

TOWN OF WOODSTOCK CLIMATE SMART TASK FORCE

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Application for 5 Points

June 14, 2020

PE10 Action: GHG Tracking system

5 Points

The purpose of this addendum is to present the component elements of Woodstock's GHG emissions: carbon dioxide, methane, and nitrous oxide, and to calculate the CO_{2e} effective emissions. The procedure follows the guideline issued by the California Air Resources Board.¹

2019 Metric Tons, CO₂ and CO_{2e}

Table summarizing Woodstock's GHG emissions for 2019 in terms of metric tons CO_{2e} and comparing it with carbon dioxide emissions.

CO ₂ Metric Tons	564.5
CO _{2e} Metric Tons	567.7
Difference	3.2
Percent Difference	0.57%

Woodstock Scope 1 GHG Emissions

The recommended approach for calculating emissions from stationary combustion is to use activity data and default emission factors by fuel type that involves the following six steps:

1. Determine annual consumption of each fuel combusted at your facilities;
2. Determine the appropriate CO₂ emission factors for each fuel;
3. Determine the appropriate CH₄ and N₂O emission factors for each fuel;
4. Calculate each fuel's CO₂ emissions;
5. Calculate each fuel's CH₄ and N₂O emissions; and
6. Convert CH₄ and N₂O emissions to CO₂ equivalent and determine total emissions.

Step 1: Annual Consumption of Each Fuel Combusted

Woodstock uses a four part tracking system based on data required for its yearly financial report to the Office of the State Comptroller. The energy usage and cost reports documents all of Woodstock's Scope 1 & 2 GHG sources. Exhibits from the town's financial reports showing quantities of fossil fuels used by Woodstock are shown on pages 2 – 5 of the PE10 GHG Tracking Report.

Step 2: Select the Appropriate CO₂ Emission Factor for Each Fuel

The Protocol provides default emission factors for a wide variety of fuels in Appendix G, Table G.1. Emission factors are provided in units of CO₂ per unit energy and CO₂ per unit mass or volume.

¹ California Air Resources Board, *Local Government Operations Protocol For the quantification and reporting of greenhouse gas emissions inventories*, Version 1.1, May 2010, Chapter 6, Pages 31-34

Step 3: Select the Appropriate CH₄ and N₂O Emission Factors for Each Fuel

Estimating CH₄ and N₂O emissions depend not only on fuel characteristics, but also on technology type and combustion characteristics, usage of pollution control equipment, and maintenance and operational practices. Due to this complexity, estimates of CH₄ and N₂O emissions from stationary sources are much more uncertain than estimates of CO₂ emissions. CH₄ and N₂O also account for much smaller quantities of emissions from stationary combustion than CO₂. Table G.3 and G.4 provide default emission factors by fuel type and sector.^{2,3}

Emission Factors for CO₂, CH₄, and N₂O

	Emission Factor kg CO ₂ /Gallon	Methane kg/gallon	Nitrous Oxide kg/gallon
Distillate Fuel Oil #2 (Heating Fuel)	10.21	0.0015	0.0001
Distillate Fuel Oil #2 (Diesel)	10.21	0.0015	0.0001
Propane	5.59	0.0001	0.0001
Gasoline	8.78	0.0010	0.0001
GWP	1	21	310

Step 4: Calculate Each Fuel's CO₂ Emissions

To determine CO₂ emissions from combustion, multiply fuel use from Step 1 by the CO₂ emission factor from Step 2, and then convert kilograms to metric tons.

Step 5: Calculate Each Fuel's CH₄ and N₂O Emissions

To determine CH₄ emissions from combustion, multiply fuel use from Step 1 by the CH₄ emission factor from Step 3, and then convert kilograms to metric tons. Repeat the procedure to calculate total emissions of N₂O.

Equation 6.7	Converting to CO ₂ e and Determining Total Emissions
CO₂ Emissions (metric tons CO ₂ e)	= CO ₂ Emissions (metric tons) × 1 (GWP)
CH₄ Emissions (metric tons CO ₂ e)	= CH ₄ Emissions (metric tons) × 21 (GWP)
N₂O Emissions (metric tons CO ₂ e)	= N ₂ O Emissions (metric tons) × 310 (GWP)
Total Emissions (metric tons CO ₂ e)	= CO ₂ + CH ₄ + N ₂ O (metric tons CO ₂ e)

Step 6: Convert CH₄ and N₂O Emissions to Units of CO₂ Equivalent

The IPCC global warming potential factors provided in Equation 6.7 (and Appendix E)⁴ are used to convert CH₄ and N₂O emissions to units of CO₂ equivalent. The sum of emissions for all three gases determines the total GHG emissions from stationary combustion.

² Ibid. Page 203

³ Ibid. Page 206

⁴ Ibid. Page 198

Woodstock Scope 1 GHG Emissions from Fossil Fuels, by Year

The table shows the calculated values of the GHG emissions.

Yearly Data for CO₂, CH₄, N₂O, CO₂e

		Volume	Metric Tons CO ₂	Methane Kgm	Nitrous Oxide Kgm	Methane CO ₂ e	Nitrous Oxide CO ₂ e	Metric Tons CO ₂ e
2011	Gasoline (gals)	23,150	205.8	23.1500	2.3150	0.4862	0.7177	207.0
	Diesel Fuel (gals)	23,500	238.8	35.2500	2.3500	0.7403	0.7285	240.2
	Fuel Oil (gals)	6,767	68.8	10.1505	0.6767	0.2132	0.2098	69.2
	Propane (gals)	4,064	23.4	0.5689	0.4064	0.0119	0.1260	23.5
2012	Gasoline (gals)	21,786	193.7	21.7860	2.1786	0.4575	0.6754	194.8
	Diesel Fuel (gals)	22,258	226.2	33.3870	2.2258	0.7011	0.6900	227.5
	Fuel Oil (gals)	4,691	47.7	7.0365	0.4691	0.1478	0.1454	48.0
	Propane (gals)	3,283	18.9	0.4596	0.3283	0.0097	0.1018	19.0
2013	Gasoline (gals)	20,576	182.9	20.5760	2.0576	0.4321	0.6379	184.0
	Diesel Fuel (gals)	23,176	235.5	34.7640	2.3176	0.7300	0.7185	236.9
	Fuel Oil (gals)	5,024	51.0	7.5360	0.5024	0.1583	0.1557	51.4
	Propane (gals)	4,704	27.1	0.6586	0.4704	0.0138	0.1458	27.3
2014	Gasoline (gals)	20,031	178.1	20.0310	2.0031	0.4207	0.6210	179.1
	Diesel Fuel (gals)	23,739	241.2	35.6085	2.3739	0.7478	0.7359	242.7
	Fuel Oil (gals)	3,504	35.6	5.2560	0.3504	0.1104	0.1086	35.8
	Propane (gals)	5,733	33.0	0.8027	0.5733	0.0169	0.1777	33.2
2015	Gasoline (gals)	19,780	175.9	19.7800	1.9780	0.4154	0.6132	176.9
	Diesel Fuel (gals)	23,891	242.7	35.8365	2.3891	0.7526	0.7406	244.2
	Fuel Oil (gals)	2,631	26.7	3.9465	0.2631	0.0829	0.0816	26.9
	Propane (gals)	5,592	32.2	0.7829	0.5592	0.0164	0.1734	32.4
2016	Gasoline (gals)	20,724	184.2	20.7240	2.0724	0.4352	0.6424	185.3
	Diesel Fuel (gals)	22,193	225.5	33.2895	2.2193	0.6991	0.6880	226.9
	Fuel Oil (gals)	2,454	24.9	3.6810	0.2454	0.0773	0.0761	25.1
	Propane (gals)	4,808	27.7	0.6731	0.4808	0.0141	0.1490	27.9
2017	Gasoline (gals)	19,988	177.7	19.9880	1.9988	0.4197	0.6196	178.7
	Diesel Fuel (gals)	22,520	228.8	33.7800	2.2520	0.7094	0.6981	230.2
	Fuel Oil (gals)	2,500	25.4	3.7500	0.2500	0.0788	0.0775	25.6
	Propane (gals)	4,915	28.3	0.6881	0.4915	0.0145	0.1524	28.5
2018	Gasoline (gals)	20,800	184.9	20.8000	2.0800	0.4368	0.6448	186.0
	Diesel Fuel (gals)	24,845	252.4	37.2675	2.4845	0.7826	0.7702	254.0
	Fuel Oil (gals)	2,762	28.1	4.1430	0.2762	0.0870	0.0856	28.2
	Propane (gals)	5,825	33.6	0.8155	0.5825	0.0171	0.1806	33.8
2019	Gasoline (gals)	20,390	181.3	20.3902	2.0390	0.4282	0.6321	182.3
	Diesel Fuel (gals)	23,555	239.3	35.3328	2.3555	0.7420	0.7302	240.8
	Fuel Oil (gals)	2,814	28.6	4.2212	0.2814	0.0886	0.0872	28.8
	Propane (gals)	4,786	27.6	0.6701	0.4786	0.0141	0.1484	27.7

Woodstock Scope 2 GHG Emissions

To calculate Scope 2 emissions from electricity use, follow these three steps:

1. Determine your annual electricity use from each facility;
2. Select the appropriate emission factors that apply to the electricity used; and
3. Determine your total annual emissions in metric tons of carbon dioxide equivalent.

Step 1: Determine Annual Electricity Consumption

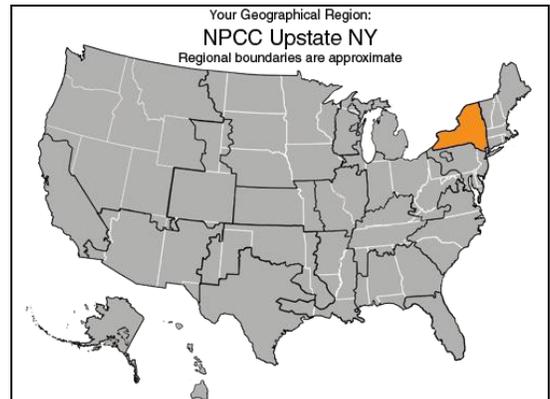
Reporting Scope 2 emissions from electricity consumption begins with determining annual electricity use at each facility. The preferred sources for determining annual electricity use are monthly electric bills or electric meter records. Both sources provide the number of kilowatt hours (kWh) or megawatt hours (MWh) of electricity consumed.⁵

Woodstock created a database of all Central Hudson utility bills received since January, 2011, providing detail kWh usage for every facility.. The totals are checked yearly against Central Hudson's online records for consistency and accuracy.

Step 2: Select Appropriate Emission Factors

An electricity emission factor represents the amount of GHGs emitted per unit of electricity consumed. It is usually reported in units of pounds of GHG per kWh or MWh. There are two options for recommended electricity emission factors under this Protocol. Woodstock chose the second option and uses the eGRID regional default emission factors for the Upstate New York subregion.

The EPA's Emissions & Generation Resource Integrated Database (eGRID) documents carbon dioxide, methane, nitrogen oxides, sulfur dioxide, and nitrous oxide emissions from electric generation by geographic region.



eGRID Database – Upstate New York

The eGRID database is periodically updated to account for changes in the generation profile and fuel sources. Carbon Dioxide emissions in upstate NY have been declining because of the retirements of coal-fired power plants. Because of substantial hydroelectric and nuclear resources, EPA's Upstate NY sub-region has the lowest level of emissions from electric generation in the country.

There is a lag between when eGRID data is collected and when EPA makes it public. The following table identifies the eGRID version and the year its emission factors were used.

⁵ Ibid. Pages 39-41

Amended Woodstock GHG Tracking System

Fiscal Year	eGRID Version	eGRID Release	Upstate NY CO ₂ lbs./MWh ⁶
2019	eGRID2018	9-Mar-20	253.1
2018	eGRID2016	15-Feb-18	294.1
2017	eGRID2014 version 2	27-Feb-17	366
2016	eGRID2014	13-Jan-17	377
2015	eGRID2012	8-Oct-15	409
2014	eGRID2010	24-Feb-14	546
2013	eGRID2009	10-May-12	498
2012	eGRID2009	10-May-12	498
2011	eGRID2009	10-May-12	498

Emission Factors Associated With eGRID Versions

	CO2 lbs/MWh	Methane lbs/GWh	Nitrous Oxide lbs/GWh	CO2e lbs/MWh
eGRID2018	253.1	18.0	2.0	253.9
eGRID2016	294.7	21.0	3.0	295.9
eGRID2014V2	365.7	30.7	4.1	367.6
eGRID2014	377.2	32.3	4.4	379.2
eGRID2012	408.80	15.59	3.83	410.31
eGRID2010	545.79	16.30	7.24	548.37
eGRID2009	497.92	15.94	6.77	500.35

⁶ Environmental Protection Agency, "Power Profiler," Available at <https://www.epa.gov/energy/power-profiler/>

Step 3: Determine Total Annual Emissions

To determine annual emissions, multiply annual electricity use (in MWh) from Step 1 by the emission factors for CO₂, CH₄, and N₂O from Step 2. There's no need to calculate the CO₂e emission factor because eGRID provides this factor directly.

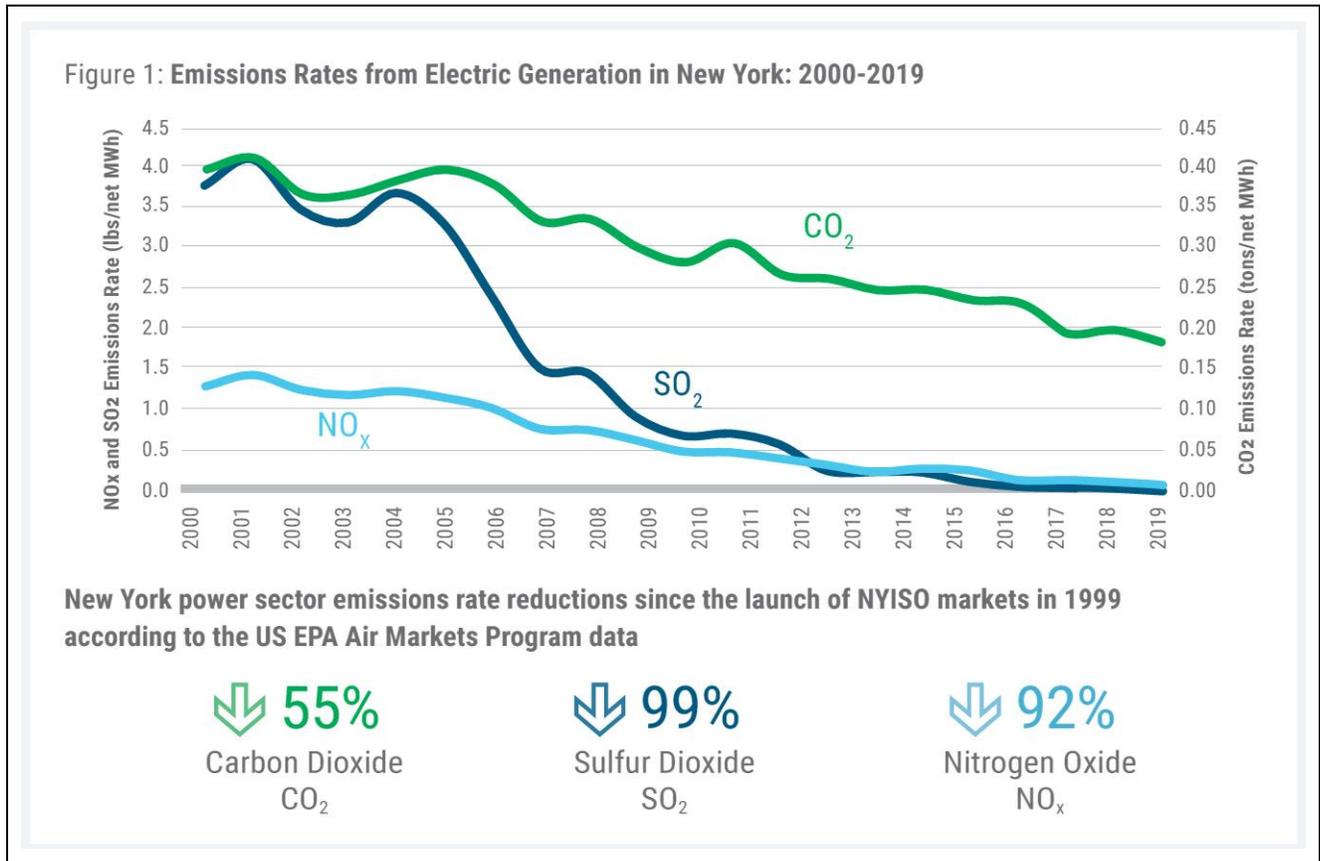
Units for methane and nitrous oxide have been converted to kgm to allow comparison with fossil fuel emissions. A check sum for electricity emissions was calculated to insure the LGOP protocol yields the same CO₂e amount as identified by the eGRID dataset.

Woodstock Scope 2 GHG Emissions by Year

Yearly Scope 2 Emissions for CO₂, CH₄, N₂O, CO₂e

		Volume	Metric Tons CO2	Methane Kgm	Nitrous Oxide Kgm	Methane CO2e	Nitrous Oxide CO2e	Metric Tons CO2e
2011	Electricity (Grid)	617,410	139.4	4.5645	1.9386	0.0959	0.6010	140.1
	Electricity (Hydro)							
2012	Electricity (Grid)	639,570	144.4	4.7283	2.0082	0.0993	0.6225	145.2
	Electricity (Hydro)							
2013	Electricity (Grid)	729,123	164.7	5.3904	2.2894	0.1132	0.7097	165.5
	Electricity (Hydro)							
2014	Electricity (Grid)	724,325	179.3	5.4759	2.4322	0.1150	0.7540	180.2
	Electricity (Hydro)							
2015	Electricity (Grid)	747,877	138.7	5.4076	1.3285	0.1136	0.4118	139.2
	Electricity (Hydro)							
2016	Electricity (Grid)	732,875	125.4	10.9800	1.4847	0.2306	0.4603	126.1
	Electricity (Hydro)							
2017	Electricity (Grid)	764,419	126.8	10.8843	1.4536	0.2286	0.4506	127.5
	Electricity (Hydro)							
2018	Electricity (Grid)	805,383	107.6	7.8443	1.1206	0.1647	0.3474	108.1
	Electricity (Hydro)	18,500	0.0	0.0000	0.0000	0.0000	0.0000	0.0
2019	Electricity (Grid)	764,484	87.8	6.3822	0.7091	0.1340	0.2198	88.0
	Electricity (Hydro)	44,000	0.0	0.0000	0.0000	0.0000	0.0000	0.0

Emission Rates from Electric Generation in New York: 2001-2019⁷



⁷ NYISO, "Power Trends 2020,"

Woodstock Scope 1 & 2 Emissions

		Volume	Metric Tons CO2	Methane Kgm	Nitrous Oxide Kgm	Methane CO2e	Nitrous Oxide CO2e	Metric Tons CO2e
2011	Gasoline (gals)	23,150	205.8	23.1500	2.3150	0.4862	0.7177	207.0
	Diesel Fuel (gals)	23,500	238.8	35.2500	2.3500	0.7403	0.7285	240.2
	Fuel Oil (gals)	6,767	68.8	10.1505	0.6767	0.2132	0.2098	69.2
	Propane (gals)	4,064	23.4	0.5689	0.4064	0.0119	0.1260	23.5
	Electricity (Grid)	617,410	139.4	4.5645	1.9386	0.0959	0.6010	140.1
	Electricity (Hydro)							
	Sum of Fuel Σ		676.2	73.6839	7.6867	1.5474	2.3829	680.1
2012	Gasoline (gals)	21,786	193.7	21.7860	2.1786	0.4575	0.6754	194.8
	Diesel Fuel (gals)	22,258	226.2	33.3870	2.2258	0.7011	0.6900	227.5
	Fuel Oil (gals)	4,691	47.7	7.0365	0.4691	0.1478	0.1454	48.0
	Propane (gals)	3,283	18.9	0.4596	0.3283	0.0097	0.1018	19.0
	Electricity (Grid)	639,570	144.4	4.7283	2.0082	0.0993	0.6225	145.2
	Electricity (Hydro)							
	Sum of Fuel Σ		630.9	67.3974	7.2100	1.4153	2.2351	634.5
2013	Gasoline (gals)	20,576	182.9	20.5760	2.0576	0.4321	0.6379	184.0
	Diesel Fuel (gals)	23,176	235.5	34.7640	2.3176	0.7300	0.7185	236.9
	Fuel Oil (gals)	5,024	51.0	7.5360	0.5024	0.1583	0.1557	51.4
	Propane (gals)	4,704	27.1	0.6586	0.4704	0.0138	0.1458	27.3
	Electricity (Grid)	729,123	164.7	5.3904	2.2894	0.1132	0.7097	165.5
	Electricity (Hydro)							
	Sum of Fuel Σ		661.2	68.9249	7.6374	1.4474	2.3676	665.0
2014	Gasoline (gals)	20,031	178.1	20.0310	2.0031	0.4207	0.6210	179.1
	Diesel Fuel (gals)	23,739	241.2	35.6085	2.3739	0.7478	0.7359	242.7
	Fuel Oil (gals)	3,504	35.6	5.2560	0.3504	0.1104	0.1086	35.8
	Propane (gals)	5,733	33.0	0.8027	0.5733	0.0169	0.1777	33.2
	Electricity (Grid)	724,325	179.3	5.4759	2.4322	0.1150	0.7540	180.2
	Electricity (Hydro)							
	Sum of Fuel Σ		667.2	67.1740	7.7329	1.4107	2.3972	671.0
2015	Gasoline (gals)	19,780	175.9	19.7800	1.9780	0.4154	0.6132	176.9
	Diesel Fuel (gals)	23,891	242.7	35.8365	2.3891	0.7526	0.7406	244.2
	Fuel Oil (gals)	2,631	26.7	3.9465	0.2631	0.0829	0.0816	26.9
	Propane (gals)	5,592	32.2	0.7829	0.5592	0.0164	0.1734	32.4
	Electricity (Grid)	747,877	138.7	5.4076	1.3285	0.1136	0.4118	139.2
	Electricity (Hydro)							
	Sum of Fuel Σ		616.2	65.7535	6.5179	1.3808	2.0205	619.6

Amended Woodstock GHG Tracking System

		Volume	Metric Tons CO2	Methane Kgm	Nitrous Oxide Kgm	Methane CO2e	Nitrous Oxide CO2e	Metric Tons CO2e
2016	Gasoline (gals)	20,724	184.2	20.7240	2.0724	0.4352	0.6424	185.3
	Diesel Fuel (gals)	22,193	225.5	33.2895	2.2193	0.6991	0.6880	226.9
	Fuel Oil (gals)	2,454	24.9	3.6810	0.2454	0.0773	0.0761	25.1
	Propane (gals)	4,808	27.7	0.6731	0.4808	0.0141	0.1490	27.9
	Electricity (Grid)	732,875	125.4	10.9800	1.4847	0.2306	0.4603	126.1
	Electricity (Hydro)							
	Sum of Fuel Σ		587.8	69.3476	6.5026	1.4563	2.0158	591.2
2017	Gasoline (gals)	19,988	177.7	19.9880	1.9988	0.4197	0.6196	178.7
	Diesel Fuel (gals)	22,520	228.8	33.7800	2.2520	0.7094	0.6981	230.2
	Fuel Oil (gals)	2,500	25.4	3.7500	0.2500	0.0788	0.0775	25.6
	Propane (gals)	4,915	28.3	0.6881	0.4915	0.0145	0.1524	28.5
	Electricity (Grid)	764,419	126.8	10.8843	1.4536	0.2286	0.4506	127.5
	Electricity (Hydro)							
	Sum of Fuel Σ		587.0	69.0904	6.4459	1.4509	1.9982	590.5
2018	Gasoline (gals)	20,800	184.9	20.8000	2.0800	0.4368	0.6448	186.0
	Diesel Fuel (gals)	24,845	252.4	37.2675	2.4845	0.7826	0.7702	254.0
	Fuel Oil (gals)	2,762	28.1	4.1430	0.2762	0.0870	0.0856	28.2
	Propane (gals)	5,825	33.6	0.8155	0.5825	0.0171	0.1806	33.8
	Electricity (Grid)	805,383	107.6	7.8443	1.1206	0.1647	0.3474	108.1
	Electricity (Hydro)	18,500	0.0	0.0000	0.0000			0.0
	Sum of Fuel Σ		606.6	70.8703	6.5438	1.4883	2.0286	610.1
2019	Gasoline (gals)	20,390	181.3	20.3902	2.0390	0.4282	0.6321	182.3
	Diesel Fuel (gals)	23,555	239.3	35.3328	2.3555	0.7420	0.7302	240.8
	Fuel Oil (gals)	2,814	28.6	4.2212	0.2814	0.0886	0.0872	28.8
	Propane (gals)	4,786	27.6	0.6701	0.4786	0.0141	0.1484	27.7
	Electricity (Grid)	764,484	87.8	6.3822	0.7091	0.1340	0.2198	88.0
	Electricity (Hydro)	44,000	0.0	0.0000	0.0000			0.0
	Sum of Fuel Σ		564.5	66.9964	5.8637	1.4069	1.8177	567.7