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Special Report

PSR 652

July 2011

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Benchmarking Energy Use in Pulp and Paper Operations for 2008-2010

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Special Report

BENCHMARKING ENERGY USE IN PULP AND PAPER OPERATIONS FOR 2008-2010

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ACKNOWLEDGEMENTS

The development of this benchmarking study report was made possible by a financial contribution from Natural Resources Canada.

Additional funding was provided by Enbridge Gas Distribution Inc., Union Gas Ltd., BC Hydro, Fortis BC, Hydro-Québec and CEATI Customer Energy Solutions Interest Group, including contributions from Manitoba Hydro, Ontario Power Authority, and SaskPower.

ABSTRACT

We conducted benchmarking comparisons of the energy use in 35 mills producing pulp, paper and board from chemical, mechanical and recycled pulp for the period 2008 to 2010. The energy usage was reported by process area following a procedure developed for the International Energy Agency. Reporting energy usage by process area, instead of for the entire mill site, allowed meaningful comparisons of the energy usage for mills with widely varying processes and configurations. The results were compared with those from a similar study of the energy use in 49 pulp, paper and board mills for the period from 2002 to 2004.

RÉSUMÉ

Durant la période de 2008 à 2010, nous avons procédé à une analyse comparative de la consommation d'énergie dans 35 usines qui fabriquaient de la pâte, du papier et du carton à partir de pâtes chimiques, mécaniques et recyclées. Nous avons présenté la consommation d'énergie par secteur de fabrication plutôt que pour toute l'usine, selon une méthode élaborée pour l'Agence internationale de l'énergie, ce qui a permis de comparer de façon concrète la consommation d'énergie d'usines dont les configurations et les procédés sont très divers. Ces résultats ont été comparés à ceux obtenus lors d'une étude similaire de la consommation d'énergie dans 49 usines de pâtes, papiers et cartons pour la période de 2002 à 2004.

KEYWORDS

PULP MILLS, PAPER MILLS, OPERATIONS, ENERGY CONSUMPTION, DATA RECORDING, EFFICIENCY.

Introduction

We conducted benchmarking comparisons of the energy use in 35 mills producing pulp, paper and board from chemical, mechanical and recycled pulp for the period 2008 to 2010. A similar benchmarking study was conducted for 49 pulp, paper and board mills for the period from 2002 to 2004 [1]. In this report, we present the results for the current study (2008-2010) and make comparisons with the results for the earlier study (2002-2004).

Method

The energy usage in the pulp and paper mills was reported by process area following the procedure described elsewhere [2]. This procedure was prepared by an international project team led by researchers from FPInnovations operating under a mandate from the International Energy Agency (IEA). It is similar to the method used in the earlier study [3]. Reporting energy usage by process area, instead of for the entire mill site, allows meaningful comparisons of energy usage for mills with widely varying processes and configurations.

The energy use for process areas was determined in the following four steps:

1. Divide the mill into process areas defined by their product;
2. Collect data on energy inputs and outputs, fibre production and data quality for the whole mill and for each individual process area;
3. Reconcile the data; an estimate of data quality is used to weight the needed corrections;
4. Calculate specific energies for each process area from the reconciled data.

Process Areas

The mill was divided into three types of process areas: energy conversion, pulp manufacturing and paper manufacturing. Each area is defined by its product. Figure 1 shows the process areas of a pulp and paper mill that produces newsprint and kraft market pulp from thermomechanical and kraft processes.

In the energy conversion areas, e.g. power boiler, purchased and self-generated energy are converted to fuel, steam and electricity for use in process areas or for sale. The energy conversion areas are defined by their energy product, e.g. steam. Purchased energy includes fuels, electricity and steam. Self-generated energy includes hog fuel, spent pulping liquor and hydroelectric power.

In the pulp manufacturing areas, e.g. kraft pulping, energy and fibre resources are used to produce intermediate fibre products such as wood chips and pulp. The pulp manufacturing areas are defined by their fibre product. Some areas, such as kraft evaporators, do not produce fibre products. The product for these areas is the fibre product associated with their operation. Thus, the product for kraft evaporators is the unbleached kraft pulp produced in making the black liquor. The kraft recovery boiler is included in the pulp manufacturing area since it is integral to the production of unbleached kraft pulp. The production for each area is expressed on an oven-dried basis.

In the product manufacturing areas, e.g. pulp machine, energy and pulp are used to produce final fibre products such as market pulp, paper and board. The production for these areas is expressed in terms of finished product, ready for sale, whether shipped or inventoried. Some areas, such as water treatment, do not produce fibre products. The product for these areas is the total mill production of market pulp, paper and board. The production for each area is expressed on an air-dried basis (10% moisture).

Technology descriptors were reported for the energy conversion and pulp and product manufacturing areas to account for different energy use by different technologies used to produce the same product. For example in kraft pulping, the energy use varies with the digester technology, e.g. batch or continuous.

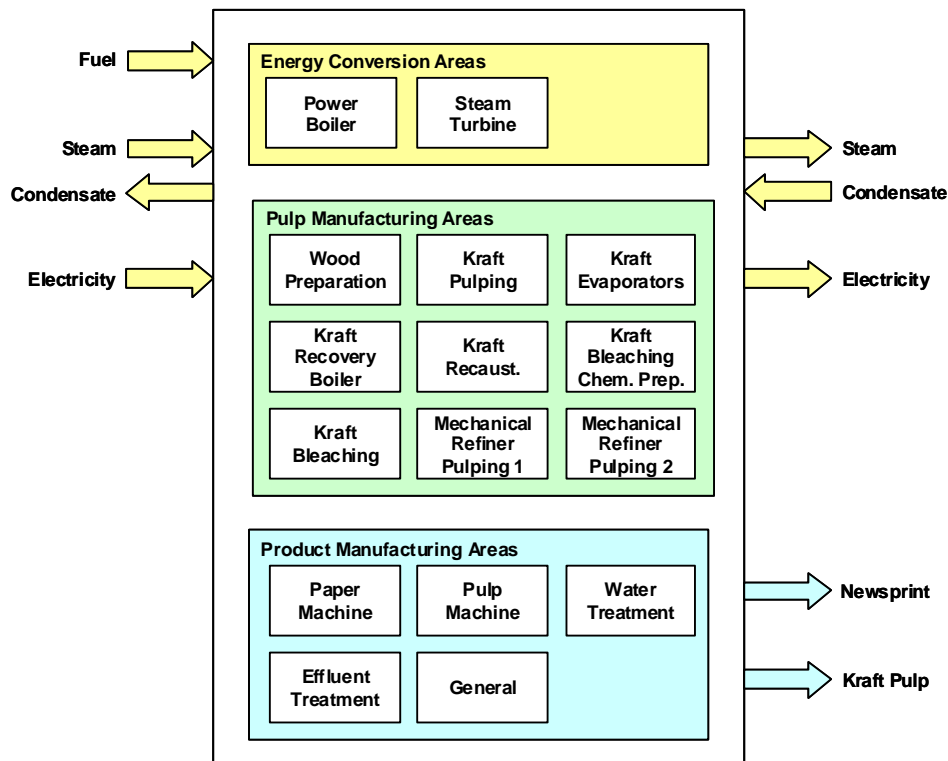


Figure 1. A diagram of a pulp and paper mill showing energy conversion, pulp manufacturing and product manufacturing areas. This mill produces newsprint and kraft market pulp from thermomechanical pulp (TMP) and kraft pulp.

Data Collection

Energy and fibre data were collected for the entire mill and for individual process areas, typically for four consecutive quarters. Data were reported separately for three classes of energy: fuel, heat and power.

Three types of fuel were reported depending on their source: fossil fuel, biofuel and other fuel, e.g. tires. The energy content for each fuel type was reported as gross calorific value, i.e. higher heating value.

Only heat energy of high value (temperature) was reported: steam, condensate and hot water. Hot water was included to allow for meaningful comparisons among a few areas, e.g. kraft bleaching, where heating demands can be met by steam or by clean hot water produced elsewhere from condensing steam, such as from kraft evaporators.

Data Reconciliation

Ideally, all the energy inputs to the mill would be allocated to the areas in the mill and to any energy sales, i.e. energy inputs and outputs would balance. Realistically, there is not a perfect energy balance due to instrument measurement errors and estimations when measurements are unavailable. The data quality was reported along with the amount of energy and fibre. The data quality was used to weight the corrections needed to reconcile the data so that energy inputs and outputs balanced. The data quality factors and their weights are given in Table I.

A. Reliable instrumentation with good calibration	0
B. Less reliable instrumentation	1
C. Calculated by heat and material balance from measured values	2
D. Estimated when measurements unavailable	4

Calculations

The specific energy consumption is the energy consumed by an area, e.g. kWh electricity, divided by its production, e.g. oven-dried tonnes unbleached kraft pulp. The specific energy production is the energy produced by an area divided by its production. The specific energies were calculated using the reconciled data.

Three additional energy values were calculated from the reconciled energy data: total fuel, net steam and total heat. Total fuel consumed by an area is the sum of the fossil fuel, biofuel and other fuels consumed by the area. The net steam consumed by an area is the enthalpy of the steam consumed less the enthalpy of the condensate returned to the boiler area. The net steam produced by an area is the enthalpy of the steam produced less the enthalpy of the condensate consumed.

The total heat consumed by an area is the net steam consumed plus the enthalpy of the hot water consumed. The total heat produced by an area is the net steam produced plus the enthalpy of the hot water produced.

Results

Data Analysis

We collected energy and production data from 35 mills on a quarterly basis. For most mills, we collected four consecutive quarters of data. Twenty-three of the mills also participated in the earlier energy benchmarking survey [1]. The distribution of mills by pulping process and product type is shown in Table II. Several mills in the survey had multiple pulping processes and/or multiple product types.

Table II. Distribution of mills by pulping process and product type.

Total number of mills	35
Mills by pulping process	
Mechanical pulping	18
Kraft pulping	14
Recycled pulping	13
Sulphite pulping	1
Mills by product type	
Pulp	16
Paper other than newsprint	14
Newsprint	14
Board	4

The difference between the energy inputs (purchased and produced) and energy outputs (consumed and sold) for a mill is an indication of how well the energy was allocated to the energy conversion and manufacturing areas. The average and 90-percentile values for the difference between energy inputs and energy outputs are shown in Table III.

Table III. Data quality. Difference between energy inputs and energy outputs in data reconciliation.

	Energy inputs – Energy outputs, %	
	Average	90-Percentile
Fossil fuel	4.1	11.7
Biofuel	0.7	2.1
Other fuel	0	0
Steam	5.7	15.6
Condensate	6.5	18.8
Hot water	0	0
Electricity	2.2	6.1

The differences between energy inputs and energy outputs for steam and electricity in the current survey were similar to those the earlier survey [1]; the difference for fuels and condensate were larger than in the earlier survey. Similar to the earlier survey, the largest differences were for steam and condensate. There were no difference for other fuel and hot water, as these energy types were typically consumed in one area and the consumed values were set equal to the produced or purchased values.

Similar to the earlier survey [1], there were some problems in allocating the electricity to process areas. The power distribution and metering sometimes were not arranged by process area. The total electricity consumption was correct, but the allocation to some process areas was not reliable for some mills. However, the power was well measured in areas such as mechanical pulping and steam generators where there was significant electricity consumption or production.

Generally, the process area definitions in the current and earlier surveys were identical, allowing direct comparisons between the current and earlier results [1, 2]. However, the definitions for kraft recovery boiler, power boiler and kraft bleaching were different for the two methods. Common process areas definitions were used for these areas: the kraft recovery boiler and power boiler areas included the boiler and deaerator; the kraft bleaching area included bleaching and bleaching chemicals preparation. As in the earlier survey, results are shown only for process areas with data from three or more companies in order to maintain confidentiality.

Pulp Manufacturing Areas

The specific energy consumption and production of the pulp manufacturing areas are shown in Tables IV to VII. The tables show the 25-percentile, median, 75-percentile and average specific energies. The average specific energy is the total energy divided by total production for the process area in all the mills. Detailed results including the specific energy distributions are given in the Appendix A. The tables also show the average specific energies in the earlier survey [1].

Table IV. Total fuel consumption of pulp manufacturing areas. Fuel consumption for kraft recovery boiler is fossil fuel and biofuel; fuel consumption for kraft recausticizing also includes other fuel. The kraft recovery boiler area includes the deaerator.

	Total Fuel Consumed, GJ/o.d. t				
	25-Percent.	Median	75-Percent.	Average	Average 2004 [1]
Kraft Recovery Boiler - Low Odour	24.3	27.7	31.0	27.4	26.7
Kraft Recausticizing	2.0	2.2	2.5	2.3	2.1

Table V. Total heat production of pulp manufacturing areas. Heat production for kraft evaporators is hot water; heat production for the remaining areas is net steam. The kraft recovery boiler area includes the deaerator.

	Total Heat Produced, GJ/o.d. t				
	25-Percent.	Median	75-Percent.	Average	Average 2004 [1]
Kraft Evaporators - Indirect Contact	0	0	0	0.2	0
Kraft Recovery Boiler - Low Odour	18.4	19.6	22.1	20.0	19.4
Mechanical Refiner Pulping - TMP for Newsprint	2.5	2.6	3.7	3.2	2.0
Mechanical Refiner Pulping - TMP for Paper	0	0.9	4.5	2.6	1.2

Table VI. Total heat consumption of pulp manufacturing areas. Heat consumption for kraft bleaching is hot water and net steam; heat consumption for the remaining areas is net steam. The kraft recovery boiler area includes the deaerator. The kraft bleaching area includes the kraft bleaching chemical preparation area.

	Total Heat Consumed, GJ/o.d. t				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Wood Preparation	0	0	0	0	0
Kraft Pulping - Continuous	2.6	3.5	4.0	3.2	2.9
Kraft Pulping - Batch	4.4	4.5	5.2	5.1	4.8
Kraft Evaporators - Indirect Contact	5.4	6.6	8.2	6.2	5.5
Kraft Recovery Boiler - Low Odour	3.2	4.1	5.2	4.4	4.2
Kraft Reausticizing	0.1	0.3	0.5	0.4	0.2
Kraft Bleaching - Softwood	2.2	2.9	3.5	3.3	3.6
Mechanical Refiner Pulping - TMP for Newsprint	0.5	0.9	1.2	0.8	0.9
Mechanical Refiner Pulping - TMP for Paper	0.1	0.3	0.8	0.6	0.6
Mechanical Peroxide Bleaching	0	0.1	0.6	0.5	0.3
Recycled Pulping	0	0	0.3	0.2	0.4

Table VII. Total electricity consumption of pulp manufacturing areas. The kraft recovery boiler area includes the deaerator. The kraft bleaching area includes the kraft bleaching chemical preparation area.

	Electricity Consumed, kWh/o.d. t				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Wood Preparation	18	28	39	31	24
Kraft Pulping - Continuous	170	206	271	198	177
Kraft Pulping - Batch	232	237	290	230	188
Kraft Evaporators - Indirect Contact	8	37	46	31	16
Kraft Recovery Boiler - Low Odour	56	80	106	85	101
Kraft Recausticizing	25	36	54	39	38
Kraft Bleaching - Softwood	154	215	324	201	169
Mechanical Refiner Pulping - TMP for Newsprint	2597	2659	2850	2600	2621
Mechanical Refiner Pulping - TMP for Paper	2597	2799	3371	2907	2820
Mechanical Peroxide Bleaching	59	90	132	104	169
Recycled Pulping	236	343	419	325	336

Product Manufacturing Areas

The specific energy consumption and production of the product manufacturing areas are shown in Tables IX and X. Detailed results including the specific energy distributions are given the Appendix A. The tables also show the average specific energies in the earlier survey [1].

Table IX. Total heat consumption of product manufacturing areas. Heat consumption is net steam.

	Total Heat Consumed, GJ/a.d. t				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Paper Machine - Newsprint	4.7	5.2	5.8	5.2	5.7
Paper Machine - Uncoated Mechanical	4.8	5.7	6.8	5.7	6.0
Board Machine	3.5	4.1	4.7	3.9	7.5
Pulp Machine - Steam Dryer	4.0	4.9	5.4	4.5	4.5
Water Treatment	0	0	0	0	0
Effluent Treatment - Activated Sludge	0	0	0	0	0
Effluent Treatment - Aerated Lagoon	0	0	0	0	0.2
General/Buildings	0	0.3	0.6	0.5	0.4

Table X. Electricity consumption of product manufacturing areas.

	Electricity Consumed, kWh/a.d. t				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Paper Machine - Newsprint	545	622	686	618	573
Paper Machine - Uncoated Mechanical	529	690	817	703	703
Board Machine	276	338	397	309	561
Pulp Machine - Steam Dryer	113	143	210	140	153
Water Treatment	16	26	47	33	32
Effluent Treatment - Activated Sludge	24	41	55	43	54
Effluent Treatment - Aerated Lagoon	43	51	68	52	65
General/Buildings	9	39	66	42	34

Energy Conversion Areas

The specific energy consumption and production of the energy conversion areas are shown in Tables XI to XIV. Detailed results including the specific energy distributions are given the Appendix A. The tables also show the average specific energies in the earlier survey [1].

Table XI. Total fuel consumption of power boilers. Fuel consumption is fossil fuel, biofuel and other fuel. The power boiler area includes the deaerator.

	Total Fuel Consumed, GJ/GJ				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Power Boiler	1.1	1.3	1.5	1.4	1.4

Table XII. Total heat consumption of power boilers. Heat consumption is net steam. The power boiler area includes the deaerator.

	Total Heat Consumed, GJ/GJ				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Power Boiler	0.1	0.1	0.1	0.1	0.1

Table XIII. Electricity consumption of power boilers. The power boiler area includes the deaerator.

	Electricity Consumed, GJ/GJ				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Power Boiler	4	8	17	9	7

Table XIV. Total heat consumption of steam turbines. Heat consumption is net steam.

	Total Heat Consumed, MJ/kWh				
	25- Percent.	Median	75- Percent.	Average	Average 2004 [1]
Steam Turbine - Back-Pressure	3.7	3.7	3.9	3.9	4.0
Steam Turbine - Condensing	5.9	9.2	12.6	7.5	8.9

Discussion

The most striking observation from the results is how similar the specific energy values in the current survey are to those in the earlier survey [1]. Except for areas where there were only minor energy consumptions, significant changes (95% confidence) were reported for only three process areas: Mechanical Refiner Pulping - TMP for Newsprint, Mechanical Refiner Pulping - TMP for Paper and Board Machine. Other areas, e.g. Kraft Evaporators - Indirect Contact, had notable changes but these changes were small relative to their range of values.

For TMP refining for newsprint areas, the average specific heat production increased from 2.0 to 3.2 GJ/o.d. t. This increase resulted from the increase of refining lines with heat recovery from 58 to 92% of pulp production. Similarly for TMP refining for paper areas, the average specific heat production increased from 1.2 to 2.6 GJ/o.d. t. This increase resulted from the increase of refining lines with heat recovery from 40 to 63% of pulp production.

There were four board machines in the current survey and five in the earlier survey. The average specific heat consumption decreased from 7.5 to 3.9 GJ/a.d. t and the average specific electricity consumption decreased from 561 to 309 kWh/a.d. t. However, three of the board machines in the earlier survey produced coated board, compared with none in the current survey, and thus are expected to consume more energy.

There were changes in process technology between the two surveys from those with higher energy consumption to those with lower energy consumption for producing the same product, e.g. kraft pulping (batch to continuous), kraft evaporators (direct to indirect contact). This was due in part to which mills participated in survey, and in part to closures of process areas with higher energy consumption. There was also a change in mechanical paper production from newsprint to uncoated and coated mechanical paper due in part to conversions and closures of newsprint paper machines.

Conclusions

- Energy consumption and production data were presented for individual process areas in 35 pulp and paper mills.
- For most process areas, the specific energy values were similar to those in the earlier benchmarking study for the period 2002 to 2004.
- There was an increase in the specific heat production for mechanical refiner pulping due to a larger fraction of refiner lines having heat recovery.
- There were changes in process technology from those with higher energy consumption to those with lower energy consumption for producing the same product.

References

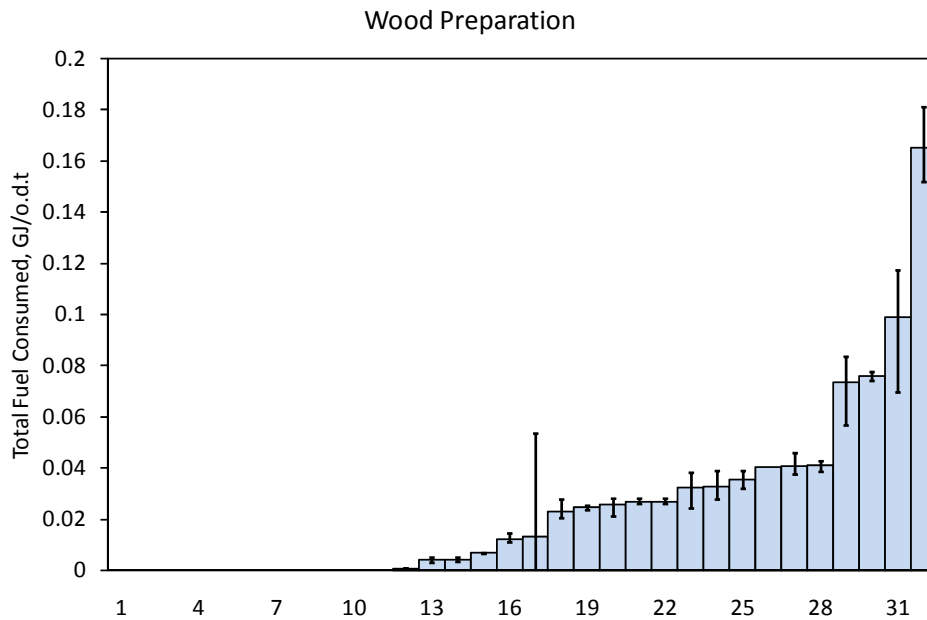
1. Francis D.W. and Towers M.T. Benchmarking Energy Use in Pulp and Paper Operations, PRR 1762, June 2005.
2. Francis D.W. and Browne T.C. Reporting Guidelines for Energy Use in Pulp and Paper Operations, PSR 589, February 2008.
3. Francis DW. Method for Benchmarking Energy Use in Pulp and Paper Operations, PPR 1596, May 2002.

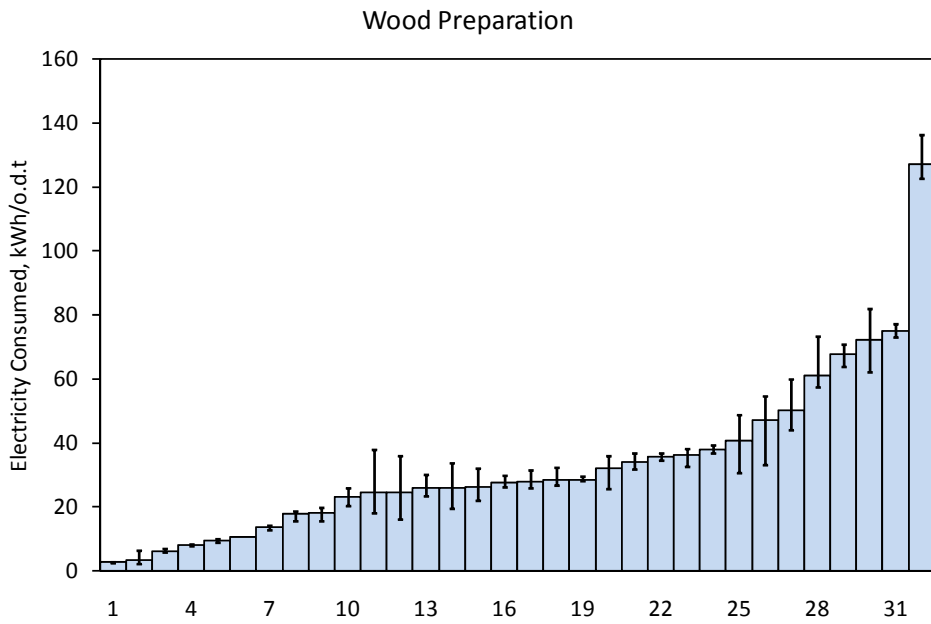
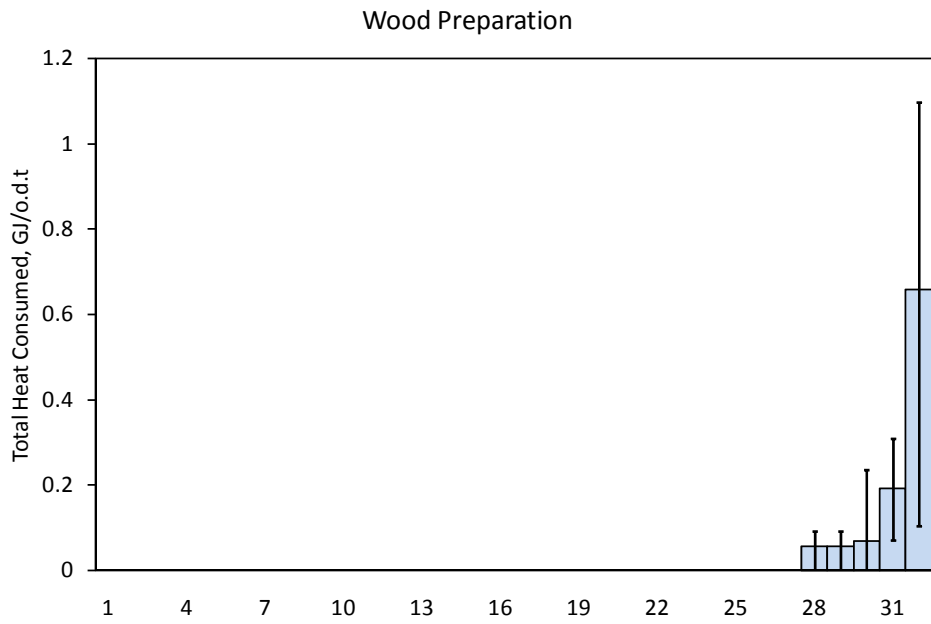
Appendix A – Energy Data for Process Areas

The energy data for the pulp manufacturing, product manufacturing and energy conversion areas are shown in the following tables and figures. In the figures, the columns show the annual energy consumption or production. The bars show the range of quarterly values.

Wood Preparation

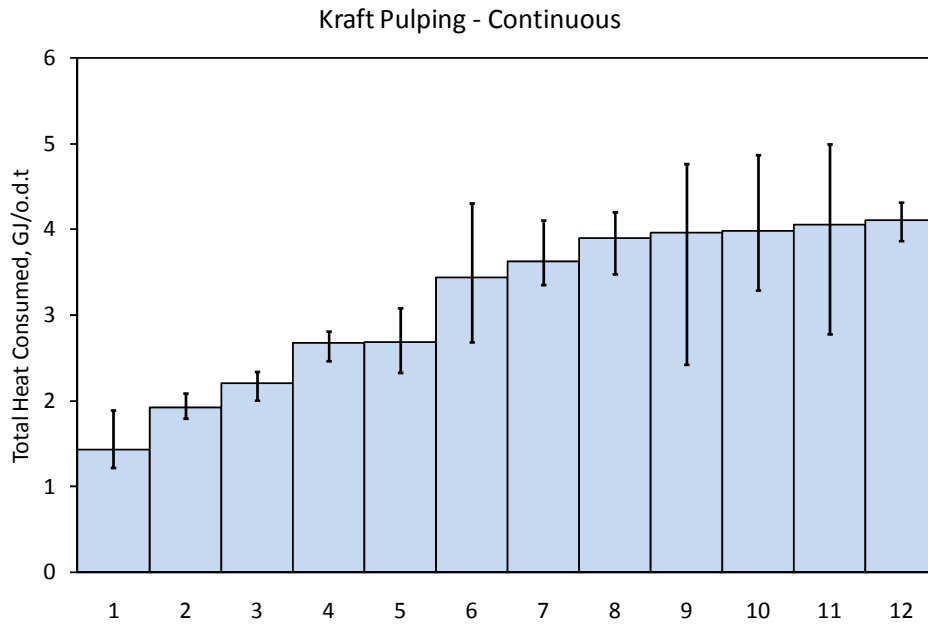
Area	Wood Preparation			
Number	32			
Production, o.d.t	1,1501,551			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0.01	0.03	0.02
Fossil Fuel Consumed, GJ/o.d.t	0	0.01	0.03	0.02
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	0	0	0	0.03
Net Steam Consumed, GJ/o.d.t	0	0	0	0.03
Hot Water Consumed, GJ/o.d.t	0	0	0	0.01
Electricity Consumed, kWh/o.d.t	18	28	39	31

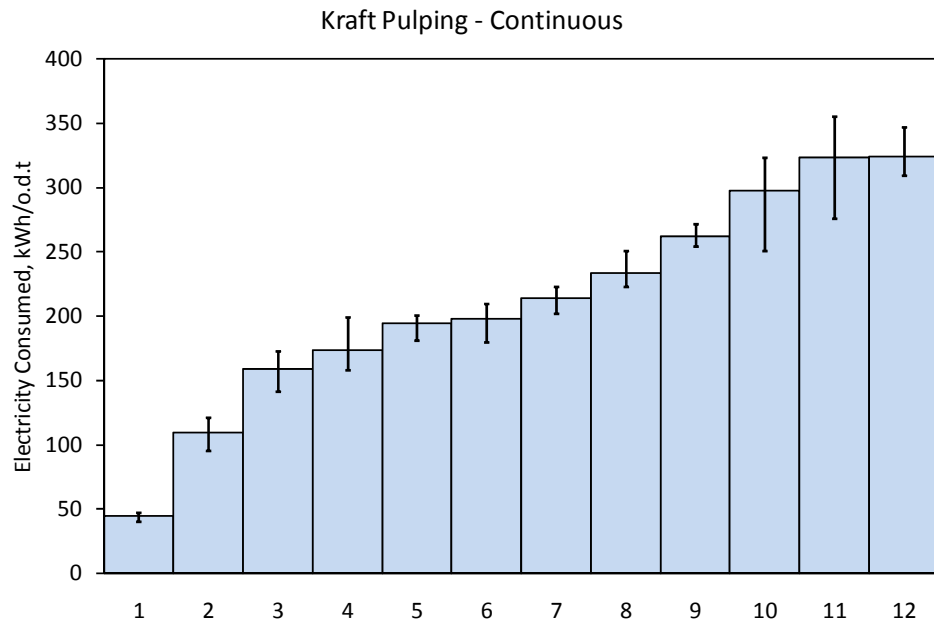




Kraft Pulping - Continuous

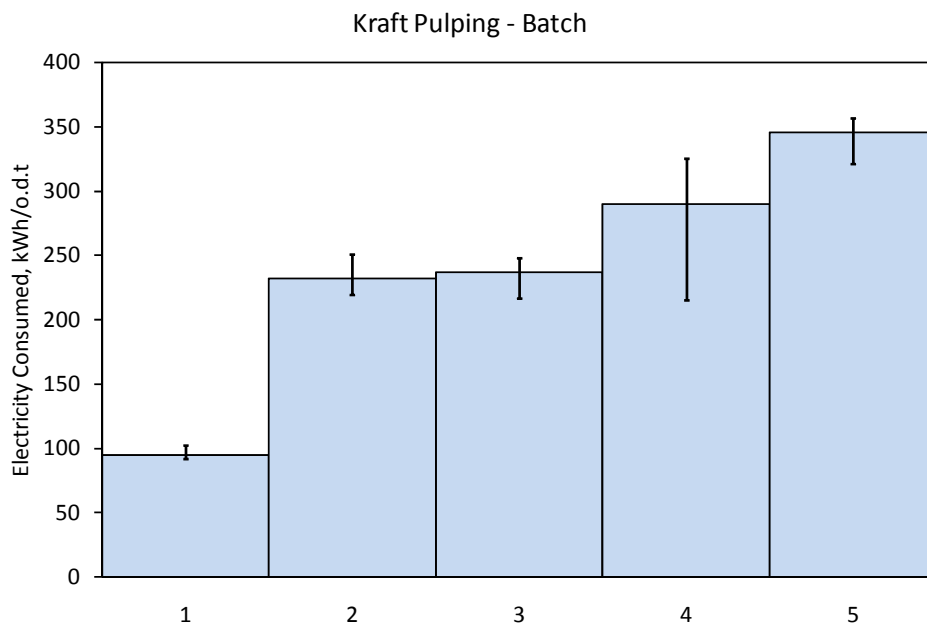
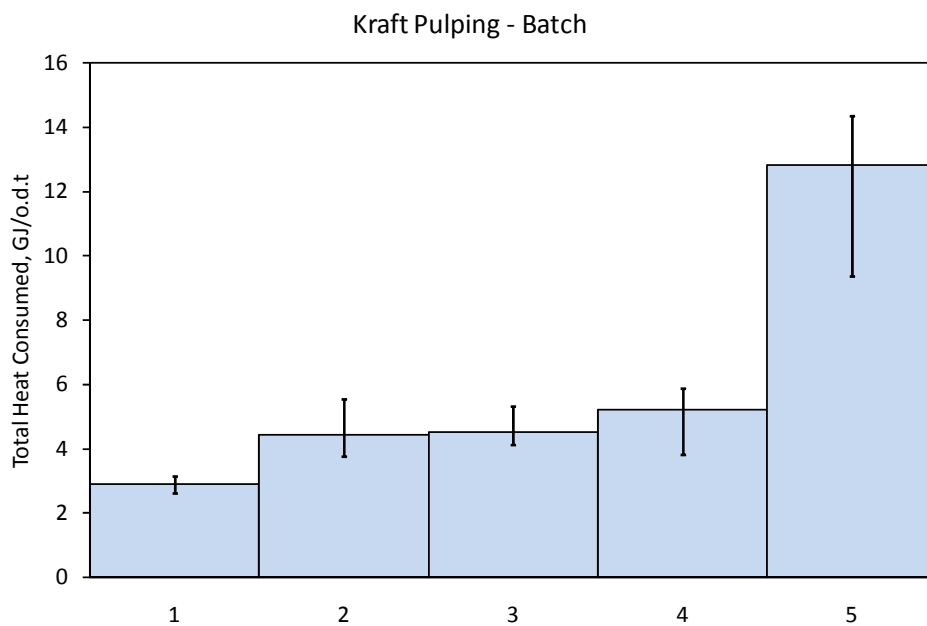
Area	Kraft Pulping - Continuous			
Number	12			
Production, o.d.t	3,117,527			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	2.56	3.54	3.97	3.16
Net Steam Consumed, GJ/o.d.t	2.56	3.54	3.97	3.16
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	170	206	271	198





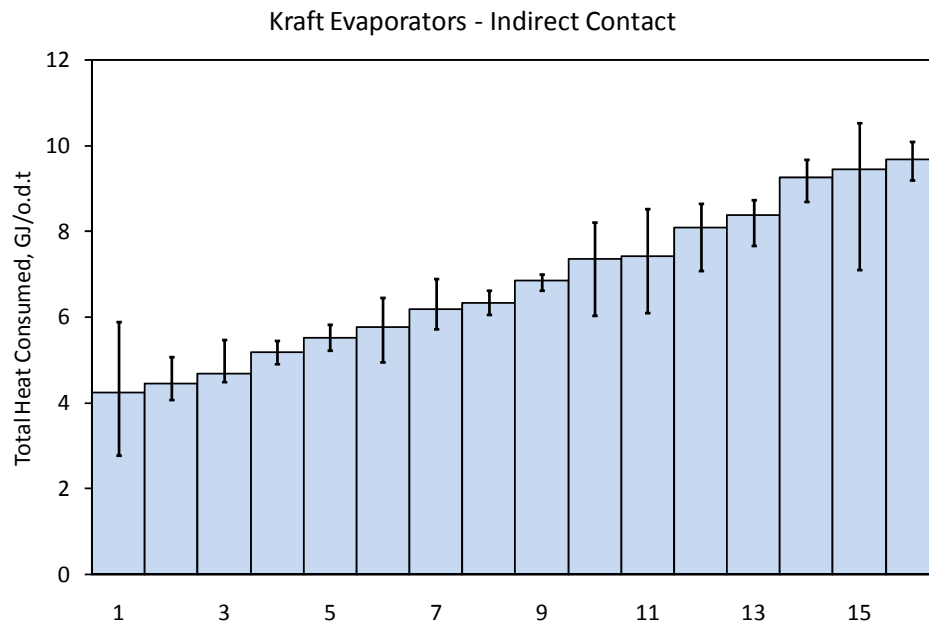
Kraft Pulping - Batch

Area	Kraft Pulping - Batch			
Number	5			
Production, o.d.t	666,094			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	4.44	4.53	5.21	5.05
Net Steam Consumed, GJ/o.d.t	4.44	4.53	5.21	5.05
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	232	237	290	230

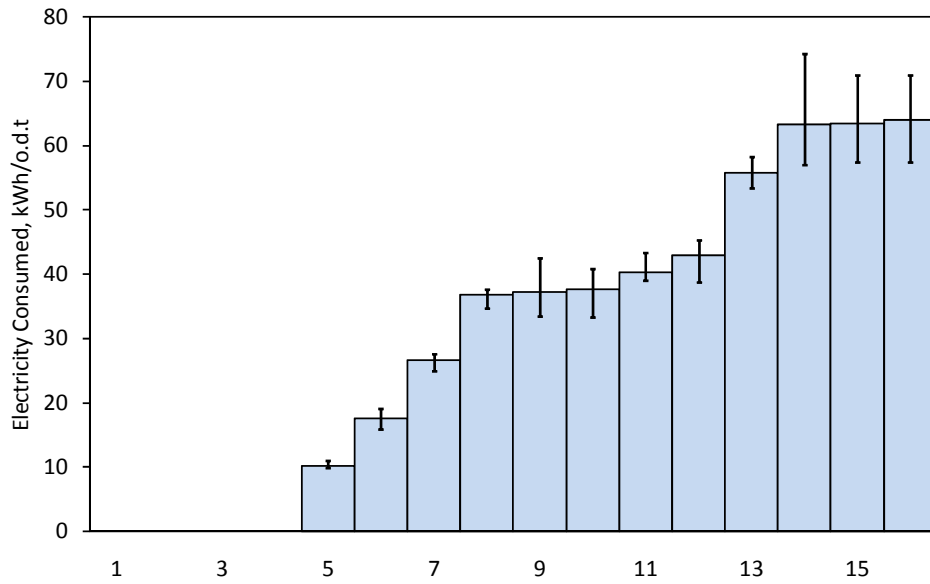


Kraft Evaporators – Indirect Contact

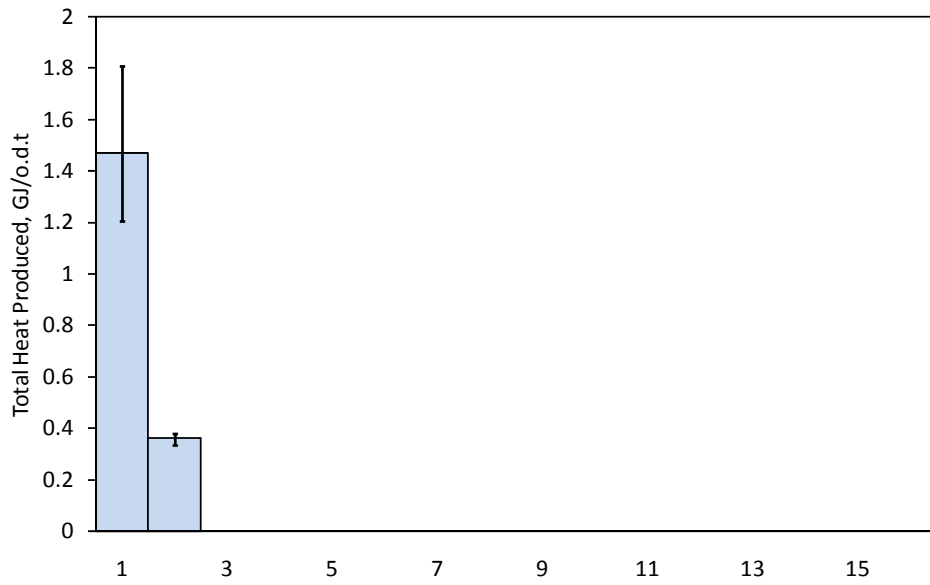
Area	Kraft Evaporators - Indirect Contact			
Number	16			
Production, o.d.t	3,607,746			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	5.43	6.60	8.17	6.20
Net Steam Consumed, GJ/o.d.t	5.43	6.60	8.17	6.20
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	8	37	46	31
Total Heat Produced, GJ/o.d.t	0	0	0	0.15
Net Steam Produced, GJ/o.d.t	0	0	0	0
Hot Water Produced, GJ/o.d.t	0	0	0	0.15



Kraft Evaporators - Indirect Contact

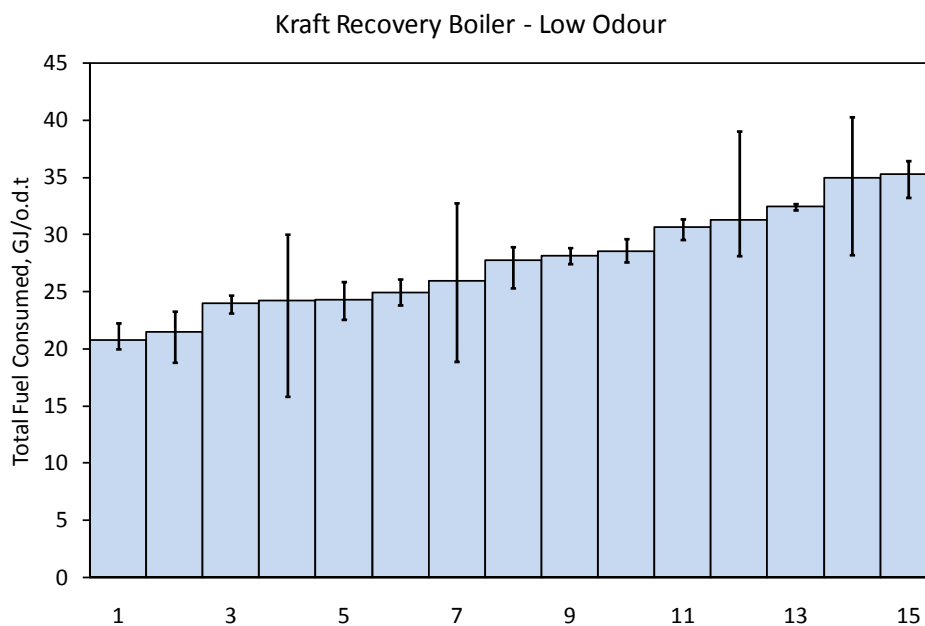


Kraft Evaporators - Indirect Contact

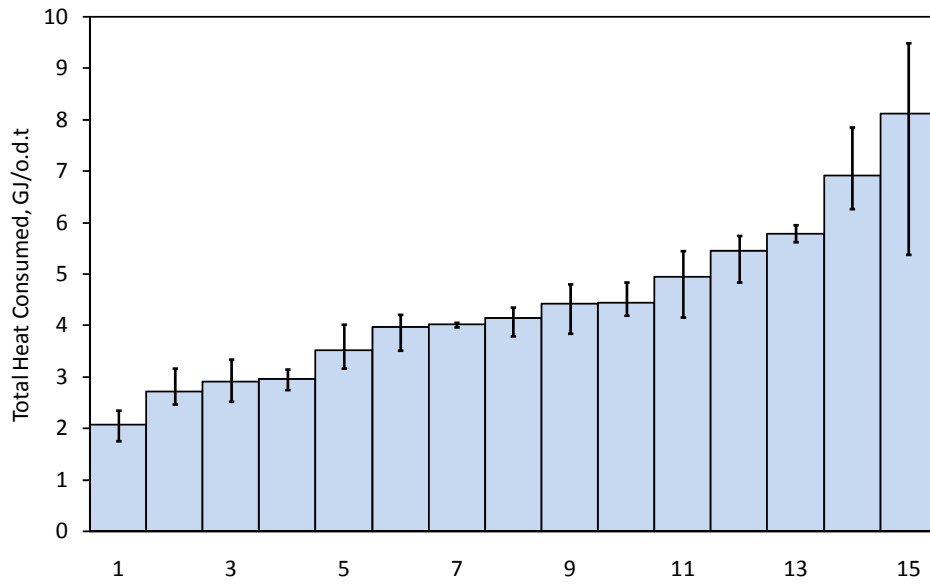


Kraft Recovery Boiler – Low Odour

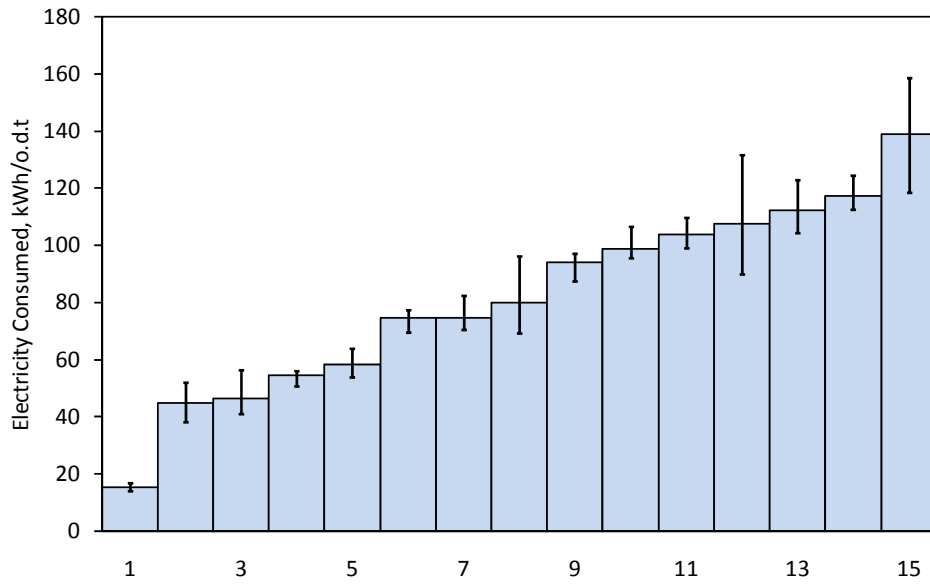
Area	Kraft Recovery Boiler - Low Odour			
Number	15			
Production, o.d.t	3,607,746			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	24.26	27.75	30.99	27.36
Fossil Fuel Consumed, GJ/o.d.t	0.07	0.38	0.64	0.45
Biofuel Consumed, GJ/o.d.t	24.12	26.52	30.45	26.91
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	3.24	4.15	5.20	4.39
Net Steam Consumed, GJ/o.d.t	3.24	4.15	5.20	4.39
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	56	80	106	85
Total Heat Produced, GJ/o.d.t	18.41	19.64	22.13	19.99
Net Steam Produced, GJ/o.d.t	18.41	19.64	22.13	19.99
Hot Water Produced, GJ/o.d.t	0	0	0	0

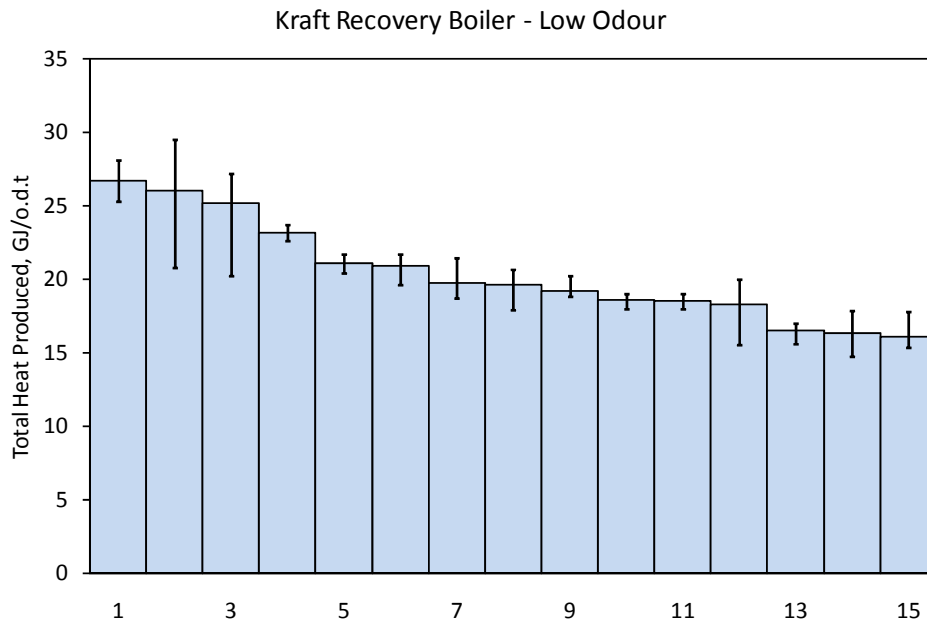


Kraft Recovery Boiler - Low Odour



Kraft Recovery Boiler - Low Odour

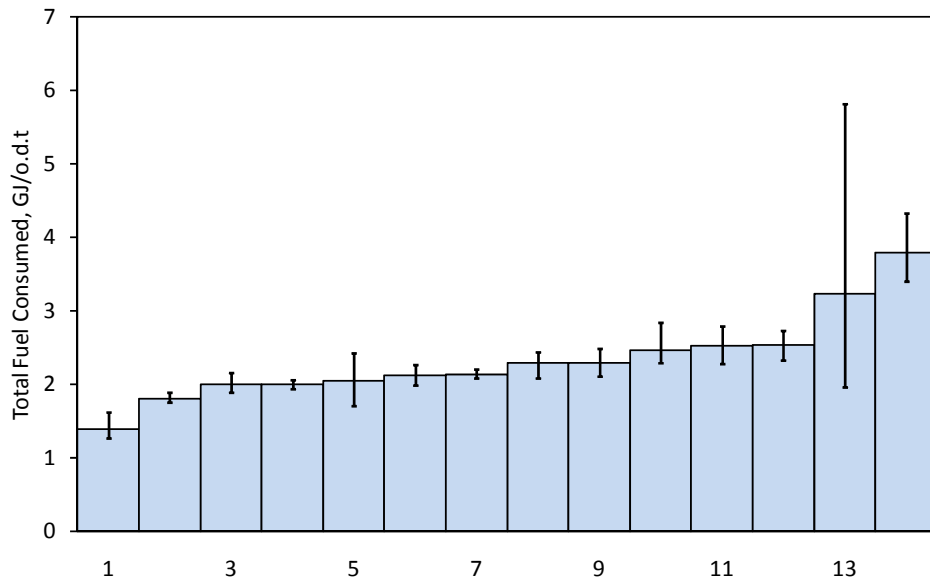




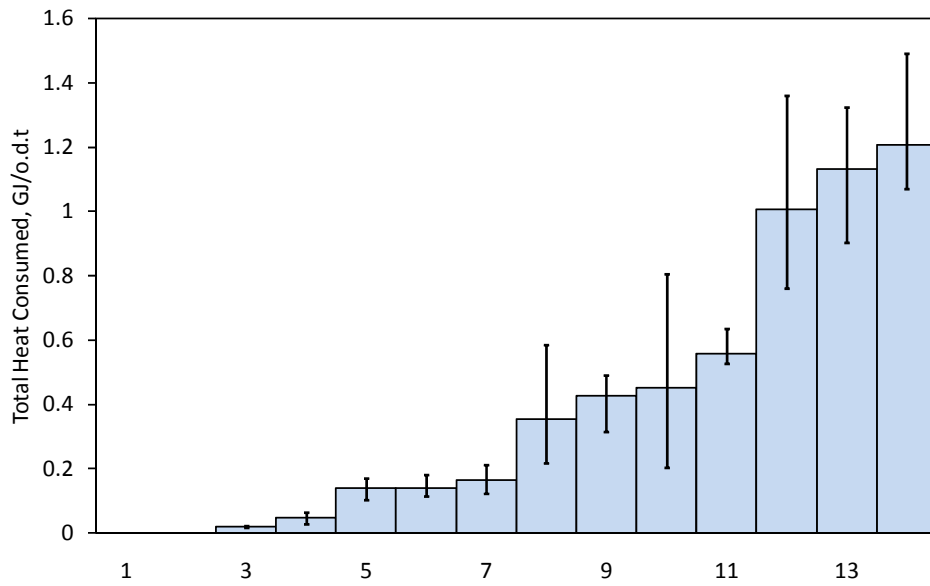
Kraft Reausticizing

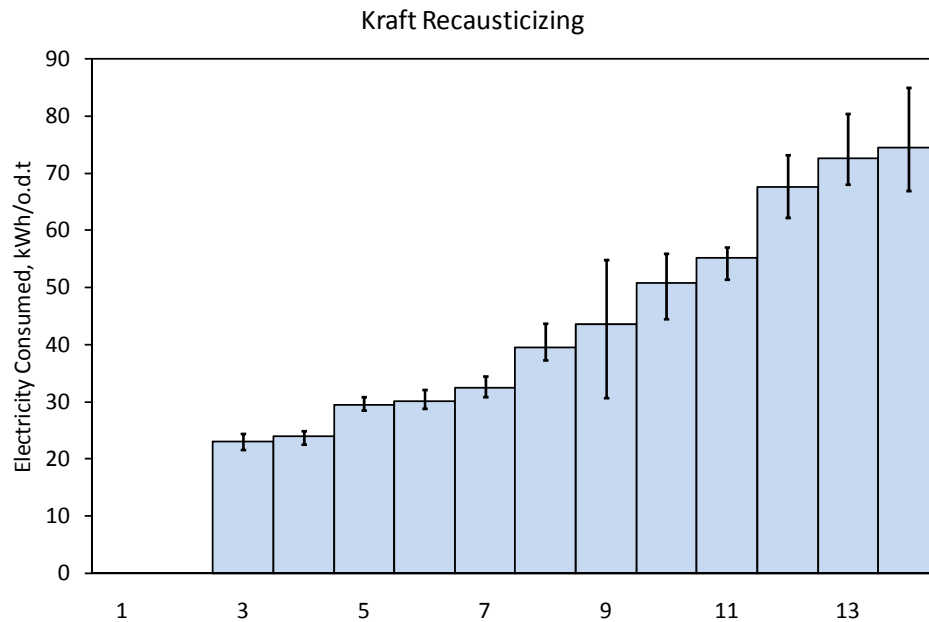
Area	Kraft Reausticizing			
Number	14			
Production, o.d.t	3,879,216			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	2.01	2.21	2.51	2.31
Fossil Fuel Consumed, GJ/o.d.t	1.92	2.09	2.51	2.16
Biofuel Consumed, GJ/o.d.t	0	0	0	0.11
Other Fuel Consumed, GJ/o.d.t	0	0	0	0.04
Total Heat Consumed, GJ/o.d.t	0.07	0.26	0.53	0.39
Net Steam Consumed, GJ/o.d.t	0.07	0.21	0.52	0.37
Hot Water Consumed, GJ/o.d.t	0	0	0	0.02
Electricity Consumed, kWh/o.d.t	25	36	54	39

Kraft Recausticizing



Kraft Recausticizing

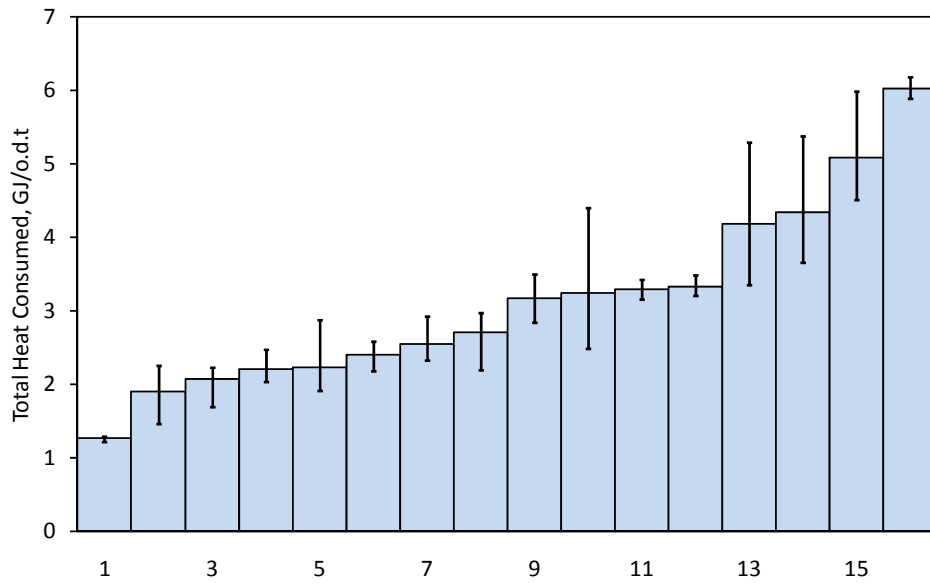




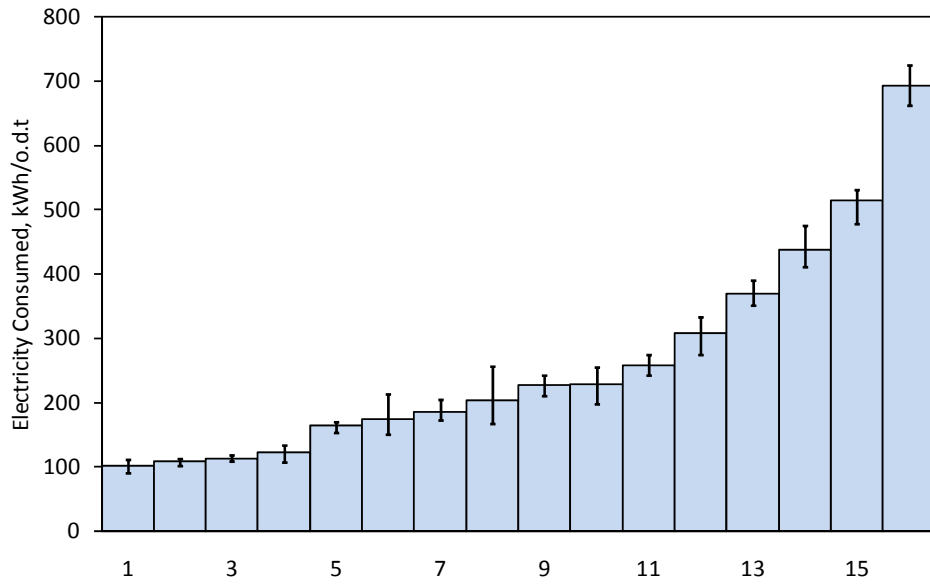
Kraft Bleaching – Softwood

Area	Kraft Bleaching - Softwood			
Number	16			
Production, o.d.t	3,436,008			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	2.23	2.94	3.54	3.35
Net Steam Consumed, GJ/o.d.t	2.39	3.14	4.78	3.04
Hot Water Consumed, GJ/o.d.t	0	0	0	0.31
Electricity Consumed, kWh/o.d.t	154	215	324	201

Kraft Bleaching - Softwood

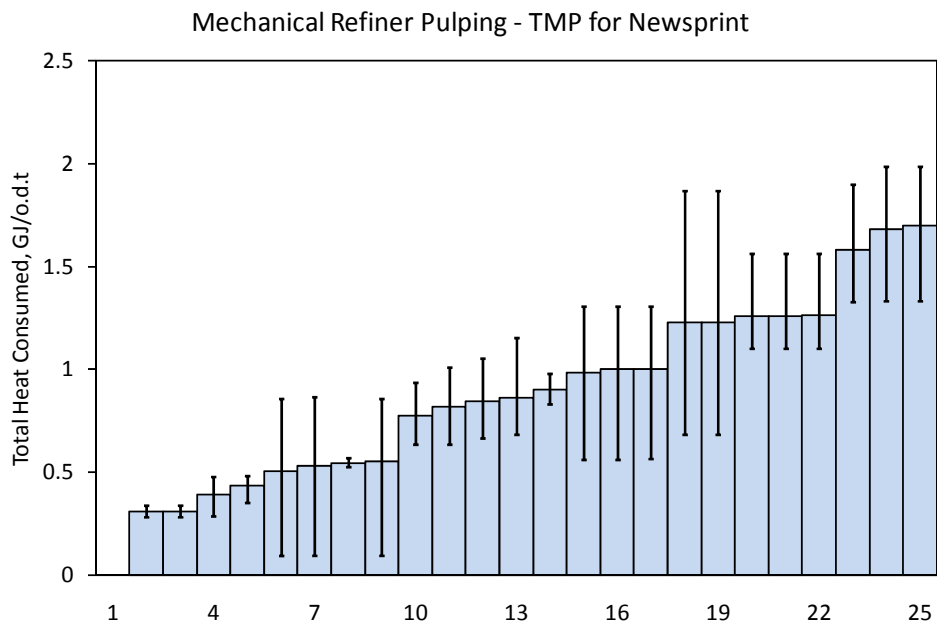


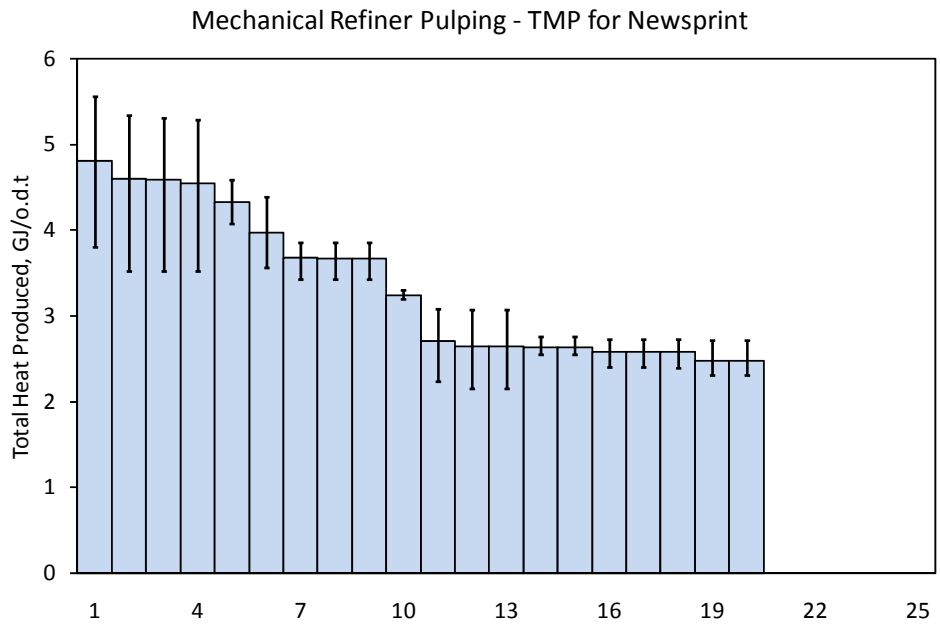
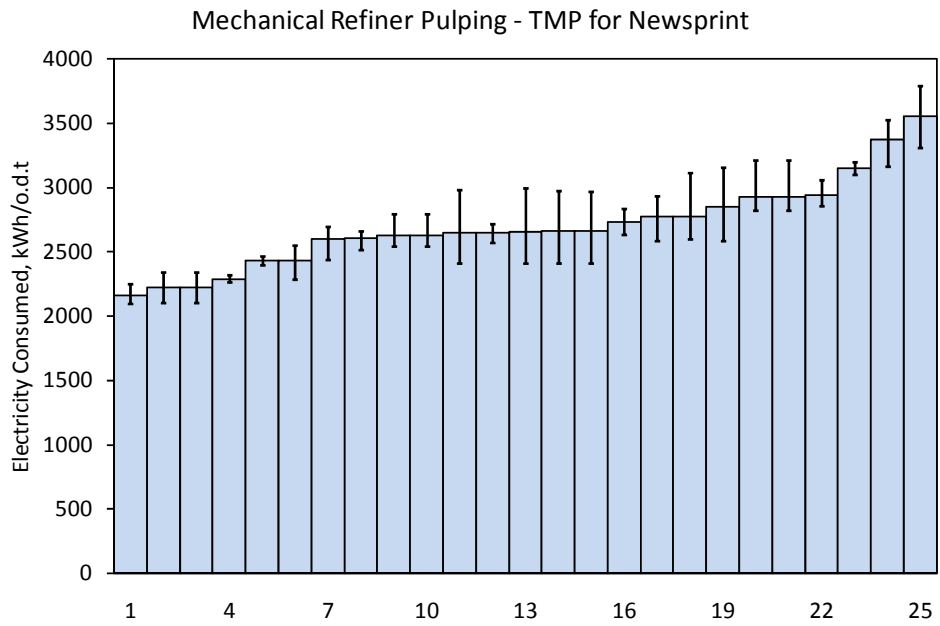
Kraft Bleaching - Softwood

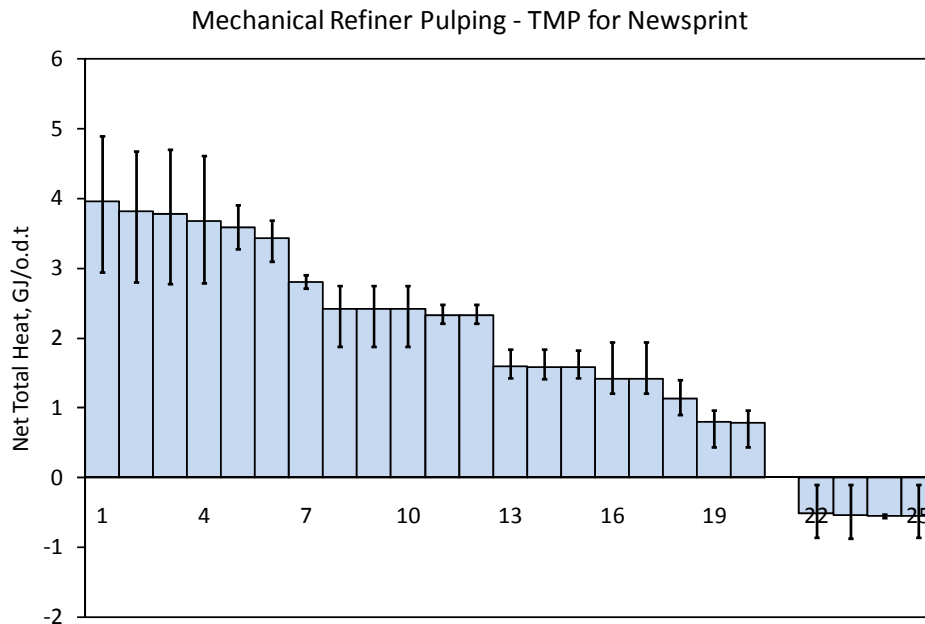


Mechanical Refiner Pulping – TMP for Newsprint

Area	Mechanical Refiner Pulping - TMP for Newsprint			
Number	25			
Production, o.d.t	2,138,475			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	0.53	0.86	1.23	0.80
Net Steam Consumed, GJ/o.d.t	0.53	0.86	1.23	0.80
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	2597	2659	2850	2600
Total Heat Produced, GJ/o.d.t	2.48	2.64	3.68	3.19
Net Steam Produced, GJ/o.d.t	2.48	2.64	3.68	3.19
Hot Water Produced, GJ/o.d.t	0	0	0	0
Net Total Heat, GJ/o.d.t	0.80	1.59	2.81	2.39
Net Total Heat = Total Heat Produced – Total Heat Consumed				



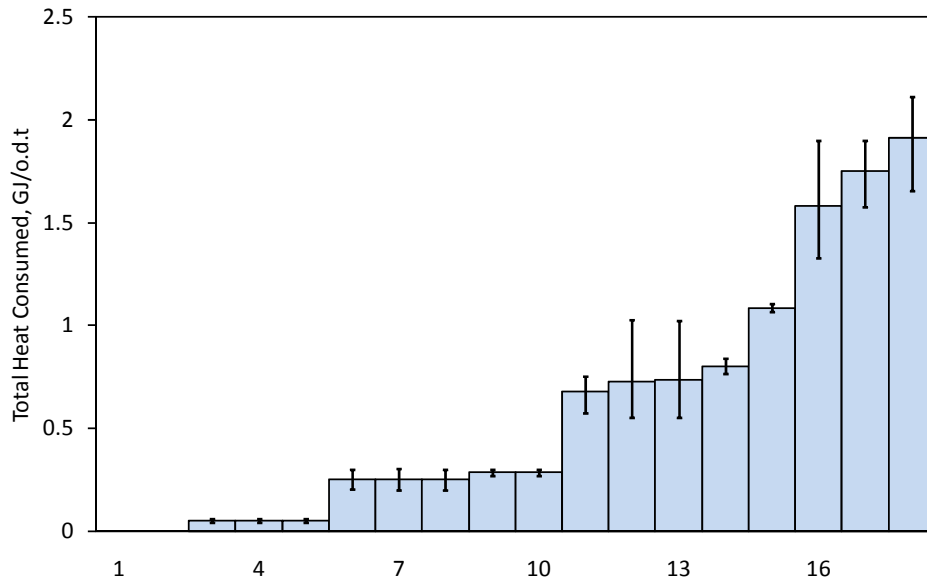




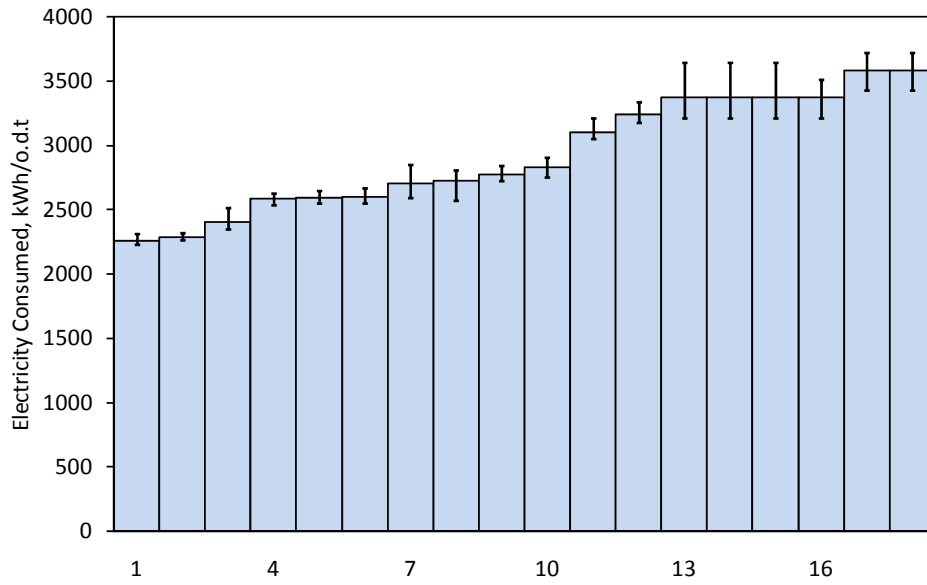
Mechanical Refiner Pulping – TMP for Paper

Area	Mechanical Refiner Pulping - TMP for Paper			
Number	18			
Production, o.d.t	1,466,983			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	0.10	0.29	0.79	0.61
Net Steam Consumed, GJ/o.d.t	0.10	0.29	0.79	0.61
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	2597	2799	3371	2907
Total Heat Produced, GJ/o.d.t	0	0.93	4.53	2.56
Net Steam Produced, GJ/o.d.t	0	0.93	4.53	2.56
Hot Water Produced, GJ/o.d.t	0	0	0	0
Net Total Heat, GJ/o.d.t	-0.05	0.53	4.27	1.95
Net Total Heat = Total Heat Produced – Total Heat Consumed				

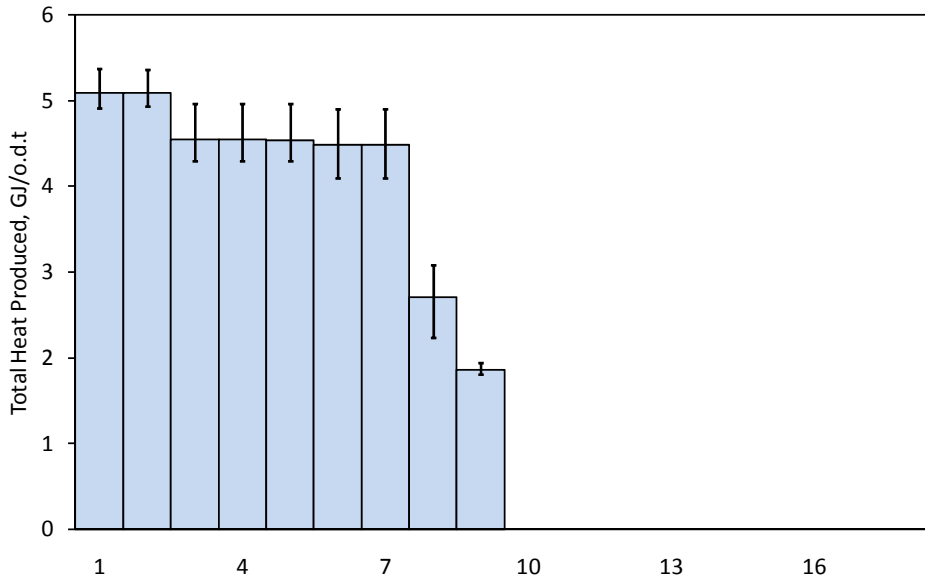
Mechanical Refiner Pulping - TMP for Paper



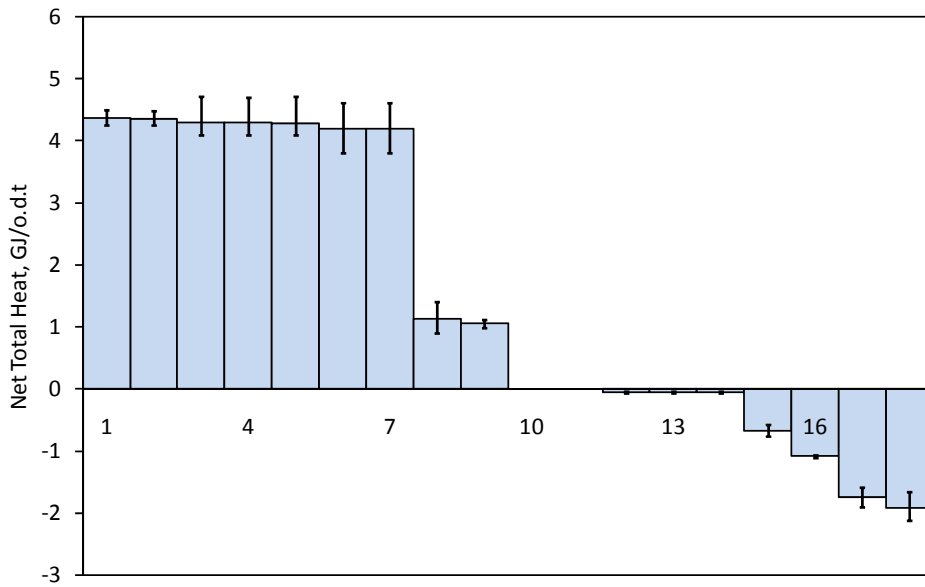
Mechanical Refiner Pulping - TMP for Paper



Mechanical Refiner Pulping - TMP for Paper

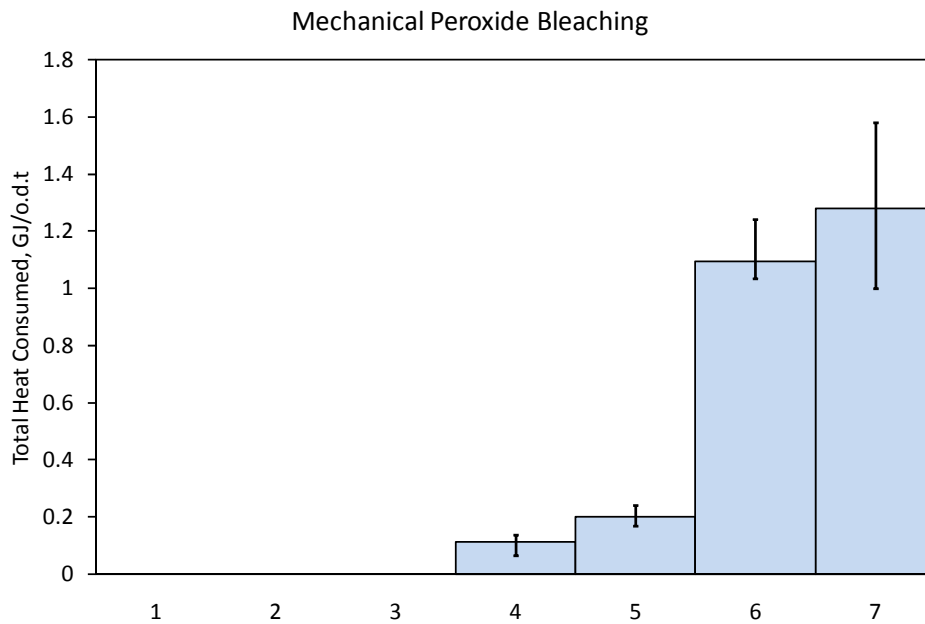


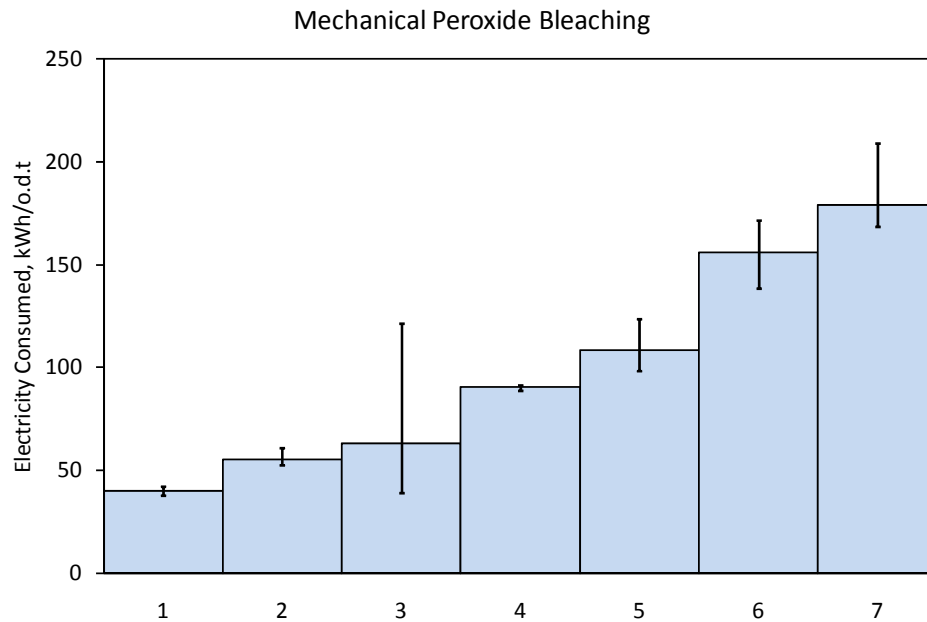
Mechanical Refiner Pulping - TMP for Paper



Mechanical Peroxide Bleaching

Area	Mechanical Peroxide Bleaching			
Number	7			
Production, o.d.t	952,062			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	0	0.11	0.65	0.50
Net Steam Consumed, GJ/o.d.t	0	0.11	0.65	0.50
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	59	90	132	104

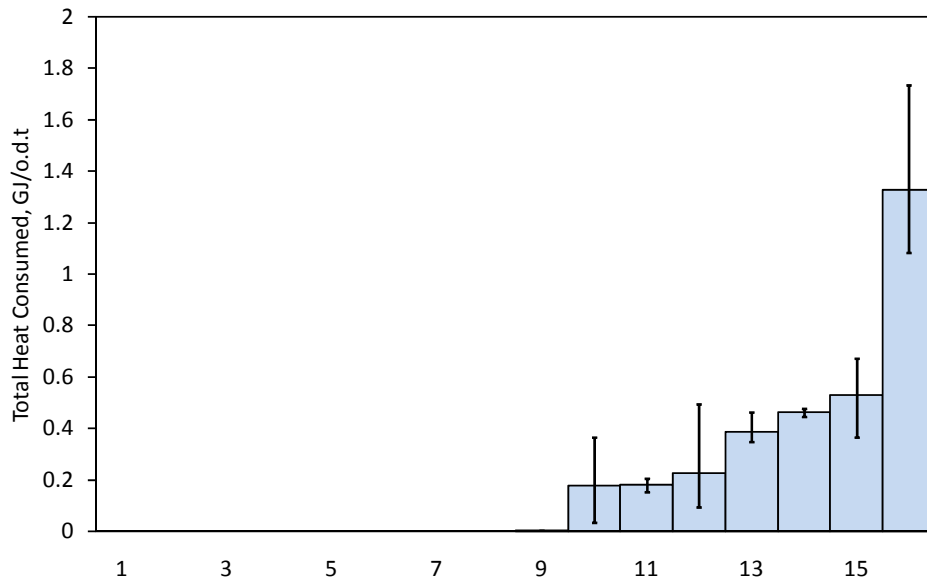




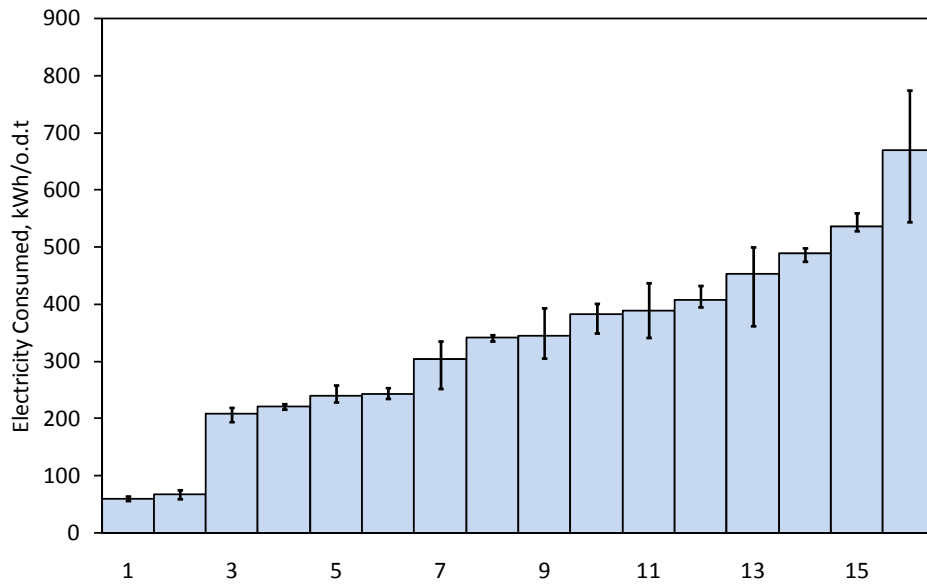
Recycled Pulping

Area	Recycled Pulping			
Number	16			
Production, o.d.t	1,600,941			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/o.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/o.d.t	0	0	0	0
Biofuel Consumed, GJ/o.d.t	0	0	0	0
Other Fuel Consumed, GJ/o.d.t	0	0	0	0
Total Heat Consumed, GJ/o.d.t	0	0	0.27	0.17
Net Steam Consumed, GJ/o.d.t	0	0	0.27	0.17
Hot Water Consumed, GJ/o.d.t	0	0	0	0
Electricity Consumed, kWh/o.d.t	236	343	419	325

Recycled Pulping

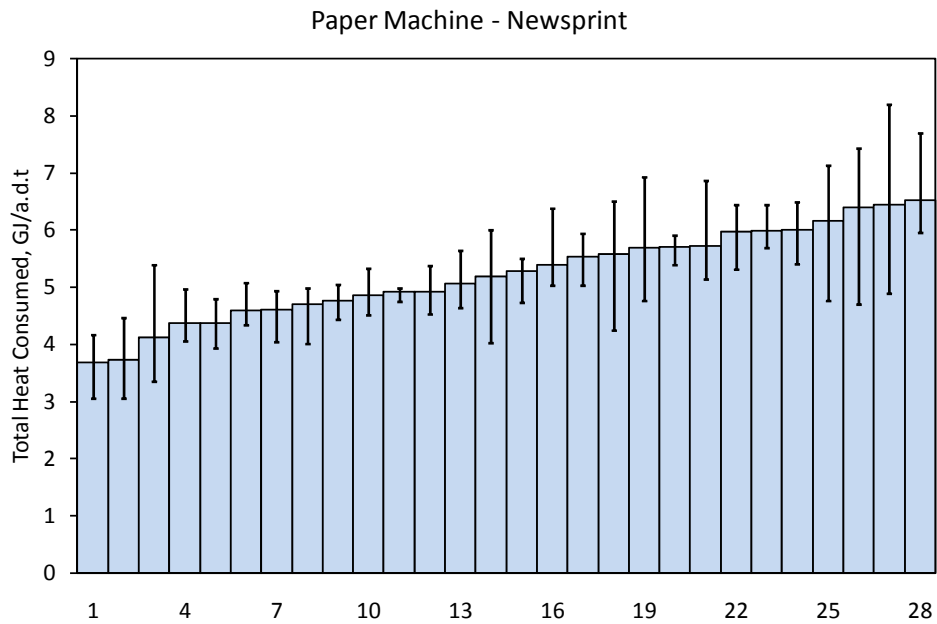


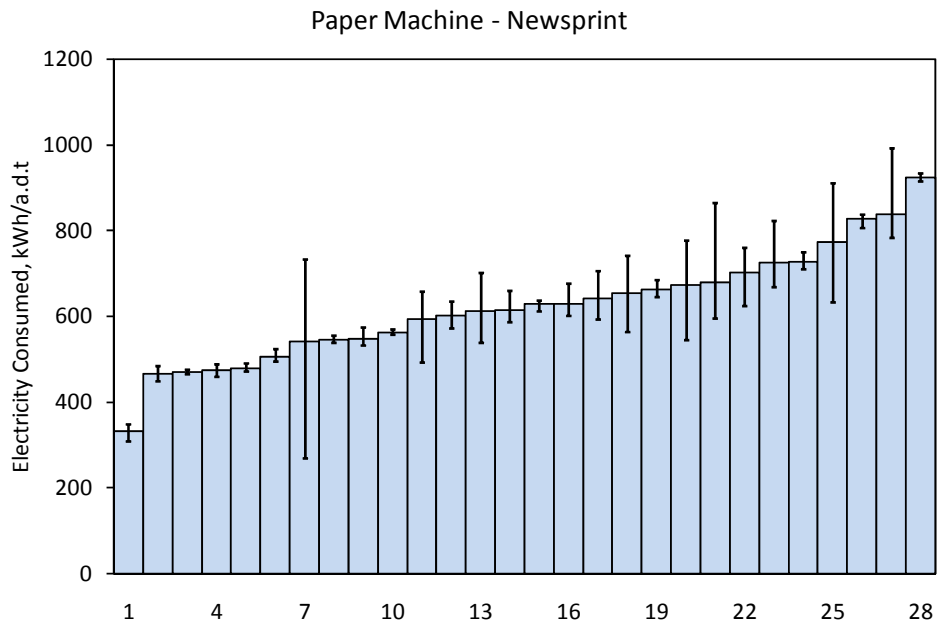
Recycled Pulping



Paper Machine – Newsprint

Area	Paper Machine - Newsprint			
Number	28			
Production, a.d.t	3,711,832			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/a.d.t	0	0	0	0
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	4.68	5.24	5.78	5.24
Net Steam Consumed, GJ/a.d.t	4.68	5.24	5.78	5.24
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	545	622	686	618

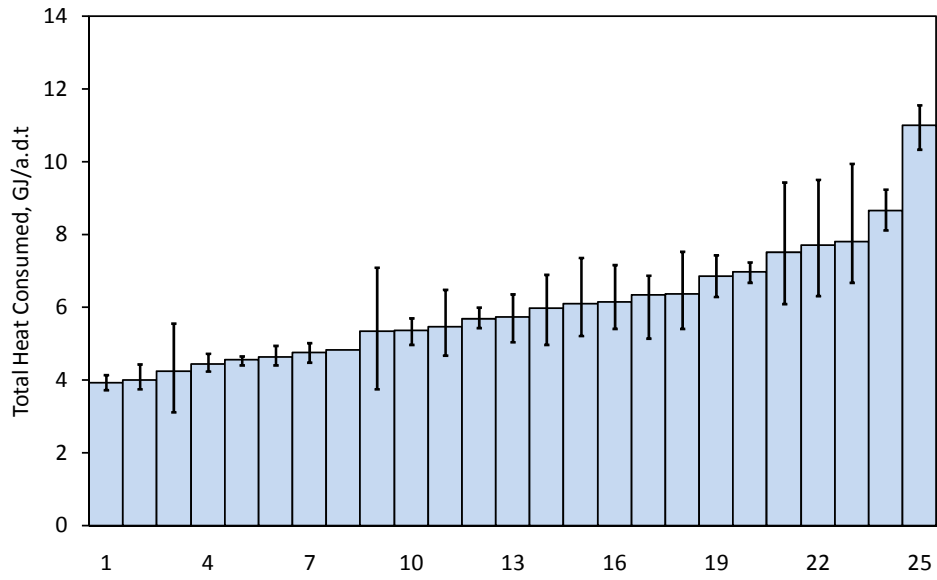




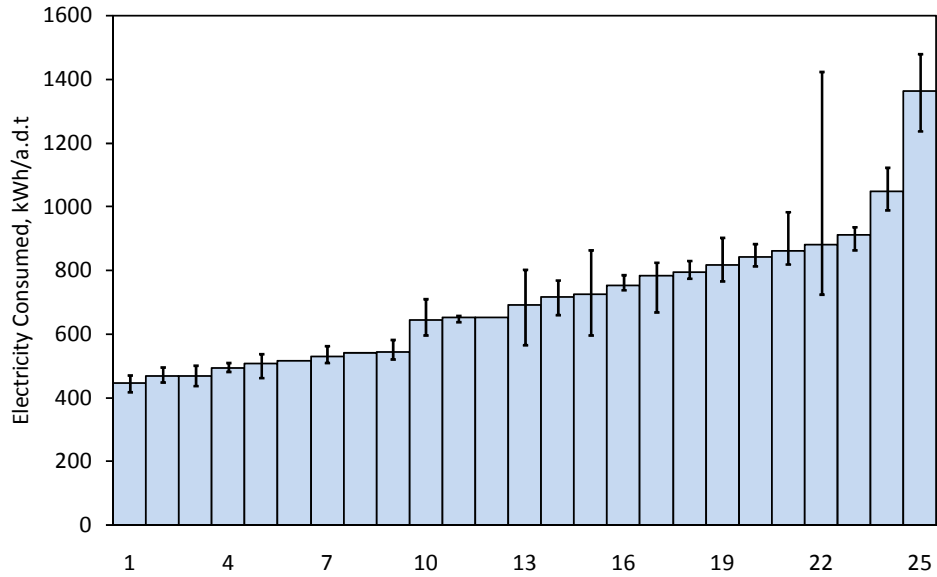
Paper Machine – Uncoated Mechanical

Area	Paper Machine - Uncoated Mechanical			
Number	25			
Production, a.d.t	2,108,496			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0	0	0	0.01
Fossil Fuel Consumed, GJ/a.d.t	0	0	0	0.01
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	4.76	5.72	6.85	5.67
Net Steam Consumed, GJ/a.d.t	4.76	5.72	6.85	5.67
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	529	690	817	703

Paper Machine - Uncoated Mechanical

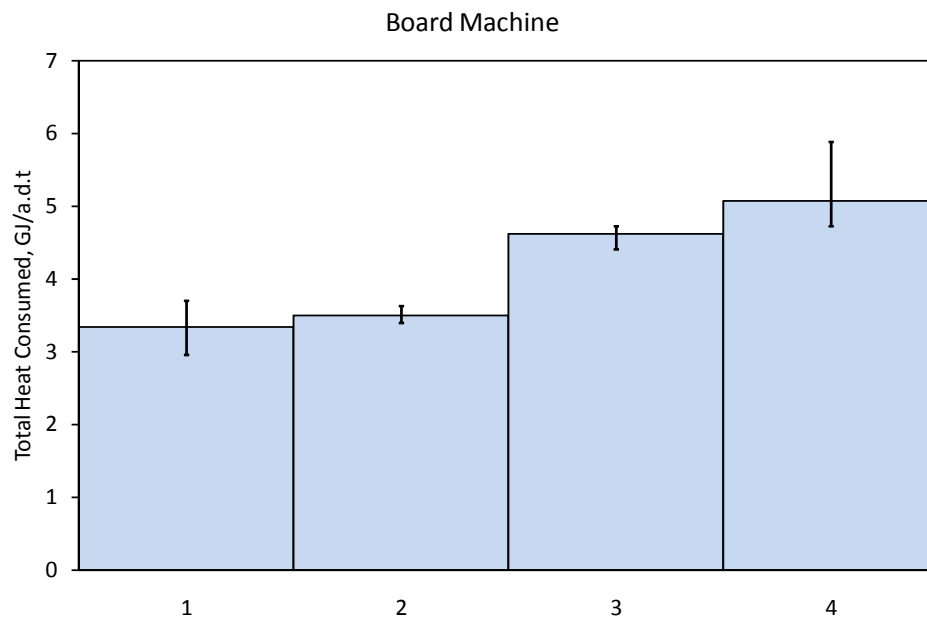


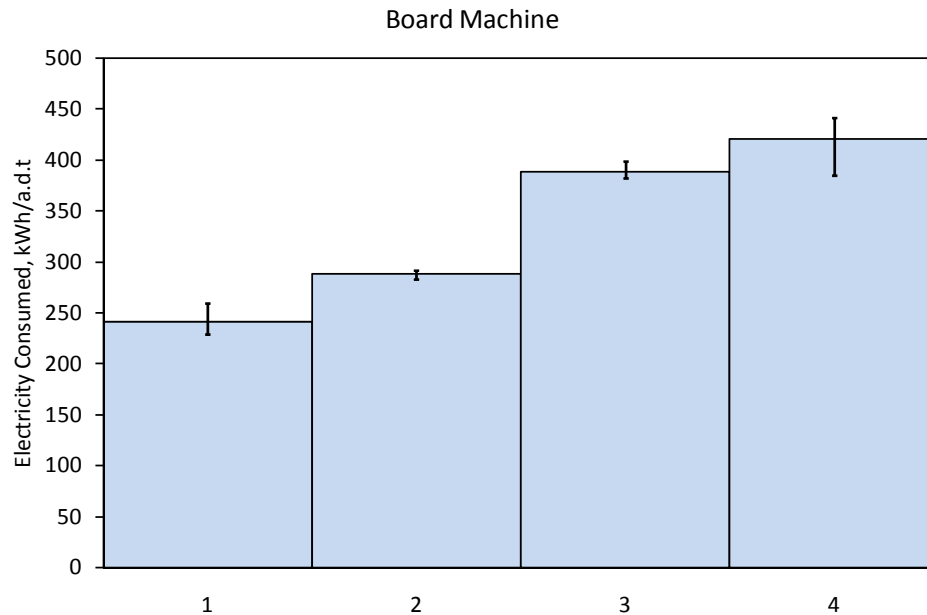
Paper Machine - Uncoated Mechanical



Board Machine

Area	Board Machine			
Number	4			
Production, a.d.t	555,005			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/a.d.t	0	0	0	0
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	3.46	4.06	4.74	3.86
Net Steam Consumed, GJ/a.d.t	3.46	4.06	4.74	3.86
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	276	338	397	309

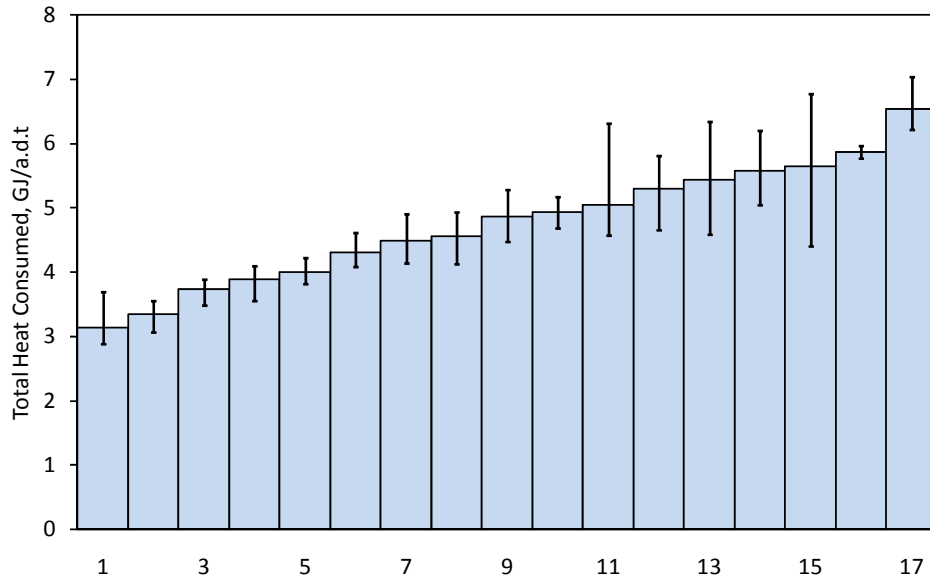




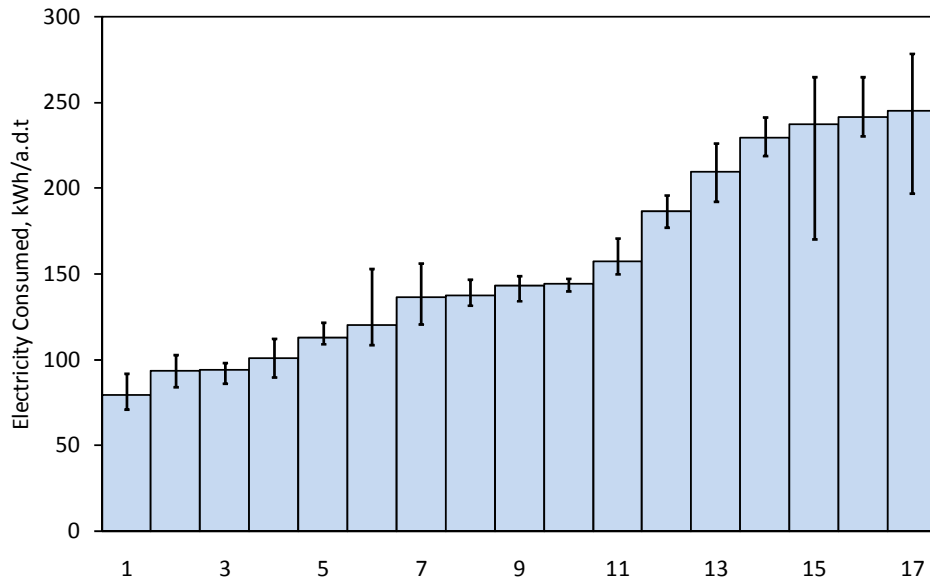
Pulp Machine – Steam Dryer

Area	Pulp Machine - Steam Dryer			
Number	17			
Production, a.d.t	3,776,791			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/a.d.t	0	0	0	0
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	4.00	4.87	5.44	4.50
Net Steam Consumed, GJ/a.d.t	4.00	4.87	5.44	4.50
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	113	143	210	140

Pulp Machine - Steam Dryer

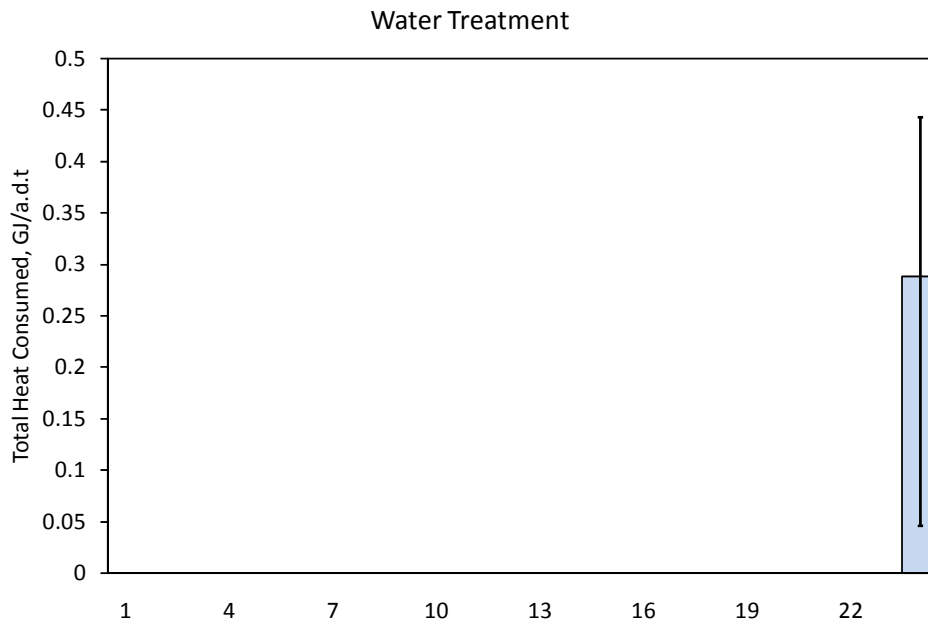


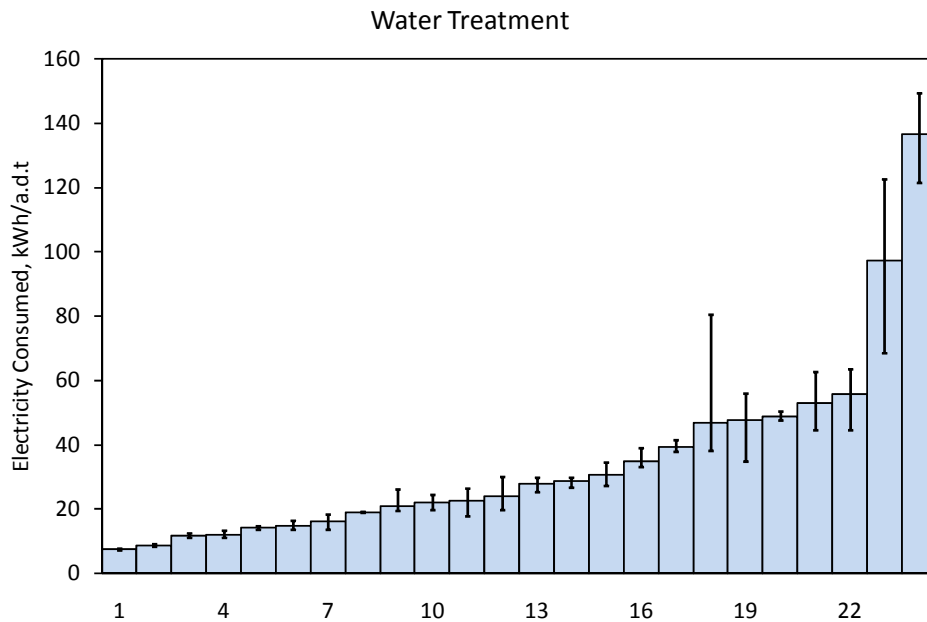
Pulp Machine - Steam Dryer



Water Treatment

Area	Water Treatment			
Number	24			
Production, a.d.t	7,887,413			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/a.d.t	0	0	0	0
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	0	0	0	0.01
Net Steam Consumed, GJ/a.d.t	0	0	0	0.01
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	16	26	47	33

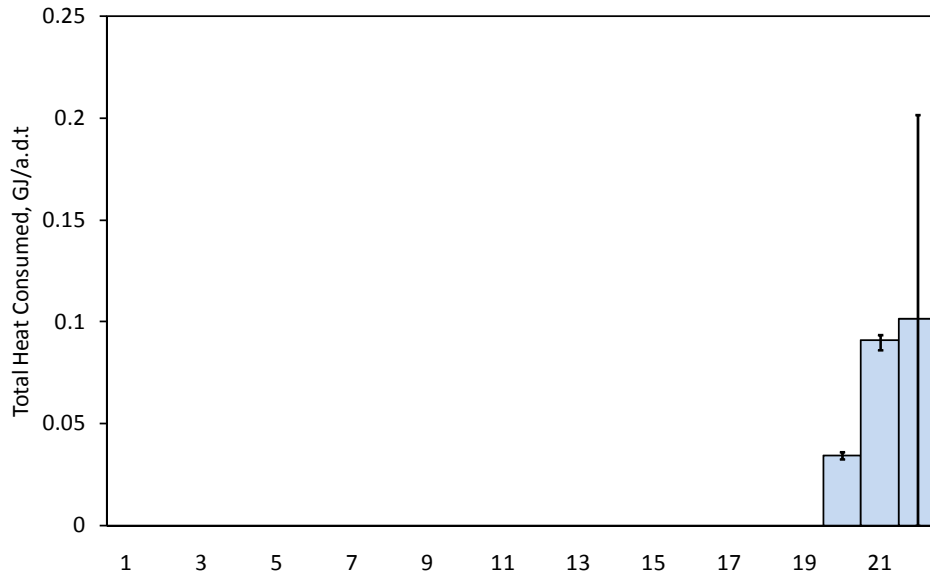




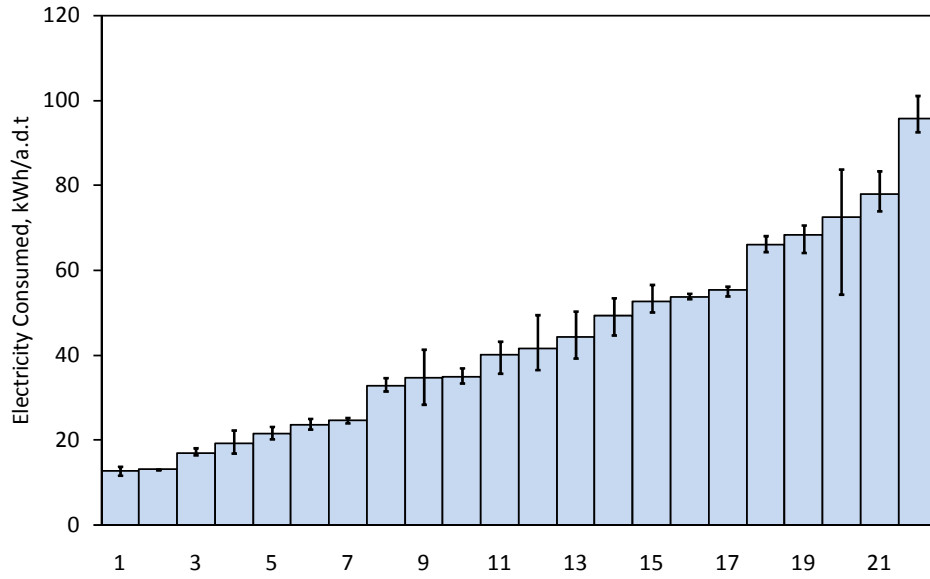
Effluent Treatment – Activated Sludge

Area	Effluent Treatment - Activated Sludge			
Number	22			
Production, a.d.t	7,446,638			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/a.d.t	0	0	0	0
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	0	0	0	0.01
Net Steam Consumed, GJ/a.d.t	0	0	0	0.01
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	24	41	55	43

Effluent Treatment - Activated Sludge

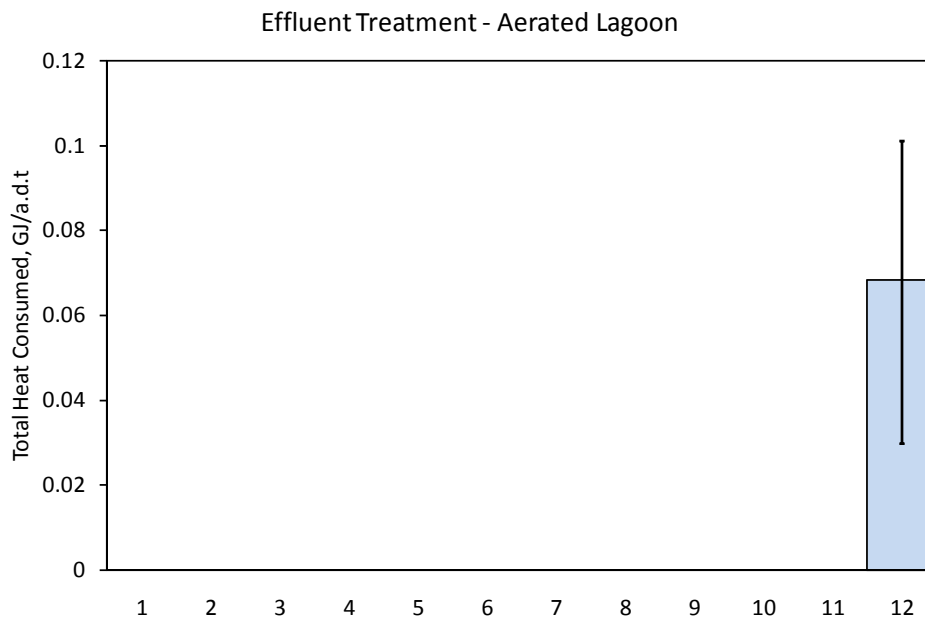


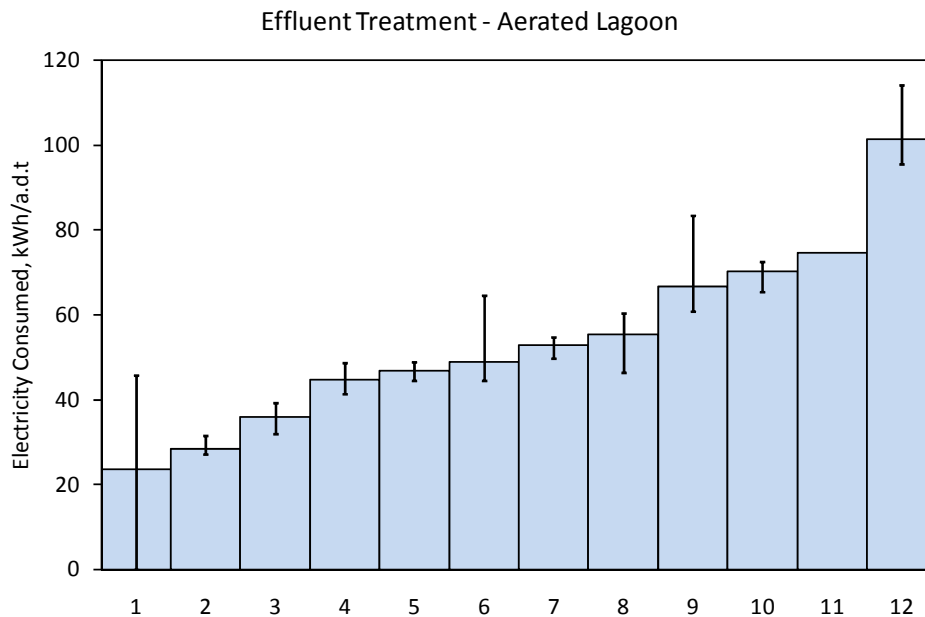
Effluent Treatment - Activated Sludge



Effluent Treatment – Aerated Lagoon

Area	Effluent Treatment - Aerated Lagoon			
Number	12			
Production, a.d.t	3,594,561			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0	0	0	0
Fossil Fuel Consumed, GJ/a.d.t	0	0	0	0
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	0	0	0	0.01
Net Steam Consumed, GJ/a.d.t	0	0	0	0.01
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	43	51	68	52

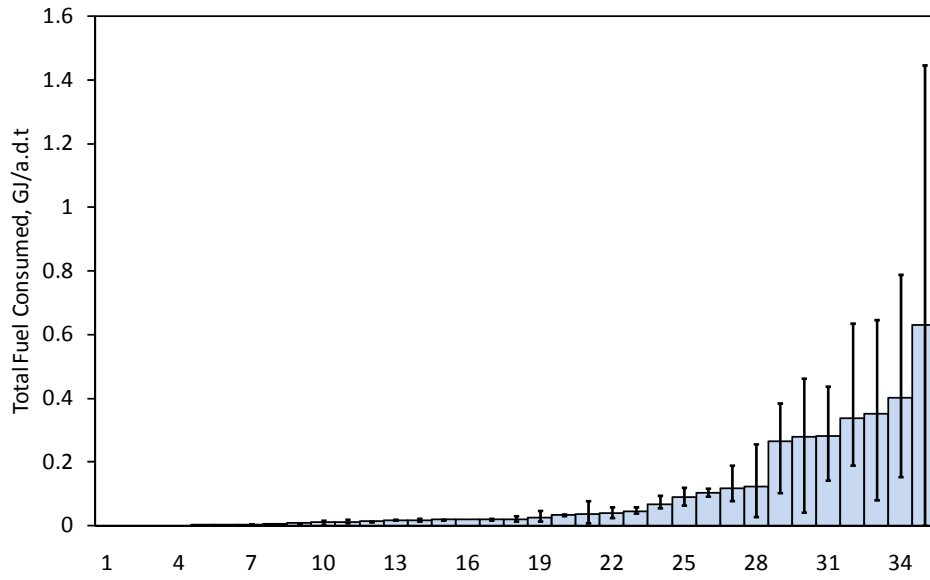




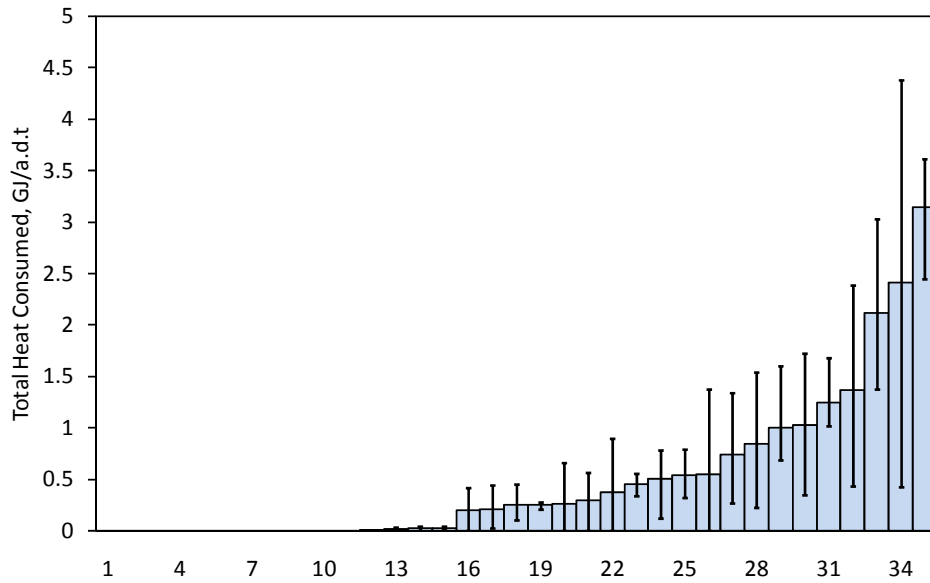
General/Buildings

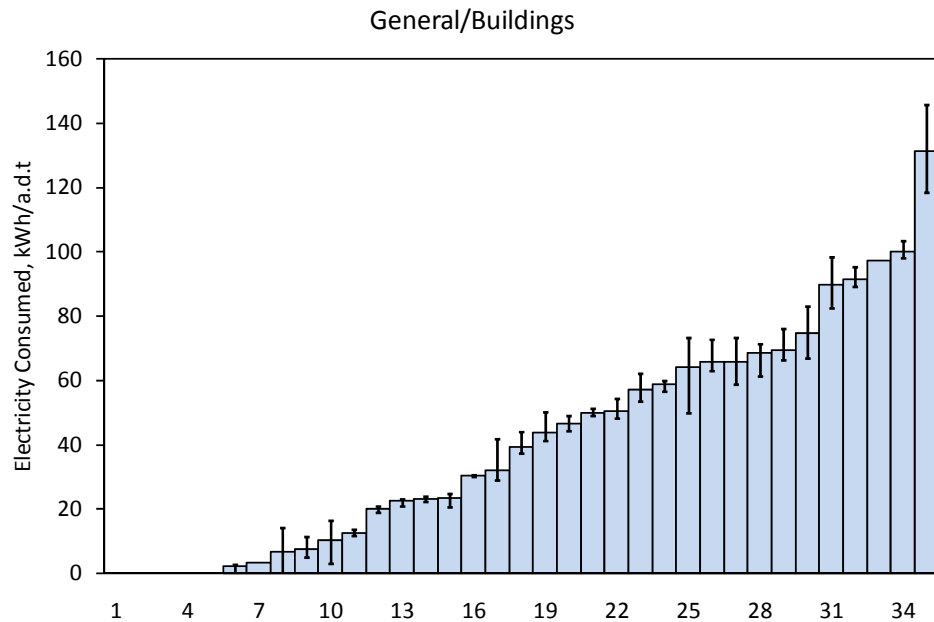
Area	General/Buildings			
Number	35			
Production, a.d.t	11,173,314			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/a.d.t	0.01	0.02	0.11	0.08
Fossil Fuel Consumed, GJ/a.d.t	0.01	0.02	0.11	0.08
Biofuel Consumed, GJ/a.d.t	0	0	0	0
Other Fuel Consumed, GJ/a.d.t	0	0	0	0
Total Heat Consumed, GJ/a.d.t	0	0.25	0.65	0.50
Net Steam Consumed, GJ/a.d.t	0	0.25	0.65	0.50
Hot Water Consumed, GJ/a.d.t	0	0	0	0
Electricity Consumed, kWh/a.d.t	9	39	66	42
Total Heat Produced, GJ/a.d.t	0	0	0	0.06
Net Steam Produced, GJ/a.d.t	0	0	0	0
Hot Water Produced, GJ/a.d.t	0	0	0	0.06

General/Buildings



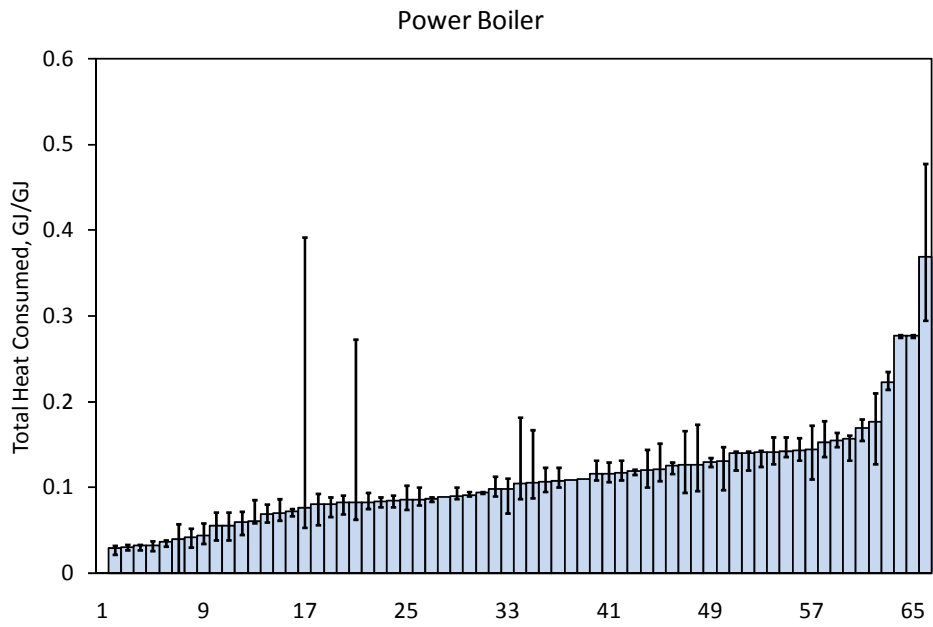
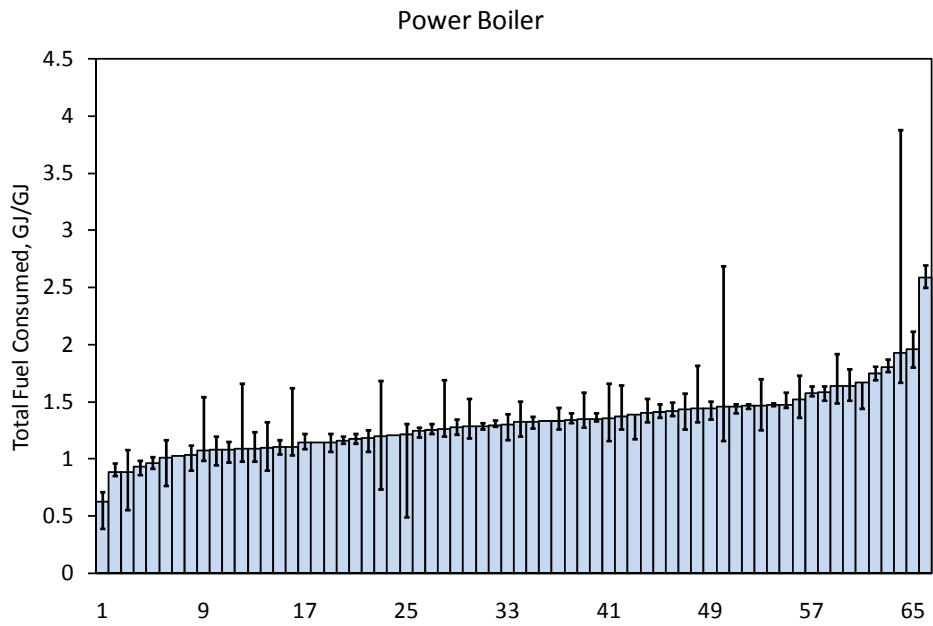
General/Buildings

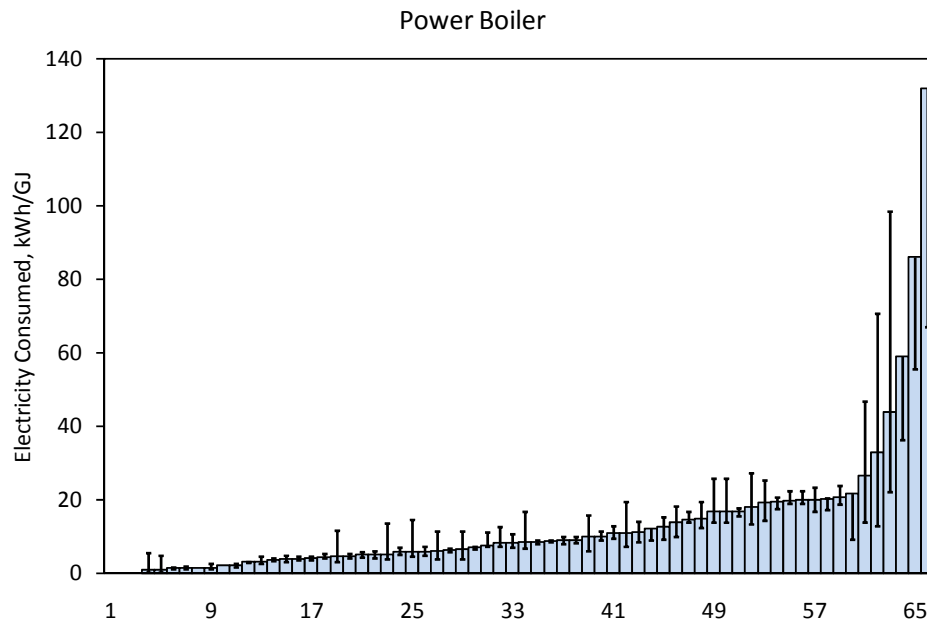




Power Boiler

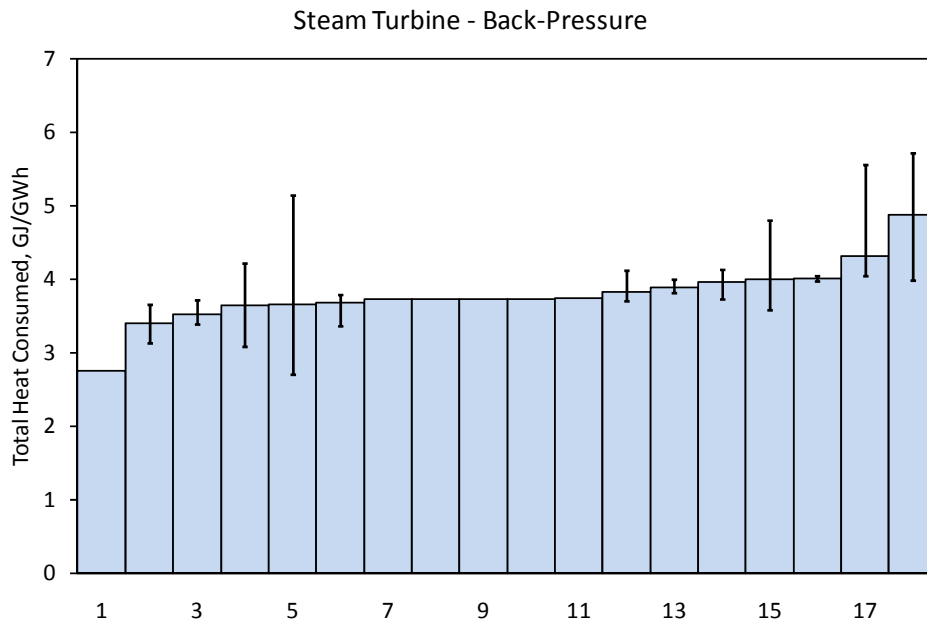
Area	Power Boiler			
Number	66			
Production, GJ	62,645,795			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/GJ	1.14	1.31	1.45	1.35
Fossil Fuel Consumed, GJ/GJ	0.23	0.99	1.26	0.32
Biofuel Consumed, GJ/GJ	0	0	1.08	1.03
Other Fuel Consumed, GJ/GJ	0	0	0	0.01
Total Heat Consumed, GJ/GJ	0.08	0.10	0.13	0.13
Net Steam Consumed, GJ/GJ	0.08	0.10	0.13	0.13
Hot Water Consumed, GJ/GJ	0	0	0	0
Electricity Consumed, kWh/GJ	4	8	17	9





Steam Turbine – Back-Pressure

Area	Steam Turbine - Back-Pressure			
Number	18			
Production, GWh	2,702			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/GWh	0	0	0	0
Fossil Fuel Consumed, GJ/GWh	0	0	0	0
Biofuel Consumed, GJ/GWh	0	0	0	0
Other Fuel Consumed, GJ/GWh	0	0	0	0
Total Heat Consumed, GJ/GWh	3.67	3.73	3.94	3.86
Net Steam Consumed, GJ/GWh	3.67	3.73	3.94	3.86
Hot Water Consumed, GJ/GWh	0	0	0	0
Electricity Consumed, kWh/GWh	0	0	0	0



Steam Turbine – Condensing

Area	Steam Turbine - Condensing			
Number	6			
Production, GWh	890			
	25-Percent.	Median	75-Percent.	Average
Total Fuel Consumed, GJ/GWh	0	0	0	0
Fossil Fuel Consumed, GJ/GWh	0	0	0	0
Biofuel Consumed, GJ/GWh	0	0	0	0
Other Fuel Consumed, GJ/GWh	0	0	0	0
Total Heat Consumed, GJ/GWh	5.90	9.24	12.58	7.51
Net Steam Consumed, GJ/GWh	5.90	9.24	12.58	7.51
Hot Water Consumed, GJ/GWh	0	0	0	0
Electricity Consumed, kWh/GWh	0	0	0	5

