysis Centre (CIEEDAC), Simon Fraser University, March 2017.

[2] http://oee.rncan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_id_ca.cfm

[3] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002501

ANNEX 2 – PAPER MILLS - NAICS 32212

CIEEDAC 2015 Input Energy Values

Paper Mills NAICS 32212

	Paper Mills except Newsprint NAICS 322121			Newsprint Mills NAICS 322122			Total
	(TJ)	% Conf *	(TJ) adj	(TJ)	% Conf *	(TJ) adj	(TJ) adj
Total Input	89,109		89,109	98,225		98,225	187,334
Elect	28,510.0		28,510	46,460.0		46,460	74,970
NG	12,122.0		12,122	xx	19.8%	5,847	17,969
Heavy Fuel Oil	xx	99.1%	463	xx	20.3%	6,006	6,469
Middle Distillate	56.0		56	125.9		126	182
Propane	xx	0.9%	4	17.0		17	21
Pet coke	-		-	-		-	-
Coal	-		-	-		-	-
Coal Coke	-		-	-		-	-
Coal Oven Gas	-		-	-		-	-
Steam	5,504.0		5,504	xx	18.4%	5,433	10,937
Refinery Fuel Gas	-		-	-		-	-
Wood Waste	18,013.0		18,013	22,095.0		22,095	40,108
Spent Pulping Liquor	24,437.0		24,437	xx	41.5%	12,239	36,676
Waste fuel	-		-	-		-	-
Confidential	466.9	[redacted]		29,528.0	[redacted]		
Check sum	89,109	100%	89,109	98,226	100%	98,223	**187,332**

* % Confidential splits are based on historic trends before the year 2015.

Confidential Input Estimating Tool	Last known year 2004 (TJ)	%	Last known year 2007 (TJ)	%
xx1	103.00	0.9%	11566	19.8%
xx2	11222	99.1%	11866	20.3%
xx3		0%	10734	18%
xx4		0%	24184	41%
xx5		0%		0%
xx6		0%		0%
Sum	**11,325.00**	**100%**	**58350**	**100%**

	Paper Mills except Newsprint	Newsprint Mills	Total
2015 Production (Kilotonnes)	4,079	3,500	**7,579**

Industry: NAICS 32211 Paper Mills

Energy Analysis of 108 Industrial Processes (pp 75-77; Paper Mills - Finishing Plants)

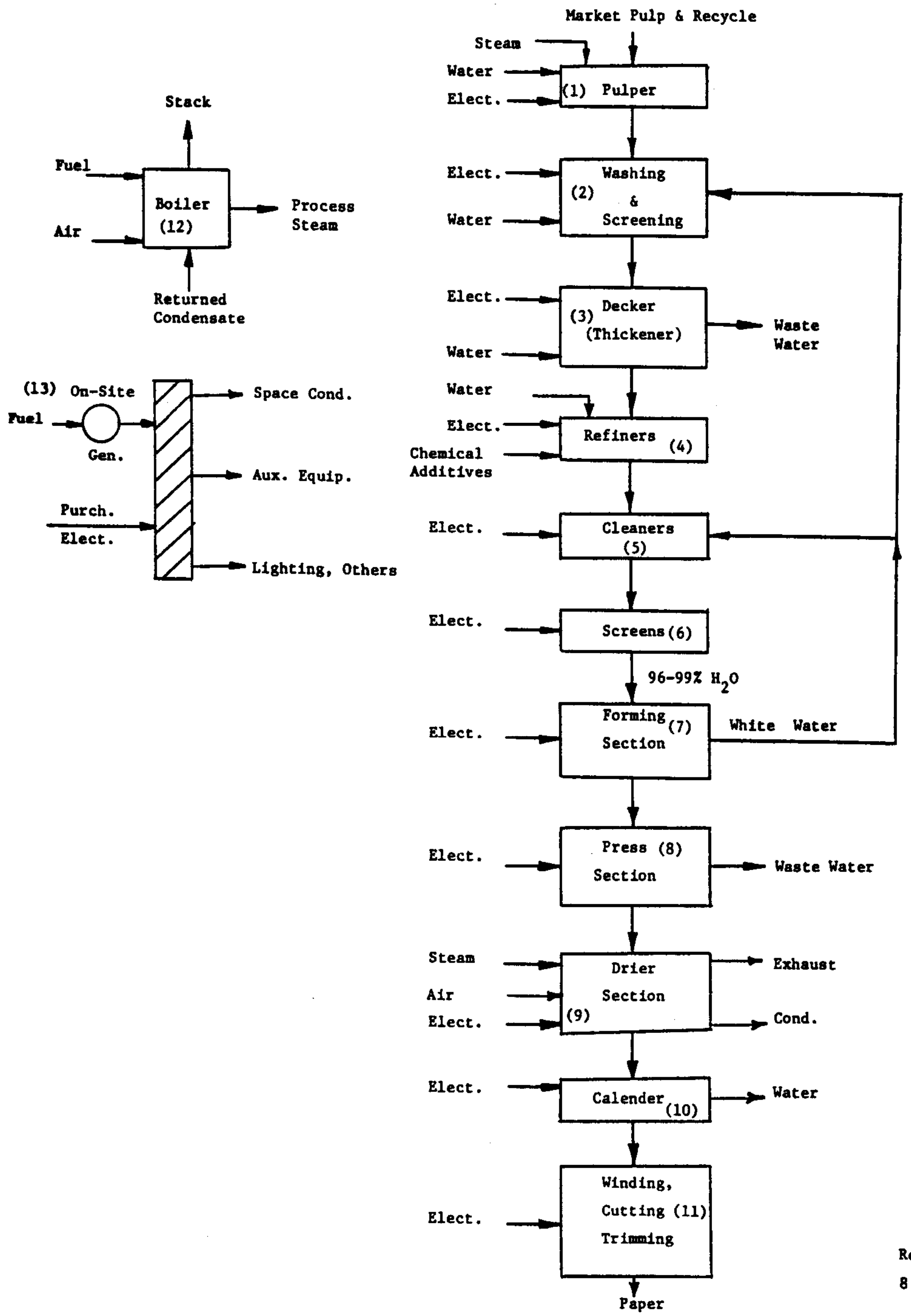
	UNIT OPERATION		INLET				OUTLET				Losses by Type (kJ)				
											1	2	3	4	5
NO	DESCRIPTION	TEMP (C)	FLOW	TEMP (C)	MASS (kg)	ENERGY (kJ)	FLOW	TEMP (C)	MASS (kg)	ENERGY (kJ)	Stack Losses (> 150 C) (kJ)	Steam (100-250C) (kJ)	Proc Gas (80-150 C) (kJ)	Liquid (25-90 C) (kJ)	Other Loss (kJ)
1	PULPER	60	PULP IN	24	0.477	0.0	PULP WTR	60	1.058	136.5					
			STEAM IN	121	0.090	210.0	LOSS			231.0					231.0
			WATER TN	24	0.495	0.0									
			ELECTRIC			157.5									
2	WASHING & SCREENING	27	PULP WTR	60	1.058	136.5	PULP WTR	27	10.598	115.5					
			WATER IN	24	0.608	0.0	LOSS			63.0					63.0
			WHTE WTR	24	8.933	0.0									
			ELECTRIC			42.0									
3	DECKER	27	PULP WTR	27	10.598	115.5	PULP WTR	27	2.700	21.0					
			WATER IN	24	0.608	0.0	White Water	27	8.505	99.8				99.8	
			ELECTRIC			52.5	LOSS			47.3					47.3
4	REFINERS	24	PULP WTR	27	2.700	21.0	PULP WTR	24	10.980	0.0					
			WATER IN	24	8.235	0.0	LOSS			73.5					73.5
			CHEM IN	24	0.045	0.0									
			ELECTRIC			52.5									
5	CLEANERS	24	PULP WTR	24	10.980	0.0	PULP WTR	24	90.000	0.0					
			WHTE WTR	24	79.020	0.0	LOSS			47.3					47.3
			ELECTRIC			47.3									
6	SCREENS	24	PULP WTR	24	90.000	0.0	PULP WTR	24	90.000	0.0					
			ELECTRIC			52.5	LOSS			52.5					52.5
7	FORMING SECTION	-9	PULP WTP	24	90.000	0.0	PULP WTR	24	2.048	0.0					
			ELECTRIC			210.0	WHTE WTR	24	87.975	0.0					
							LOSS			210.0					210.0
8	PRESS SECTION	24	PULP WTR	24	2.048	0.0	PULP OUT	24	1.287	0.0					
			ELECTRIC		0.000	262.5	WW	24	0.761	0.0					
							LOSS			250.0					250.0
9	DRIER	66	PULP IN	24	1.287	0.0	PAPER	66	0.477	36.8					
			STEAM IN	121	0.090	3675.0	COND OUT	104	1.440	487.2					
			AIR IN	24	3.240	0.0	EXHAUST	116	4.050	2783.6			2783.6		
			ELECTRIC			105.0	LOSS			472.5					472.5
10	CALENDAR	24	PAPER IN	66	0.477	36.8	PAPER	24	0.450	0.0					
			ELECTRIC			47.3	WATER	24	0.027	0.0					
							LOSS			84.0					84.0
11	WINDING CUTTING TRIM	24	PAPER IN	24	0.450	0.0	PAPER	24	0.450	0.0					
			ELECTRIC			47.3	LOSS			47.3					47.3
12	BOILER	121	RET COND	104	1.440	262.5	STACK	232	4.500	945.0	945.0				
			MAKE UP	24	0.090	0.0	PROC STM	121	1.440	3885.0					224.7
			AIR IN	24	4.500	0.0	AUX STM	121	0.090	315.0					
			FUEL			5145.0	LOSS			262.5					262.5
13	ELEC GENERATION		CW IN	25	16.763	0.0	ELECT		0.000	624.8					
			AIR IN	25	1.283	0.0	STACK	316	1.283	378.0	378.0				
			FUEL			1879.5	CW OUT	35	16.763	782.3				782.3	
							LOSS			94.5					94.5
										Column Totals (kJ) -->	1323.0	0.0	2783.6	882.0	2160.0
										Losses / Cooling Ratios -->	18%	0%	37%	12%	29%
															7148.5
															96%

Total Steam Input (derived)	3885.0	This is a derived input from Fuel ->	3885.0	>(Excludes Aux Stm)
Total Refrigeration (derived)		This is a derived input from Electricity ->		
Total Electric Input	1076.3	Generated Electricity (derived) ->	624.8	
Total Fuel Input	7024.5			
Total Energy Inputs	8100.8			
Net Electric Input	451.5			
Net Fuel Input	7024.5			
Net Energy Input	7476.0	Similar to CIEEDAC Reported Energy; used to Calculate Ratios		

2621-1 - Paper Mills

(Finishing Plant)

PROCESS FLOW



Revision 3

8 Aug 1980

ANNEX 3 – CHEMICAL PULP MILLS - NAICS 322112

CIEEDAC 2015 Input Energy Values

Chemical Pulp Mills NAICS 322112

	Chemical Pulp Mills NAICS 322112			Total
	(TJ)		(TJ) adj	(TJ) adj
Total Input	277,957		277,957	277,957
Elect	31,330.0		31,330	31,330
NG	29,063.0		29,063	29,063
Heavy Fuel Oil	xx	93.2%	4,227	4,227
Middle Distillate	xx	6.8%	310	310
Propane	109.5		109	109
Pet coke	-		-	-
Coal	-		-	-
Coal Coke	-		-	-
Coal Oven Gas	-		-	-
Steam			-	-
Refinery Fuel Gas	-		-	-
Wood Waste	49,208.0		49,208	49,208
Spent Pulping Liquor	163,709.0		163,709	163,709
Waste fuel	-		-	-
Confidential	4,537.0	[redacted]		
Check sum	277,956		277,956	277,956

* % Confidential splits are based on historic trends before the year 2015

Confidential Input Estimating Tool	Last known year 2011	
	(TJ)	%
xx1	6950.00	93.2%
xx2	509.8	6.8%
xx3		0%
xx4		0%
xx5		0%
xx6		0%
Sum	**7,459.80**	**100%**

2015 Production (Kilotonnes)	9498	**9,498**

Industry: NAICS 322112: Chemical Pulp Mills

Energy Analysis Of 108 Industrial Processes (pp 67-68; Pulp Mills - Kraft Process)

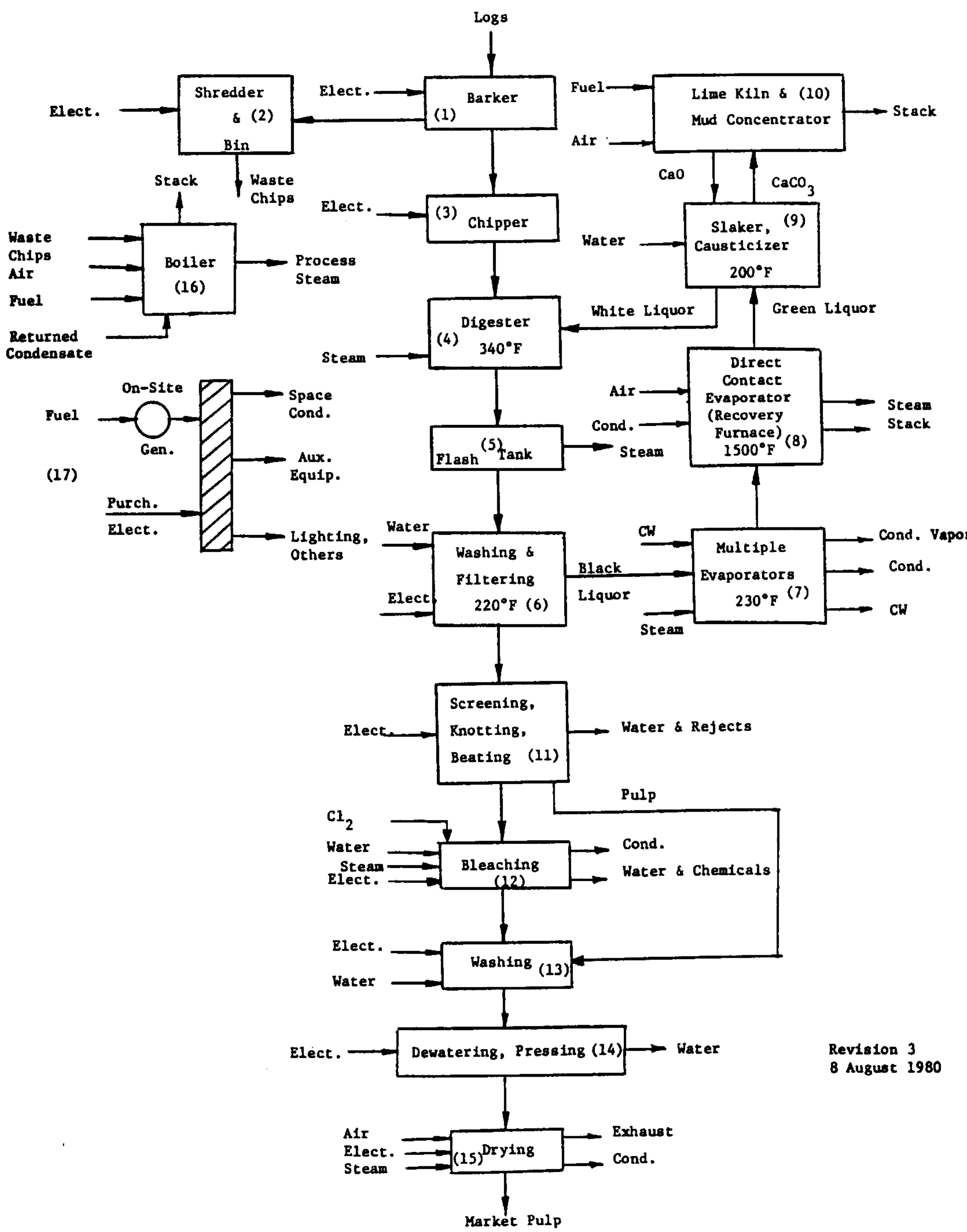
	UNIT OPERATION		INLET				OUTLET				Losses by Type (kJ)				
											1	2	3	4	5
NO	DESCRIPTION	TEMP (C)	FLOW	TEMP (C)	MASS (kg)	ENERGY (kJ)	FLOW	TEMP (C)	MASS (kg)	ENERGY (kJ)	Stack Losses (> 150 C) (kJ)	Steam (100-250C) (kJ)	Proc Gas (80-150 C) (kJ)	Liquid (25-90 C) (kJ)	Other Loss (kJ)
1	BARKER	24	LOGS IN	24	2.322	0	BARK OUT	-9	0.342	0.0					
			ELECTRIC			42	WOOD OUT	24	1.980	0.0					
							LOSS			42.0					42.0
2	SHREDDER & BIN	24	BARK IN	24	0.342	0	WST CHPS	24	0.342	0.0					
			ELECTRIC			42	LOSS			42.0					42.0
3	CHIPPER	24	WOOD IN	24	1.980	0	WOOD CHP	24	1.980	0.0					
			ELECTRIC			78.75	LOSS			78.8					78.8
4	DIGESTER	171	WOOD CHP	24	1.980	0	PULP MIX	171	4.779	2466.5					
			STEAM IN	171	0.783	2220.75	LOSS			214.2					214.2
			WHITE LQ	91	2.016	459.9									
5	BLOW TANK	104	PULP MIX	171	4.779	2466.45	PULP LIQ	104	4.212	996.5					
							VENT STM	104	0.567	1417.5		1417.5			
							LOSS			52.5					52.5
6	WASHING & FILTERS	104	PULP LIQ	104	4.212	996.45	BLACK LQ	54	4.842	556.5					
			WATER IN	24	3.911	0	PULP WTR	54	0.581	370.7					
			ELECTRIC			131.25	LOSS			200.6					200.6
7	MULTIPLE EVAP.	110	BLACK LQ	54	4.842	556.5	COND VAP	93	0.693	973.4				973.4	
			STEAM IN	144	0.860	2368.8	COND	93	0.860	252.0				113.4	
			CW IN	24	22.500	0	BLACK LQ	66	1.449	210.0					
							CW OUT	35	22.500	1154.0				1154.0	
							LOSS			336.0					336.0
8	DIRECT CONTACT EVAP	816	STRONG LQ	66	1.449	210	GREEN LQ	816	0.356	472.5					
			AIR IN	24	3.960	0	STEAM	204	2.673	8032.5					
			RET COND	66	2.673	472.5	STACK	149	5.054	2094.8	2094.8				
	(assumed from Pulping Liquor)		EXOTHERM			10815	LOSS			897.8					897.8
9	SLAKER & CAUSTICIZER	93	GREEN LQ	816	0.356	472.5	WHITE LQ	91	2.016	459.9					
			CaO	649	0.140	80.535	$CaCO_3$	57	0.419	30.5					
			WATER IN	24	1.940	0	LOSS			314.7					314.7
	(assumed from Pulping Liquor)		EXOTHERM			252									
10	KILN	649	CaCO3	57	0.419	30.45	CaO	649	0.140	80.5					
			AIR IN	24	0.450	0	STACK	427	0.729	431.7	431.7				
			FUEL			1102.5	LOSS			87.2					87.2
			ENDOTHRM			-693									
11	SCREENING KNOTTING	60	PULP / WATER	54	3.281	370.65	PULP	60	1.800	210.0					
			ELECTRIC			262.5	WATER	60	0.284	52.5				52.5	
							PULP	60	1.197	136.5					
							LOSS			239.4					239.4
12	BLEACHING	29	PULP IN	60	1.800	210	WATER/CHEMS	38	42.210	2388.8				2388.8	
			CHLOR GAS	24	0.027	0	COND OUT	99	0.990	315.0					
			STEAM IN	127	0.990	2625	PULP/ WTR	29	1.652	78.8					
			WATER IN	24	42.035	0	LOSS			262.5					262.5
			ELECTRIC			210									
13	WASHING	32	WATER IN	24	2.700	0	PULP/WTR	32	5.549	220.5					
			PULP / WTR	29	1.652	78.75	LOSS			36.8					36.8
			BLCH PLP	60	1.197	136.5									
			ELECTRIC			47.25									
14	DEWATERING PRESSING	32	PULP / WTR	32	5.549	220.5	PULP	32	1.125	36.8					
			ELECTRIC			315	WATER	32	4.424	157.5				157.5	
							LOSS			341.3					341.3
15	DRYING	66	PULP	32	0.225	36.75	MKT PULP	66	0.450	24.2					
			AIR IN	24	10.350	0	EXHAUST	116	11.025	2464.4			2464.4		
			STEAM IN	127	1.215	3150	COND STM	104	1.215	409.5					
			ELECTRIC			105	LOSS			393.8					393.8
16	BOILER	149	AIR IN	24	3.240	0	STACK	232	3.240	686.7	686.7				
			MAKE UP	24	1.350	0	PROC STEAM	149	1.215	3150.0					
			WSTE CHP	24	0.342	420	AUX STEAM	149	0.135	315.0					
			FUEL			3753.75	WSTE ASH	-9	0.072	0.0					
							LOSS			22.1					22.1
17	ELECT GEN		CW IN	24	16.088	0	ELECT			598.5					
			AIR IN	24	0.293	0	STACK	316	0.293	357.0	357.0				
			FUEL			1795.5	CW OUT	35	16.088	750.8				750.8	
							LOSS			89.3					89.3
							Column Totals (BTU) -->				3570.1	1417.5	2464.4	5590.2	3650.5
							Losses / Cooling Ratios -->				19%	8%	13%	30%	19%

Total Steam Input (derived)	10364.6	This is a derived input from Fuel ->	11182.5	> (excludes Aux Steam) 16692.7
Total Refrigeration (derived)		This is a derived input from Elect ->		89%
Net Exothermic - Endothermic	10374.0			
Total Electric Input	1233.8	Generated Electricity (derived) ->	598.5	
Total Fuel Input	7071.8			
Total Energy Inputs	8305.5			
Net Steam Input	0.0			
Net Electric Input	635.3			
Input from Pulping Liquor	11067.0			
Net Fuel Input	7071.8			
Net Energy Input	18774.0	Similar to CIEEDAC Reported Energy; used to Calculate Ratios		

2611-1 - Pulp Mills

(Kraft Process)

PROCESS FLOW



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ANNEX 4 – DAIRY PRODUCTS - NAICS 3115

CIEEDAC 2015 Input Energy Values

Dairy Products NAICS 3115

	Dairy Products NAICS 3115			Total
	(PJ)	% Conf *	(PJ) adj	(PJ) adj
Total Input	11.6		11.6	11.6
Elect	3.8		3.8	3.8
NG	xx	94.1%	7.3	7.3
Diesel Fuel Oil, Light FO and Kerosene	xx	2.9%	0.2	0.2
Heavy Fuel Oil	xx	3.0%	0.2	0.2
Still Gas and Petroleum Coke	-		-	-
LPG and Gas Plant NGL	xx	0.0%	-	-
Coal	-		-	-
Coke and Coke Oven Gas	xx	0.0%	-	-
Wood Waste and Pulping Liquor	-		-	-
Other	-		-	-
Refinery Fuel Gas	-		-	-
Wood Waste	-		-	-
Spent Pulping Liquor	-		-	-
Waste fuel	-		-	-
Confidential	7.8	[redacted]		
Check sum	11.6	100%	11.6	**11.6**

* % Confidential splits are based on historic trends before the year 2015.

Confidential Input Estimating Tool	Last known year	
	(PJ)	%
XX1	**6.4**	94.1%
XX2	**0.2**	2.9%
XX3	**0.2**	3%
XX4	**0**	0%
XX5	**0**	0%
xx6		0%
Sum	**6.80**	**100%**

Industry: NAICS 3115 Dairy Products

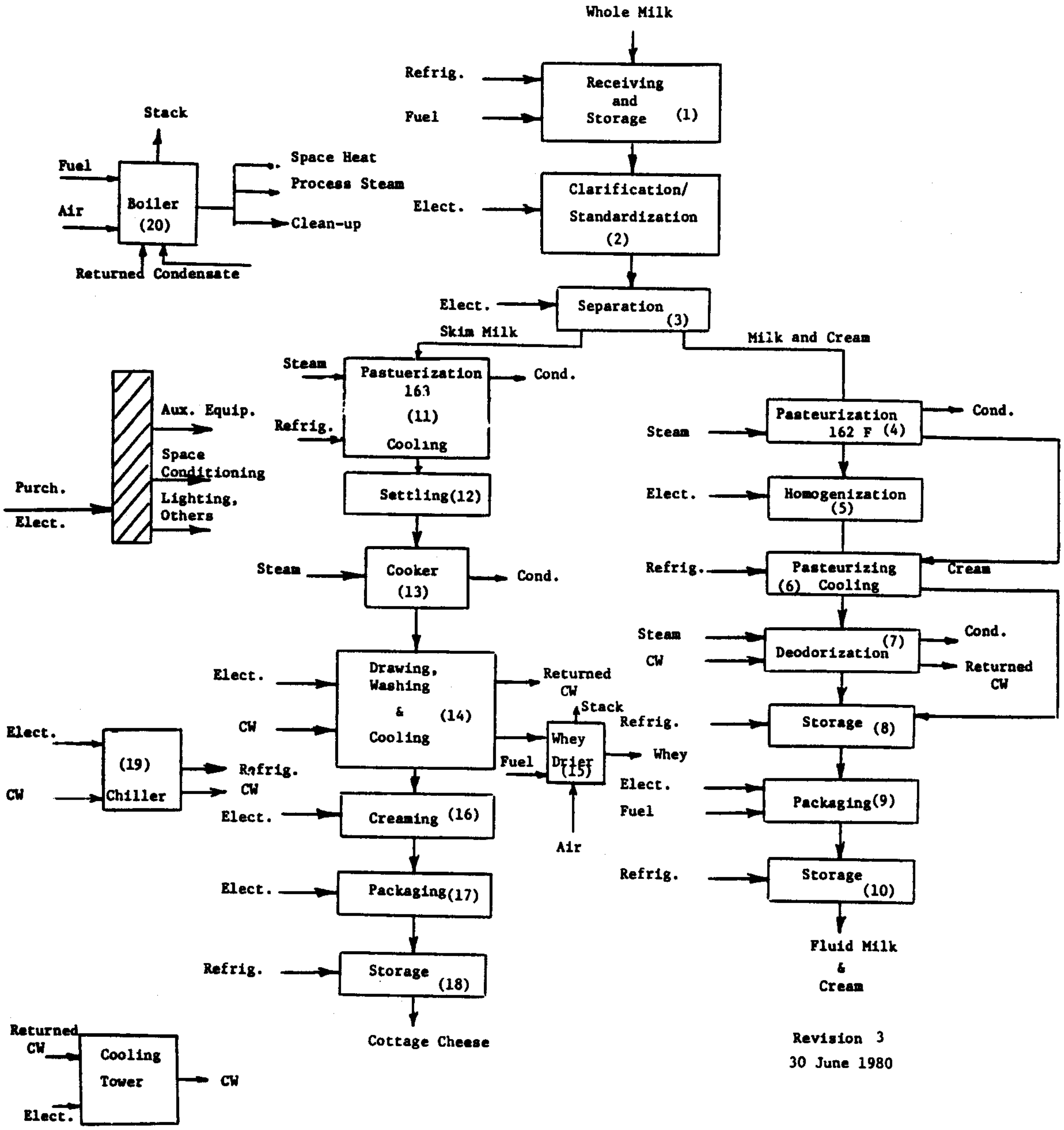
Energy Analysis of 108 Industrial Processes (pp 18-20, Fluid Milk)

	UNIT OPERATION		INLET				OUTLET				Losses by Type (kJ)					Cooling Energy Req'ts by Temp/Type				
											1	2	3	4	5	1	2	3	4	5
NO	DESCRIPTION	TEMP	FLOW	TEMP	MASS	ENERGY	FLOW	TEMP	MASS	ENERGY	Stack Losses (> 150 C)	Steam (100-250C)	Proc Gas (80-150 C)	Liquid (25-90 C)	Other Loss	Direct Cooling (Proc. mixing)	Open Cycle Cooling Air or Water	Atm. Cooling (eg, cool. tow er)	Refrig Cooling (60 to 32F)	Low Temp Refrig'n (31 to –58F)
		(C)		(C)	(kg)	(kJ)		(C)	(kg)	(kJ)	(kJ)	(kJ)	(kJ)	(kJ)	(kJ)	(kJ)	(kJ)	(kJ)	(kJ)	(kJ)
1	RECEIVING / STORAGE	4	MILK	4	0.473	-38.6	MILK	4	0.473	-38.6										
			REFRIG	-29		-15.4	LOSS			-4.9					-4.9					15.4
			FUEL			10.5														
2	STANDARD & HOLDING	9	MILK	4	0.473	-38.6	MILK	9	0.473	-29.8										
			ELECTRIC			7.5	LOSS			-1.4					-1.4					
3	SEPARATOR	10	MILK	9	0.473	-29.8	MILK	10	0.450	-26.3										
			ELECTRIC			15.9	SKIM MILK	10	0.009	-0.5										
							CREAM	10	0.014	-0.7										
							LOSS			13.5					13.5					
4	PASTURIZATION	73	MILK	10	0.450	-26.3	MILK	38	0.450	26.3										
			CREAM	10	0.014	-0.7	CREAM	38	0.014	0.7										
			STEAM	121	0.032	76.7	COND	82	0.032	7.7										
							LOSS			14.9					14.9					
5	HOMOGENIZATION	38	MILK	38	0.450	26.3	MILK	38	0.450	26.3										
			ELECTRIC			9.0	LOSS			9.0					9.0					
6	COOLING	1	MILK	38	0.450	26.3	MILK	1	0.450	-44.1										
			CREAM	38	0.014	0.7	CREAM	1	0.014	-1.4										
			REFRIG	-29		-73.8	LOSS			-1.4					-1.4					73.8
7	DEODERIZATION	3	MILK	1	0.450	-44.1	MILK	3	0.450	-38.9										
			STEAM	121	0.009	21.0	COND	82	0.009	3.2										
			CW IN	24	0.225	0.0	CW OUT	35	0.225	10.5				10.5				10.5		
							LOSS			2.1					2.1					
8	STORAGE	3	MILK	3	0.450	-38.9	MILK	3	0.450	-38.9										
			CREAM	1	0.014	-1.4	CREAM	3	0.014	-1.2										
			REFRIG	-29		-7.8	LOSS			-7.9					-7.9					7.8
9	PACKAGE	3	MILK	3	0.450	-38.9	MILK	3	0.450	-38.9										
			CREAM	3	0.014	-1.2	CREAM	3	0.014	-1.2										
			FUEL			12.6	LOSS			60.1					60.1					
			ELECTRIC			47.5														
10	STORAGE	3	MILK	3	0.450	-38.9	MILK	3	0.450	-32.6										
			CREAM	3	0.014	-1.2	CREAM	3	0.014	-1.2										
			REFRIG	-29		-15.4	LOSS			-15.4					-15.4					15.4
11	PASTUERIZATION	73	SKIM MILK	10	0.009	-0.5	SKIM MILK	1	0.009	-0.8										
			STEAM	121		1.6	COND	82	0.0005	0.1										
			REFRIG	-29		-1.5	LOSS			0.3					0.3					1.5
12	SETTLING	3	SKIM MILK	1	0.009	-0.8	SKIM MILK	3	0.009	-0.7										
							LOSS			-0.1					-0.1					
13	COOKER	100	SKIM MILK	3	0.009	-0.7	SKIM MILK	100	0.009	2.8										
			STEAM	121	0.014	34.7	COND	82	0.014	3.3										
							LOSS			27.7					27.7					
14	DRAWING /WASH /COOLING	27	SKIM MILK	100	0.009	2.8	SKIM MILK	27	0.008	0.1										
			CW IN	24	0.059	0.0	WHEY	27	0.001	0.0										
			ELECTRIC			2.0	CW OUT	35	0.059	2.7				2.7				2.7		
							LOSS			2.0					2.0					
15	DRIER	82	WHEY IN	27	0.001	0.0	WHEY OUT	82	0.0005	0.1										
			AIR IN	24	0.003	0.0	STACK	260	0.004	2.7	2.7									
			FUEL			3.2	LOSS			0.3					0.3					
16	CREAMING	24	SKIM MILK	27	0.008	0.1	CTG CHEZ	24	0.008	0.0										
			ELECTRIC			1.8	LOSS			1.9					1.9					
17	PACKAGING	24	CTG CHEZ	24	0.008	0.0	CTG CHEZ	24	0.008	0.0										
			ELECTRIC			0.8	LOSS			0.8										
18	STORAGE	3	CTG CHEZ	24	0.008	0.0	CTG CHEZ	3	0.008	-0.7										
			REFRIG	-29		-5.9	LOSS			-5.3					-5.3					5.9
19	REFRIGERATION	-29	CW IN	24	3.600	0.0	REFRIG	-29		-119.8										
			ELECTRIC			63.0	CW OUT	35	3.600	172.3				172.3				172.3		
							LOSS			10.5					10.5					
20	BOILER	121	COND	82	0.041	10.0	STEAM	121	0.055	133.9										
			AIR	24	0.833	0.0	SPACE HEAT	121	0.012	30.1										
			MAKE UP	24	0.086	0.0	CLEAN UP	121	0.059	145.7				145.7						
			FUEL			582.8	STACK	232	0.833	174.8	174.8									
							LOSS			108.2					108.2					
									Column Totals (kJ) -->		177.56	0	0	331.28	214.2	0	0	185.535	0	119.8
									Losses / Cooling Ratios -->		23%	0%	0%	44%	28%	0%	0%	25%	0%	16%

Total Steam Input (derived)	133.9	This is a derived input from Fuel ->	133.9	>(excludes space htg)
Total Refrigeration (derived)	-119.8	This is a derived input from Electricity	-119.8	
Total Electric Input	147.4	Generated Electricity (derived) ->	0.0	
Total Fuel Input	609.0			
Total Energy Inputs	756.4			
Net Electric Input	147.4			
Net Fuel Input	609.0			
Net Energy Input	756.4	Similar to CIEEDAC Reported Energy; used to Calculate Ratios		

2026 - FLUID MILK

PROCESS FLOW



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ANNEX 5 – MEAT PRODUCTS - NAICS 3116

CIEEDAC 2015 Input Energy Values

Meat Products NAICS 3116

	Meat Products NAICS 3116			Total
	(PJ)	% Conf *	(PJ) adj	(PJ) adj
Total Input	19.4		19.4	19.4
Elect	6.5		6.5	6.5
NG	xx	97.1%	12.4	12.4
Diesel Fuel Oil, Light FO and Kerosene	xx	2.2%	0.3	0.3
Heavy Fuel Oil	xx	0.7%	0.1	0.1
Still Gas and Petroleum Coke	-		-	-
LPG and Gas Plant NGL	0.1		0.1	0.1
Coal	-		-	-
Coke and Coke Oven Gas	-		-	-
Wood Waste and Pulping Liquor	xx		-	-
Other	-		-	-
Confidential	12.8	[redacted]		
Check sum	19.4	100%	19.4	**19.4**

* % Confidential splits are based on historic trends before the year 2015.

Confidential Input Estimating Tool	Last known year 2006 (PJ)	%
xx1	13.20	97.1%
xx2	0.3	2.2%
xx3	0.1	1%
xx4		0%
xx5		0%
xx6		0%
Sum	**13.60**	**100%**

Industry: NAICS 3116 Meat Products

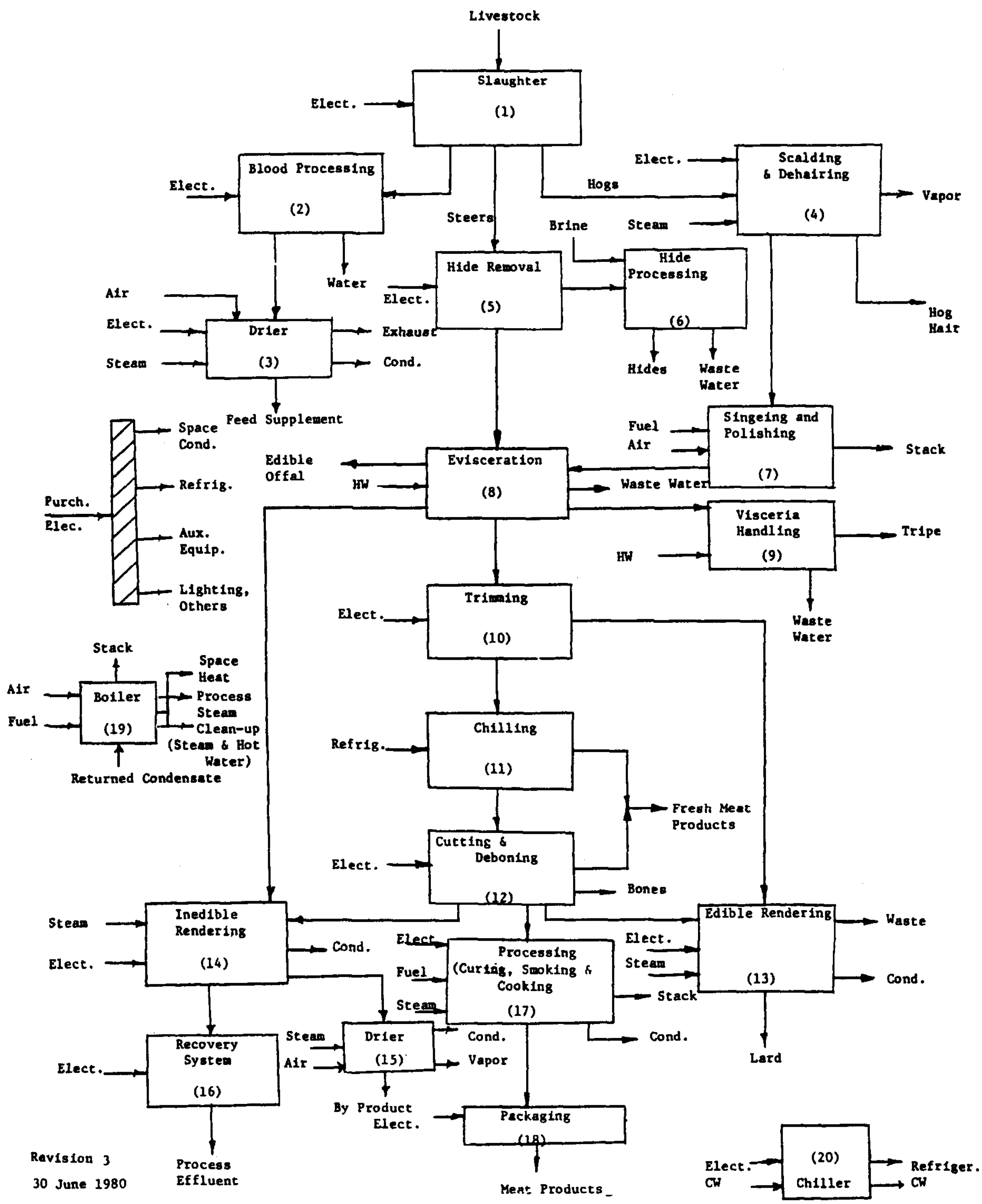
Energy Analysis of 108 Industrial Processes (pp 15-17, Meat Packing)

	UNIT OPERATION		INLET				OUTLET				Losses by Type (kJ)				
											1	2	3	4	5
NO	DESCRIPTION	TEMP (C)	FLOW	TEMP (C)	MASS (kg)	ENERGY (kJ)	FLOW	TEMP (C)	MASS (kg)	ENERGY (kJ)	Stack Losses (> 150 C) (kJ)	Steam (100-250C) (kJ)	Proc Gas (80-150 C) (kJ)	Liquid (25-90 C) (kJ)	Other Loss (kJ)
1	SLAUGHTER	24	HOG IN	24	0.168	0.0	HOG OUT	24	0.159	0.0					
			STEER IN	24	0.716	0.0	STR OUT	24	0.689	0.0					
			ELECTRIC			4.3	LOSS	24	0.036	0.0					
							LOSS			4.3					4.3
2	BLOOD PROCESSING	24	BLOOD IN	23	0.036	0.0	BLOOD OUT	24	0.009	0.0					
			ELECTRIC			0.4	WATER	24	0.027	0.0					
							LOSS			0.4					0.4
3	BLOOD DRYER	93	BLOOD IN	24	0.009	0.0	FD SUPPLY	93	0.005	0.6					
			STEAM IN	121	0.027	76.7	EXHAUST	100	0.050	20.5		20.5			
			AIR IN	24	0.045	0.0	COND	82	0.027	9.8					
			ELECTRIC			0.4	LOSS			46.2					46.2
4	SCALDING & DE-HAIRING	27	HOG IN	24	0.159	0.0	HOG OUT	27	0.158	1.8					
			STEAM IN	121	0.032	87.6	HOG HAIR	27	0.002	0.0					
			ELECTRIC			3.8	VAPOR	100	0.032	86.5		86.5			
							LOSS			3.0					3.0
5	HIDE REMOVAL	24	STEERS	24	0.689	0.0	STEEPS	24	0.653	0.0					
			ELECTRIC			1.7	HIDE	24	0.036	0.0					
							LOSS			1.7					1.7
6	HIDE PROCESSING	24	HIDE	24	0.036	0.0	HIDE	24	0.036	0.0					
			BRINE	24	0.005	0.0	WSTE WATER	24	0.005	0.0					
7	SINGEING & POLISHING	29	HOG TN	27	0.158	1.8	HOG OUT	29	0.158	3.7					
			AIR IN	24	0.171	0.0	STACK	260	0.171	40.3	40.3				
			FUEL			47.0	LOSS			4.3					4.3
8	EVISCERATION	24	HOG IN	29	0.158	3.7	CARCASS	24	0.545	0.0					
			STEER IN	24	0.653	0.0	ED OFFAL	24	0.072	0.0					
			HW IN	60	0.590	89.5	VISCERA	24	0.108	0.0					
							INED REND	24	0.090	0.0					
							WSTE WATER	49	0.590	73.0				73.0	
							LOSS			20.2					20.2
9	VISCERA HANDLING	24	VISCERA	24	0.108	0.0	TRIPE	24	0.108	0.0					
			HW IN	60	1.179	178.8	WSTE WATER	49	1.179	145.1				145.1	
							LOSS			33.7					33.7
10	TRIMMING	24	CARCASS IN	24	0.545	0.0	CARC OUT	24	0.500	0.0					
			ELECTRIC			1.7	ED REND	24	0.023	0.0					
							FAT	24	0.023	0.0					
							LOSS			1.7					1.7
11	CHILLING	2	CARCASS IN	24	0.500	0.0	CARCASS OUT	2	0.360	-31.8					
			REFRIG	-29		-289.3	MEAT PRODS	2	0.140	-13.0					
							LOSS			-244.4					
12	CUTTING & DEBONING	4	CARCASS IN	2	0.270	-31.8	FR MEAT	4	0.036	-2.9					
			ELECTRIC			3.2	OTHER MT	4	0.275	-22.5					
							INED REND	4	0.023	-1.8					
							ED REND	4	0.005	-0.4					
							BONES	4	0.023	-1.9					
							LOSS			0.8					0.8
13	EDIBLE RENDERING	93	ED REND.	4	0.005	-0.4	LARD	93	0.014	3.6					
			STEAM	121	0.050	127.9	COND	82	0.050	17.1					
			FAT	24	0.023	0.0	WASTES	93	0.027	10.6				10.6	
			ED REND	24	0.023	0.0	LOSS			106.1			106.1		
			ELECTRIC			9.9									
14	INEDIBLE RENDERING	93	INED REND.	24	0.090	0.0	PROC EFF	93	0.054	15.8				15.8	
			INED REND.	4	0.023	-1.2	BY PROD	93	0.059	16.4					
			STEAM	121	0.198	536.6	COND	82	0.198	68.4					
			ELECTRIC			39.5	LOSS			473.8			473.8		
15	INEDIBLE REND. DRIER	93	BY PROD.	93	0.059	16.4	PROD	93	0.036	4.1					
			STEAM	121	0.027	76.7	COND	93	0.027	11.1					
			AIR IN	24	0.113	0.0	VAPOR	104	0.135	60.6		60.6			
							LOSS			17.2					17.2
16	RECOVERY SYSTEM	66	PROD EFF	93	0.045	15.8	PROC EFF	66	0.054	9.5				9.5	
			ELECTRIC			13.2	LOSS			19.5					19.5
17	PROCESSING	24	OTHER MEAT	4	0.275	-22.5	MEAT PROD	24	0.275	0.0					
			STEAM IN	121	0.014	32.9	STACK	204	0.711	129.4	129.4				
			AIR IN	24	0.711	0.0	COND	82	0.014	4.2					
			FUEL			141.1	LOSS			49.2					49.2
			ELECTRIC			31.3									
18	PACKAGING	24	MEAT PRODS	24	0.275	0.0	MEAT PRODS	-9	0.275	0.0					
			ELECTRIC			59.3	LOSS			59.3					59.3
19	BOILER	121	COND IN	82	0.315	110.3	PROC STEAM	121	0.347	940.3					
			MAKE-UP	24	1.940	0.0	Space Htg	121	0.018	48.3					
			AIR IN	24	2.408	0.0	HW OUT	60	1.769	268.3					
			FUEL			2293.2	CLEAN-UP	121	0.122	402.5				402.5	
							STACK	260	2.408	620.0	620.0				
							LOSS			124.2					124.2
20	CHILLER	-29	CW IN	24	9.450	0.0	REFRIG	-29		-289.3					
			ELECTRIC			152.3	CW OUT	35	9.450	441.5				441.5	
										Column Totals (kJ) -->	789.705	167.58	579.81	1097.88	385.875
										Losses / Cooling Ratios -->	28%	6%	21%	39%	14%

Total Steam Input (derived)	1206.5	This is a derived input from Fuel ->	1208.6	> (exclude space htg)
Total Refrigeration (derived)	-289.3	This is a derived input from Electric	-289.3	
Total Electric Input	320.9	Generated Electricity (derived) ->	0.0	
Total Fuel Input	2481.4			
Total Energy Inputs	2802.2			
Net Electric Input	320.9			
Net Fuel Input	2481.4			
Net Energy Input	2802.2	Similar to CIEEDAC Reported Energy; used to Calculate Ratios		

2011 - MEAT PACKING PLANTS

PROCESS FLOW



ANNEX 6 – POLICY INSTRUMENTS IN CANADA - SUMMARY TABLE

	Brief Description	Carbon Pricing	Financial Incentives / Subsidies	Research	Regulatory / Policy Instrument	Information / Energy Management & Monitoring
Federal Government						
Federal Carbon Pricing Backstop System	Implementation of a carbon tax of 10$ in 2018 (increasing by 10$/y until 50$ in 2022) in all provinces and territories that do not have an equivalent carbon pricing mechanism.	X			X	
Financial Assistance for Energy Efficiency Projects - NRCAN	Cost-shared financial assistance of up to 50% of eligible costs to a maximum of $40,000 for energy management systems (EMS) projects (CAN/CSA-ISO 50001) or process integration studies.		X			X
Class 43 of Depreciable Property	Accelerated Capital Cost Allowance (CCA) rate to encourage businesses to invest in specified clean energy generation and energy efficiency equipment.		X			
Canadian Industry Program for Energy Conservation (CIPEC)	Encourages energy management best practices through dialogue and collaboration, and recognizes and rewards those who lead the way. Participating Industry Officers organize meetings, benchmark energy intensity in various sectors, develop energy efficiency guidebooks and deliver workshops.					X

ENERGY STAR for Industry	ENERGY STAR Energy Performance Indicators (EPIs) can be used to benchmark a facility's energy performance against similar facilities in a given industry.					X
Clean Growth Program	$155 million for clean technology research and development (R&D) and demonstration projects in Canada's energy, mining and forestry sectors, including efficient energy use and productivity.		X	X		
Sustainable Development Technology Canada	Funds Canadian cleantech projects and coaches the companies that lead them as they move their groundbreaking technologies to market.		X	X		
Clean Energy Innovation – Energy Innovation Program	$49 M over 3 years to support clean energy innovation, with improving industrial efficiency as one of the key priority areas.		X	X		
CanmetENERGY – Industrial System Optimisation	Within NRCan, CanmetENERGY works with industry to co-manage and share the costs of development and commercialization of a range of technologies, including process integration and energy-efficient processes for energy-intensive industries.			X		X

Provincial Governments							
BC	B.C. Ministry of Energy and Mines (and NRCan) - ISO 50001 Implementation Incentive	Up to $80,000 of cost-shared assistance to B.C. industrial companies to implement energy management system (EMS) projects that help facilities pursue compliance with the CAN/CSA-ISO 50001.		X			X
	Government of British Columbia	Carbon tax, with the possible addition of an output-based allocation system (OBAS) for emissions-intensive and trade-exposed (EITE) industries - $35 in 2018, with $5 annual increases until 2021 to $50.	X			X	
AB	Government of Alberta - Carbon Competitiveness Incentive (CCI) and Emissions Reductions Alberta (ERA)	Carbon levy of $30 in 2018, going up to $50 in 2022, and output-based allocation system (OBAS) of allowable carbon emissions intensity on individual industries, on a benchmarking basis.	X			X	
	Alberta Agriculture and Forestry - Farm Energy and Agri-Processing Program (FEAP)	Financial support (up to $250,000) to applicants who incorporate high efficiency equipment which will result in cost savings, energy conservation, and ultimately, reduced greenhouse gas emissions.		X			

MB	Government of Manitoba	Carbon tax with output-based allocation system (OBAS) of $25 in 2018, stable until 2022.	X			X	
ON	Western Climate Initiative (WCI)	On January 1, 2018, Ontario joined Québec and California in the WCI. The Cap-and-trade program has a floor price of $18 in 2018, expected to rise to $28 in 2022. Industries emitting 25,000 metric tons or more of CO_2 equivalent a year are subjected to Ontario's carbon market.	X			X	
	Ontario's Ministry of Energy, Northern Development and Mines - Northern Industrial Electricity Rate (NIER) Program	The NIER Program, effective as of 2017, assists Northern Ontario's largest industrial electricity consumers by receiving a rebate of two cents per kilowatt hour, with individual rebates capped at 2013-2016 average consumption levels, or $20 million per year per company – whichever is lower. On average, industrial electricity prices can be reduced by up to 25 percent through the program.		X		X	
QC	Western Climate Initiative (WCI)	On January 1, 2013, Québec joined California in the WCI. The Cap-and-trade program has a floor price of $18 in 2018, expected to rise to $28 in 2022. Industries emitting 25,000 metric tons or more of CO_2 equivalent a year are subjected to the Québec Cap and Trade System for Greenhouse Gas Emissions Allowances.	X			X	

	Quebec's Ministry of Natural Resources / Transition Énergétique Québec (TEQ) – ÉcoPerformance	TEQ provides financial assistance for energy efficiency and conversion projects - funding may cover up to 50% of eligible expenses up to an amount of $100k/$300k per site for small/large consumers.		X			
NS	Government of Nova Scotia	Cap-and-trade system in development following the announcement of a federal backstop pricing system.	X			X	
Utility providers							
BC	FortisBC - Incentives and equipment rebates for industrial facilities	Funding for plant-wide audits, feasibility studies and energy-efficiency upgrades, e.g. Steam trap audit and replacement rebates of 50% up to $10,000 for the audit and $250 per failed steam trap replaced.		X			X
SK	SaskPower – Industrial Energy Optimization Program (IEOP)	Customized technical assistance to identify and implement energy management and capital projects, with financial assistance (50% of the project cost, up to $500,000 for an energy efficiency capital project).		X			
MB	Manitoba Hydro - Industrial Power Smart Programs	Natural Gas Optimization Program for technical support and financial incentives to identify, evaluate and implement energy efficiency projects throughout their facilities (up to 50% of the project cost, up		X			

		to a maximum of $100,000 for energy efficiency measures).					
ON	Enbridge – Energy Management Industrial Programs	Custom and fixed incentives for customers as well as a Comprehensive Energy Management Program.		X			X
ON	Union Gas - Process Improvement Studies	Industrial Customers Incentive •66% up to $20,000 •New: study top-up Additional 34% to a maximum of $20,000		X			
QC	Énergir – Implementation of energy efficiency measures grant	Financial assistance to promote feasibility studies, including energy saving studies, and implement energy efficiency measures for a more efficient use of natural gas - $0.25 per cubic metre of natural gas saved for a maximum of $100,000.		X			
NB	NB Power – Energy Smart Industrial Program	Providing financial incentives and advice to industrial facilities - up to $20,000 to assess energy efficiency upgrades, up to $300,000 in incentives for implemented measures, and, if eligible, up to $150,000 in incentives for Energy Management Information System (EMIS).		X			X