Representative Building Energy Study
In Tompkins County
(Townhouses and Custom Homes)

Version 1.0, May 02, 2017
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1. EXECUTIVE SUMMARY

Taitem Engineering, PC conducted a building energy system study for two types of representative new homes in Tompkins County, NYS. The technologies evaluated consist of condensing gas furnace and central air conditioner, condensing propane furnace and central air conditioner, air source heat pump system (ASHP) and ground-source heat pump system (GSHP). This study includes analysis for two different building types, namely a townhouse and a custom/ luxury house. The study mainly focuses on the potential energy savings and the cost-effectiveness of the heat pump technologies compared to the conventional furnace system.

At current electricity and gas rates, the energy cost of heat pumps is slightly lower than natural gas, and significantly lower than propane. The carbon emissions of the heat pumps are significantly lower than gas or propane furnaces, and are expected to further decrease over time as the electric grid uses more renewable energy. For homes that use on-site renewable energy, heat pumps facilitate the further dramatic reduction of carbon emissions, approaching or even reaching zero carbon emissions, which has already been demonstrated on many homes in the county.

Furnaces and heat pumps both have a variety of pros and cons. For example, furnaces present higher risks of serious accidents and death due to gas leaks/explosions and carbon monoxide poisoning, with 100-200 reported fatalities in the U.S. each year. Heat pumps require attention to design in order to guarantee comfort, as they are newer to the market and contractors are still getting used to design requirements. Other pros and cons are discussed in the report.

Although heat pumps are newer than furnaces, they are no longer an emerging technology, but are well-proven, with over 30 years of international experience, well over two decades of experience in the U.S., and hundreds of installations already in Tompkins County. The installed cost of heat pumps has dropped significantly, and will likely continue to drop, unlike furnaces which are a more mature and market-saturated technology. Similarly, heat pump efficiencies will continue to increase, whereas furnace efficiencies can no longer increase beyond available maximum efficiencies due to the thermodynamic maximum 100% efficiency that they have already bumped up against. Heat pump installations are increasing rapidly, and will very likely become the heat/cooling system of the future: For a wide variety of cost, performance, environmental, and policy reasons, we strongly anticipate that within 30 years, furnaces will no longer be used at all, and virtually all heating installations will be heat pumps.

Although not accounted for in our comparisons, state and federal incentives reduce the installed cost of heat pumps, making them even more attractive than presented in this study.

This report was prepared by Umit Sirt, Ian Shapiro, and Vaibhavi Tambe. All questions and comments should be directed to Umit Sirt at (607) 277-1118, ext. 128 or usirt@taitem.com.

2. FINDINGS

In this analysis, the building envelope components (insulation, etc.) are generally in accordance with the Energy Conservation Construction Code of New York State. High-efficiency heating systems were chosen that meet the ENERGY STAR program or Tompkins County Heatsmart program. The projected building energy consumption for the townhouse and custom/luxury house are shown in Tables 2.1 and 2.2, respectively.

Table 2.1. Energy Consumption – Townhouse

	Electricity Consumption (kWh/yr)	Annual Peak Demand (kW) (in Summer)	Annual Peak Demand (kW) (in Winter)	Natural Gas Consumption (therms/yr)	Propane Gas Consumption (gallons/year)	Site EUI (kBtu/ ft^2/year)
Condensing Natural Gas Furnace with Air Conditioner	4,845	2.4		770	-	62.4
Condensing Propane Furnace with Air Conditioner	4,845	2.4		-	806	62.4
Air Source Heat Pump (ASHP)	9,352		3.8	-	-	21.3
Ground-Source Heat Pump (GSHP)	9,362		2.6	-	-	21.3

Table 2.2 Energy Consumption – Custom/ Luxury House

	Electricity Consumption (kWh/yr)	Annual Peak Demand (kW) (in Summer)	Annual Peak Demand (kW) (in Winter)	Natural Gas Consumption (therms/yr)	Propane Gas Consumption (gallons/year)	Site EUI (kBtu/ ft^2/year)
Condensing Natural Gas Furnace with Air Conditioner	12,890	7.4		1,400	-	46.0
Condensing Propane Furnace with Air Conditioner	12,546	7.5		-	1,422	44.7
Air Source Heat Pump (ASHP)	23,839		11.9	-	-	20.3
Ground-Source Heat Pump (GSHP)	22,224		7.47	-	-	19.0

- Site EUI the total energy (as reflected in the utility bills) consumed by the building in one year by the total gross floor area of the building.

In terms of Energy Use Intensities (EUI), both the propane and natural gas options are more energy intensive as compared with ASHPs and GSHPs.

We interestingly note that for the townhouse, the ASHP and GSHP are projected to have approximately the same energy use. While GSHP's are typically viewed as being more efficient than ASHP's, when ASHP's are applied without ductwork, as we do in the townhouses, there are several efficiency gains. Most importantly, the absence of ductwork reduces fan energy use, and the energy model accounts for this. There are actually other energy efficiency gains as well, which our model does not account for, that may further reduce energy use in real buildings: separate temperature control by room and elimination of duct leakage and conduction losses.

The installed cost, energy cost, equivalent annual cost (EAC) and carbon emissions for both building types are shown in Tables 2.3 and 2.4, respectively. Equivalent annual cost is a metric that allows assets of different expected life to be compared on an apples-to-apples basis, accounting for both installed cost and energy cost.

Table 2.3 Carbon Emissions and Equivalent Annual Cost – Townhouse

	Installed Cost ($)	**Energy Cost ($/yr)**	**Equivalent Annual Cost ($)**	**GHG Emissions (Annual Metric Tons of CO_2)**
Condensing Natural Gas Furnace with Air Conditioner	$10,000	$1,537	$2,300	5.8*
Condensing Propane Furnace with Air Conditioner	$10,000	$2,707	$3,470	6.8*
Air Source Heat Pump (ASHP)	$10,000	$1,172	$1,930	2.6**
Ground-Source Heat Pump (GSHP)	$30,000	$1,173	$2,900	2.6**

Table 2.4 Carbon Emissions and Equivalent Annual Cost – Custom/Luxury House

	Installed Cost ($)	**Energy Cost ($/yr)**	**Equivalent Annual Cost ($)**	**GHG Emissions (Annual Metric Tons of CO_2)**
Condensing Natural Gas Furnace with Air Conditioner	$25,000	$2,919	$4,820	11.7*
Condensing Propane Furnace with Air Conditioner	$25,000	$5,060	$6,960	12.6*
Air Source Heat Pump (ASHP)	$30,000	$2,708	$4,990	6.5**
Ground-Source Heat Pump (GSHP)	$60,000	$2,537	$5,980	6.1**

*United states Environmental Protection Agency (EPA). "Emission Factors for Greenhouse Gas Inventories" Table 1 - Stationary Combustion Emission Factors. https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf. Last Updated, April 4, 2014.
** United states Environmental Protection Agency (EPA). "Emission Factors for Greenhouse Gas Inventories" Table 6 – Electricity Emission Factors, eGRID Subregion NPCC Upstate NY. https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf. Last Updated, April 4, 2014.

The ASHP and GSHP systems have far lower greenhouse gas emissions than the furnace options.

A common fifth heating system is the hot water boiler, also known as hydronic. Hydronic systems were not included in the analysis, because they do not have cooling integrated into them. Cooling is typically provided as a separate system, either ducted or ductless. Installation costs tend to be higher than either forced air furnaces with central air conditioning or air source heat pumps. Energy costs are likely similar to those of forced air furnaces with central air conditioning.

Non-Cost Tradeoffs

- ASHP and GSHP systems are safe when compared to the furnaces. There is no risk of carbon monoxide poisoning or gas leakage.
- All systems except for the GSHP system have visible outdoor components, which require cleaning and make noise. The GSHP is extremely quiet outdoors and have no visible outdoor components, but has a compressor in the interior equipment that makes noise, typically located in the basement.
- Ductless heat pumps offer better room-by-room temperature control, because each indoor unit has its own thermostat.
- Ductless heat pumps are visible within most rooms of the house. The inside units are often called "heads". This indicates the heat pumps themselves are visible.
- Both fossil fuel and electric systems will not work when the electric grid is down. Furnaces need electricity to run fans.
- For the heat pumps, the carbon emissions will be less over time as the renewable energy increases (on-site or off-site), or even may approach or equal zero if homeowners procure renewable electric energy from home or community solar.
- Ductless heat pump indoor units need to be placed in locations to avoid comfort issues. For example, it is important to avoid placing wall-mounted indoor units above such locations as desks or sofas, to avoid cold air falling on occupants in the summer cooling season.
- All-electric homes use electricity for non-heating appliances, such as cooking stoves, clothes dryers, and domestic hot water. These can be electric resistance appliances, or can be high-efficiency (such as induction stoves, heat pump clothes dryers, and heat pump water heaters). For the study, we assumed electric resistance appliances, except for the water heaters which were assumed to be heat pump water heaters, which are already widely available and used in Ithaca.

Comments on Low-Temperature Operation

The capacity and efficiency of heat pumps become lower at lower outdoor air temperatures. This is particularly the case with air-source heat pumps (ASHP). However, recent developments in heat pumps have increased both their capacity and efficiency at low outdoor air temperatures.

The design temperature for Tompkins County is -2°F (Table 301.1, New York State Energy Code). This means that, statistically, the temperature is lower than -2°F for 1% of the year. In practice, the temperature frequently does not even get this cold. For example, for the winter of 2016-2017, the very coldest temperature was 1°F. Examining historic records from 1893 to the present, for the Cornell weather station, the normal temperature range on the coldest days of winter (January 11 – 26) is between 15°F and 31°F. In other words, on a typical midwinter day, the temperature ranges from 15°F to 31°F. The mean monthly lowest minimum temperature for the period 1883 to the present, for the coldest month (January) is -7°F. In other words, if the very coldest January temperature is taken for each year since 1893 and averaged, it is -7°F. This is consistent with a 99% design temperature of -2°F, which is a little warmer because it represents a temperature for which we design heating equipment, but does not represent the very coldest winter temperature, which occurs for just a few hours of the year. For these few hours, it is deemed acceptable for the heating equipment to temporarily not meet the load, in which case the indoor air temperature will dip below the setpoint (typically 70°F) for these few hours. For the same period of the last 124 years, the absolute very coldest single temperature recorded at Cornell was -25°F, in 1957.

(Source for above data, unless indicated: http://w2.weather.gov/climate/xmacis.php?wfo=bgm)
A common myth is that "heat pumps are not more efficient than electric resistance heat at cold outdoor temperatures." This is simply not the case.

Almost all commercially available air source heat pumps have performance rating data down to -13 F, and continue to operate even colder than that. The average efficiency of nine different air source heat pumps in the NEEP Cold Climate Air Source Heat Pump listing is 1.8 COP, at -13 F, in other words almost twice as efficient as electric resistance heat, a temperature condition that may occur for a few hours once every few decades. COP stands for coefficient of performance, an efficiency metric for heat pumps, defined by the output delivered heat divided by the input energy use.
(ColdClimateAir-SourceHeatPumpSpecificationListing-Updated 3.24.2017.xlsx)

3. ASSUMPTIONS AND METHODOLOGIES

The following assumptions are used in this study.

Energy Modeling and Equipment:

- eQUEST, a DOE2.2 based building energy simulation program is used to establish baseline energy use and to determine energy savings for the proposed design alternatives. This advanced program, which was developed under the sponsorship of the U.S. Department of Energy, applies state-of-the-art features that allow a modeler to enter key characteristics for the building shell, internal gains, and mechanical and electrical systems, along with characteristic operating strategies and schedules. The interactions between all of the different building loads, systems and plants are then simulated in hourly time intervals, using typical long-term average weather data for the location to provide a detailed account of energy consumption and demand. All simulations used Elmira_ Corning – TMY3 (most recent Typical Meteorological Year) weather data, which represents typical year conditions.
- Four townhouses with two mid and two end units are considered. In other words, the energy consumption and utility costs in this report are the average of one end and one mid unit.
- For equipment efficiencies, commonly used efficiencies are used. For the gas and propane furnaces, high-efficiency (95%) systems are used, which would qualify for Energy Star. For the air source heat pumps, an efficiency (10 HSPF) is used that complies with

the local Tompkins County Heatsmart program, which in turn requires compliance with the NEEP (Northeast Energy Efficiency Partnerships) Cold Climate Heat Pump specification. This also complies with Energy Star. For ground source heat pumps, the Energy Star efficiency is used. HSPF stands for Heating Seasonal Performance Factor, an annualized efficiency rating used for air source heat pumps.

- It is important to note that measurably higher furnace efficiencies are not available. One might only find furnaces in the 96-97% range, at best, in other words 1-2% higher than used in this study. However, measurably higher heat pump efficiencies are widely available and are commonly used, as much as 10-20% higher, or more. So, the results are conservative for the heat pumps: It is readily possible to further reduce energy use and carbon emissions by 10-20% or more. Over time, heat pump efficiencies will likely increase even further, whereas furnace efficiencies are limited and will never increase beyond the 97% range, as they are thermodynamically limited by 100%.
- The total conditioned area (square footage) assumed for the townhouse and luxury house are 1,500 and 4,000, respectively.
- Lighting power density (LPD) is assumed as 0.25 W/sf.
- 90 cfm for luxury house and 60 cfm for townhouse continuous ventilation is assumed.
- Furnace energy use includes fan motor equal to a high-efficiency variable speed motor.
- Representative internal equipment loads are used.
- Air-change method (ACH) is used for infiltration, and is assumed to be 0.15 for all the spaces (compliant with the energy code).
- All the HVAC system fans operate as needed in the unit/building.
- In the custom home models, all systems are assumed to be ducted, are located for example in a basement, and have distribution losses.
- In the townhouse models, there is no basement assumed. All systems are located within the thermal envelope, and that there are no distribution losses.
- The air source heat pump in the townhouse is ductless. All other systems are ducted.
- The number of occupants in each building type is assumed to be as 4.
- The homes with furnaces (natural gas and propane) are assumed to use natural gas for appliances such as the stove, clothes dryer, and water heater. The homes with heat pumps are assumed to use electric appliances, specifically an electric resistance clothes dryer, electric resistance stove (not induction), and heat pump water heater.

Economics:

- Electricity, Natural Gas and Propane rates are assumed to be $0.106/kWh, $0.84/Therm and $ 2.495/Gallon respectively year-around, as experienced rates in the local area. The flat charges assumed for natural gas is $16.30 /month and for electricity is $15.10 /month.
- This report does not account for the cost of providing natural gas service to each house. NYSEG will provide 100 feet of natural gas service for free. But in the case of large new developments, there may be a fee, and this will change the economics of the analysis to favor the non-gas alternatives.
- A 3% discount rate is assumed to calculate equivalent annual cost (EAC). (Priya Lavappa, Joshua Kneifel. Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – 2016, Annual Supplement to NIST Handbook 135,

https://www.wbdg.org/FFC/NIST/NISTIR_85-3273-31.pdf)

- In this type of analysis, we might typically account for some escalation (inflation) in fuel and electricity costs in coming years. However, current projections of these costs are difficult. In the past few years, these costs have actually come down. So, we do not assume any escalation in our analysis
- Installation costs are difficult to estimate. Even on a single well-defined project, installation costs can vary between contractors by as much as 50%, and depend on market conditions, equipment costs, contractor workload, project size (multiple buildings), and more.

Table 3.2 – Installation Cost - HVAC System

HVAC systems	Townhouse	Custom/ Luxury House
Condensing Gas Furnace and Air Conditioning System	$10,000	$25,000
Propane Furnace and Air Conditioning System	$10,000	$25,000
Air Source Heat Pump System	$10,000	$30,000
Ground Source Heat Pump System	$30,000	$60,000

- We surveyed multiple local contractors, past costs for several projects, current equipment pricing, trends, and published literature. Our installed cost estimates are nonetheless approximate. They are mid-range estimates, assuming some economy of scale for multiple new homes being built as part of a development, rather than as a single home. It is important to note that heat pump installed costs have been dropping. Whereas a few years ago, installed costs were commonly $10-20 per square foot, they are currently reliably below $10/SF. Although there will be a limit to continued price reductions, we do not believe we have reached pricing associated with a mature market, for heat pumps. In other words, we believe that measurable price reductions will still occur in the next few years, as best practices are refined, and as lower equipment pricing associated with larger quantities are obtained. As an example of how low prices could go, a competitively bid small heat pump (1.5 tons) in a high-performance home was recently fully installed for $3000. While this is still an outlier, it gives an idea of how affordable heat pumps may become. We anticipate that ductless air source heat pump systems will be measurably lower in installed cost than comparable furnace systems, in the near future. We anticipate that ducted air source heat pump systems will be equal or less than comparable furnace systems, also in the near future. Furnaces, on the other hand, are a mature product without any projected reduction in installed costs.
- The estimated useful life of equipment is difficult to authoritatively establish. Different sources give different estimates. Also, different components of a piece of equipment have different useful lives. For example, a geothermal well field might be expected to last 50-100 years because there are no moving parts and the

components are safely buried, whereas the associated indoor ground source heat pump that goes with the well field has a shorter life. A furnace might be expected to last 20 years, but its associated air conditioner has a useful life that is estimated to be shorter.

- Combining a variety of sources, we assume the useful life for ground source heat pumps is 17 years and for the geothermal well is 50 years, for the furnace/AC combination is 17 years, and for air source heat pumps is 17 years. These lifetime expectancies are utilized in the EAC calculations. Some of the sources we used include:
  - National Renewable Energy Laboratory. "Energy Analysis." Useful Life, March 22, 2016, http://www.nrel.gov/analysis/tech_footprint.html (Accessed April 13, 2017)
  - ASHRAE Owning and Operating Cost Database, http://xp20.ashrae.org/publicdatabase/. (Accessed August 15, 2015)
  - NY Home Performance with ENERGY STAR Effective Useful Life of Energy Efficient Measures, NYSERDA, August 2012.
  - Data obtained from a survey of the United States by ASHRAE Technical Committee TC 1.8 (Akalin, 1978). Some updates in 1986.
  - Alex Lekov, Victor Franco, and Steve Meyers, "Economics of Condensing Gas Furnaces and Water Heaters Potential in Residential Single Family Homes." In the proceedings of American Council for an Energy Efficient Economy. 2010. http://aceee.org/files/proceedings/2010/data/papers/2226.pdf
- The analysis in this report does not account for subsidies and tax credits that are available for heat pumps. These can be very substantial, to the benefit of heat pumps. For example, the federal investment tax credit for ground source heat pumps has been 30% until recently. A new state subsidy for heat pumps is in the final stages of adoption.
- In estimating the carbon emissions of natural gas equipment, we use a national-average factor from EPA (United states Environmental Protection Agency (EPA). "Emission Factors for Greenhouse Gas Inventories" Table 1 - Stationary Combustion Emission Factors. https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf. Last Updated, April 4, 2014.). It should be noted that there is evidence that methane leaks in the natural gas production and distribution system may well result in higher carbon emissions. So, the estimated impact on carbon emissions in this report might be considered as being on the low side.
- The modeling software eQuest accounts for the lower efficiency and capacity of heat pumps at colder outdoor temperatures. For example, the efficiency of the air source heat pump at 5 F outdoor temperature is calculated to be 2.3 COP. Furthermore, the software accounts for the energy required for the periodic defrost that occurs for ASHP systems.
- All equipment is sized with sufficient capacity to meet midwinter heating design loads. The air source heat pumps have electric resistance backup, that is minimally used at outdoor conditions below midwinter design temperatures, and this energy usage is accounted for in the results.

Authors

Umit Sirt, PE, CEM, BEMP, HBDP **Partner, Senior Energy Engineer**

Umit is responsible for managing and overseeing the Energy+Sustainability department, which performs benchmarking, energy studies, advanced energy models and investment-grade energy audits, technical reviews of energy studies, energy master planning, and outreach for energy efficiency. Umit was selected as one of the top 40 engineers in the U.S., under the age of 40, in 2014. Umit brings over 15 years' experience in the thermo-fluid field with a specialty in energy and HVAC-R. He has gained a reputation for quality energy auditing and high-performance design consulting. He is especially interested in building science and energy system assessments with simulation and modeling. He has built compliant energy models and given assistance to design teams for LEED and ESTIDAMA projects. He is one of the first HBDPs (High-performance Building Design Professional) in NY State and is also one of the provisional assessors in ASHRAE'S Building Energy Quotient Pilot Program (called Building bEQ). Umit published an article in ASHRAE Journal in October 2011 that discusses HVAC selection for envelope-dominated buildings. He also had given presentations nationwide that includes net-zero building design, high performing HVAC system selections, elevator controls, and tax deduction in energy efficient commercial buildings. Umit holds a B.S. in Mechanical Engineering from METU in Turkey and an M.E. in Mechanical Engineering from Stevens Institute of Technology in New Jersey.

Ian Shapiro, PE, LEED AP **Founder, Senior Engineer**

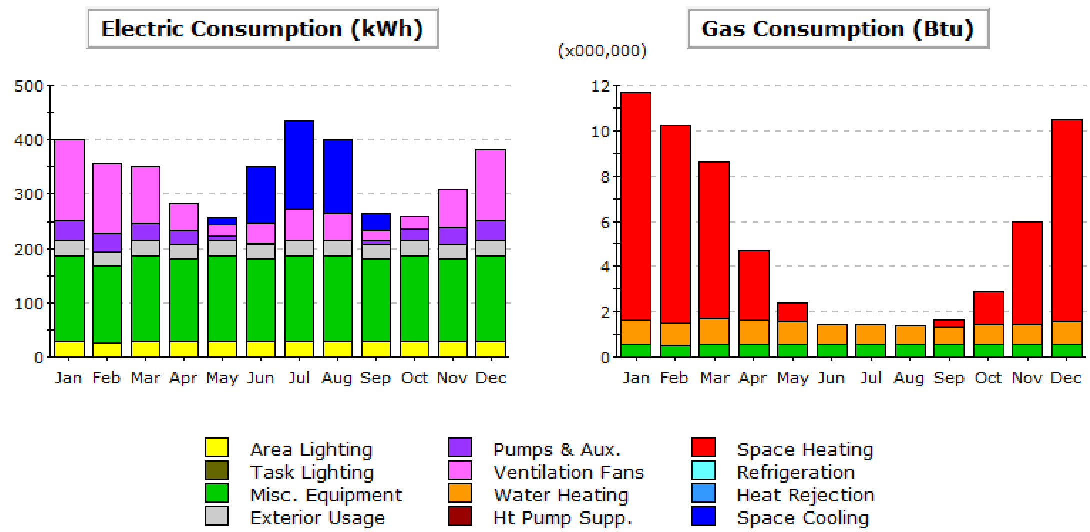
Ian founded Taitem Engineering in 1989. He has led several applied energy conservation research projects, has led many design and energy projects, and has delivered workshops in the area of energy and ventilation. He has also led the development of several computer programs which are used in the HVAC, energy, and indoor air quality fields, including TREAT (Targeted Residential Energy Analysis Tools), which was awarded the 2005 national R&D100 Award. Prior to starting Taitem Engineering, he worked for seven years at Carrier Corporation in Syracuse, where he designed heat pumps and air conditioning equipment, and holds eight patents from this work. He is the co-author of the books *Green Building Illustrated* (2014) and *Energy Audits and Improvements for Commercial Buildings* (2016), both published by Wiley. He has been a visiting lecturer at Cornell University, Tompkins Cortland Community College, and Syracuse University. He holds an undergraduate degree from McGill University, and an M.S. from Columbia University, both in mechanical engineering. Ian is a licensed engineer in the states of New York, Connecticut, Pennsylvania.

Vaibhavi Tambe, LEED Green Associate **Sustainability Consultant**

Vaibhavi works in the Energy+Sustainability department at Taitem. She is a LEED Green Associate and specializes in building energy modeling for LEED and other applications. She joined Taitem after finishing her M.S. in Built Environment from Arizona State University and her B. Arch. from the University of Pune, India.

APPENDIX A – ENERGY USE AND COSTS FOR DIFFERENT ALTERNATIVES

Townhouse (Mid Unit) - Condensing Gas Furnace and Air Conditioning System

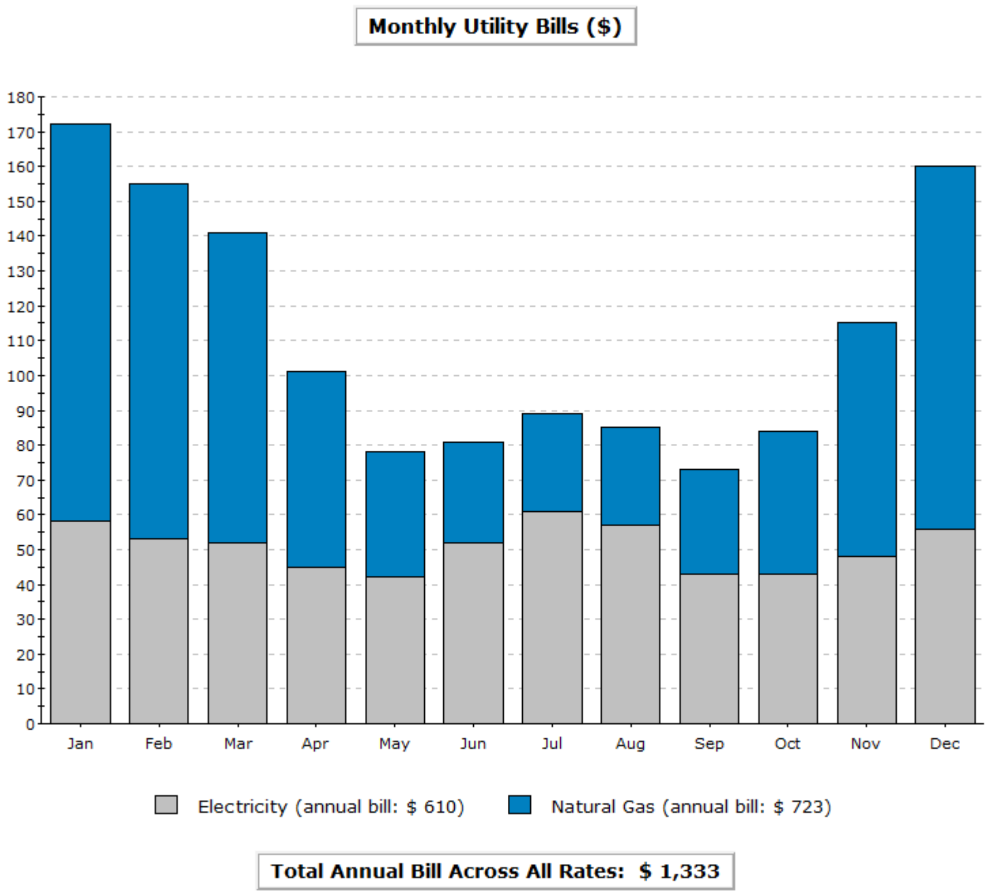


Electric Consumption (kWh)

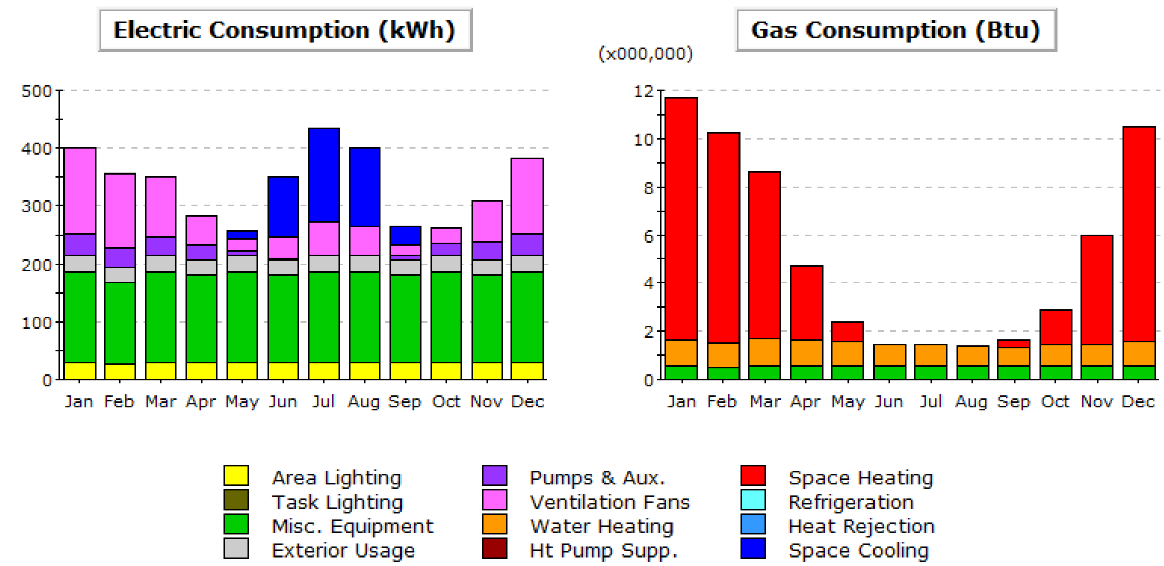
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	14.9	103.2	161.7	136.3	29.3	-	-	-	445.4
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	149.5	129.5	103.7	48.9	20.2	38.0	56.9	49.4	18.1	25.5	70.0	132.3	841.9
Pumps & Aux.	37.2	33.6	32.8	25.6	8.5	2.2	0.9	0.1	8.9	21.1	31.4	36.9	239.3
Ext. Usage	27.9	25.2	27.9	27.0	27.9	27.0	27.9	27.9	27.0	27.9	27.0	27.9	328.5
Misc. Equip.	156.9	141.7	156.9	151.8	156.9	151.8	156.9	156.9	151.8	156.9	151.8	156.9	1,847.0
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	29.1	26.3	29.1	28.1	29.1	28.1	29.1	29.1	28.1	29.1	28.1	29.1	342.2
Total	400.6	356.2	350.3	281.4	257.5	350.3	433.3	399.7	263.2	260.5	308.3	383.0	4,044.3

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	10.02	8.72	6.91	3.07	0.78	0.03	-	-	0.27	1.49	4.55	8.89	44.72
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	1.09	1.02	1.13	1.07	1.01	0.89	0.84	0.80	0.77	0.85	0.89	1.01	11.36
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.57	0.52	0.57	0.56	0.57	0.56	0.57	0.57	0.56	0.57	0.56	0.57	6.75
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	11.68	10.26	8.61	4.69	2.36	1.47	1.42	1.37	1.60	2.90	6.00	10.47	62.83


Monthly Utility Bills ($)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 610)
Natural Gas (annual bill: $ 723)
Total Annual Bill Across All Rates: $ 1,333

Townhouse (Mid Unit) - Propane Furnace and Air Conditioning System

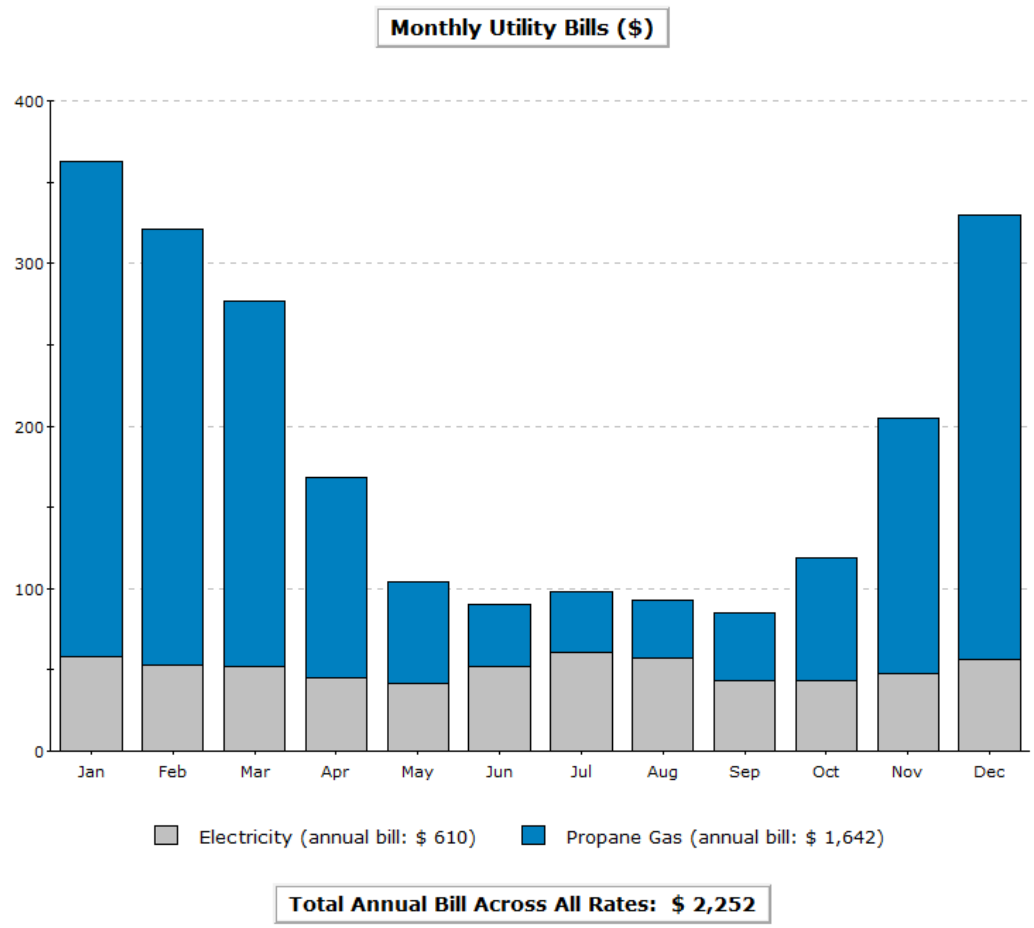


Electric Consumption (kWh)

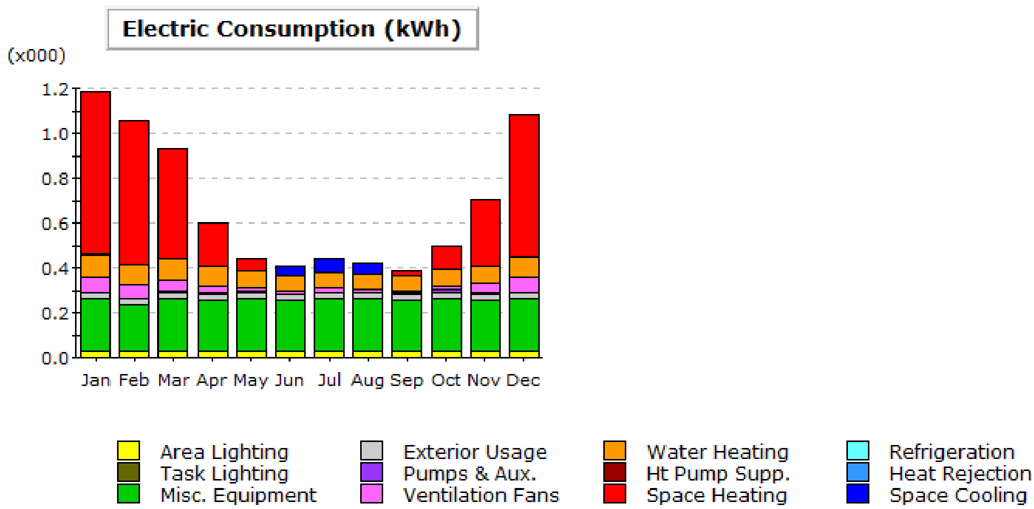
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	14.9	103.2	161.8	136.3	29.3	-	-	-	445.5
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	149.5	129.5	103.7	48.9	20.2	38.0	56.9	49.4	18.1	25.5	70.0	132.3	842.0
Pumps & Aux.	37.2	33.6	32.8	25.6	8.5	2.2	0.9	0.1	8.9	21.1	31.4	36.9	239.3
Ext. Usage	27.9	25.2	27.9	27.0	27.9	27.0	27.9	27.9	27.0	27.9	27.0	27.9	328.5
Misc. Equip.	156.9	141.7	156.9	151.9	156.9	151.9	156.9	156.9	151.9	156.9	151.9	156.9	1,847.7
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	29.1	26.3	29.1	28.1	29.1	28.1	29.1	29.1	28.1	29.1	28.1	29.1	342.2
Total	400.7	356.3	350.3	281.5	257.5	350.4	433.4	399.8	263.3	260.5	308.4	383.0	4,045.2

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	10.02	8.72	6.91	3.07	0.78	0.03	-	-	0.27	1.49	4.55	8.89	44.72
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	1.09	1.02	1.13	1.07	1.01	0.89	0.84	0.80	0.77	0.85	0.89	1.01	11.36
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.57	0.52	0.57	0.56	0.57	0.56	0.57	0.57	0.56	0.57	0.56	0.57	6.75
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	11.68	10.26	8.61	4.69	2.36	1.47	1.42	1.37	1.60	2.90	6.00	10.47	62.83

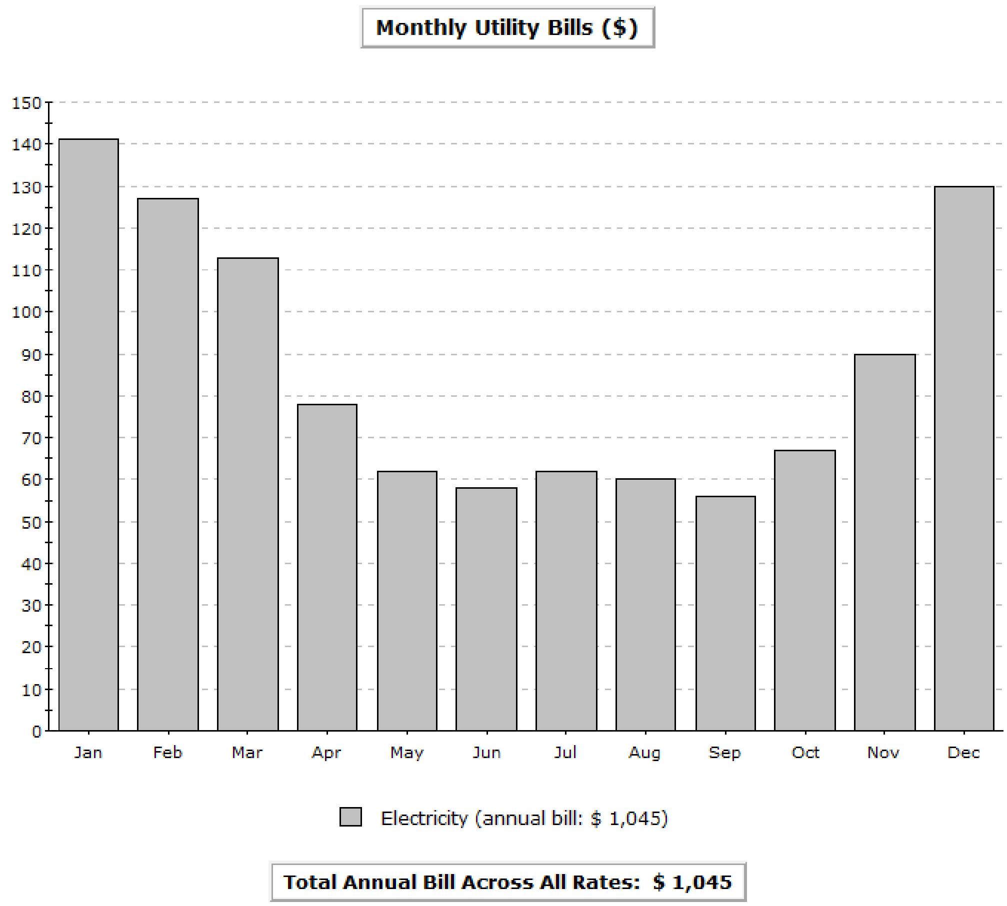

Monthly Utility Bills ($)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 610)
Propane Gas (annual bill: $ 1,642)
Total Annual Bill Across All Rates: $ 2,252

Townhouse (Mid Unit) - Air Source Heat Pump (ASHP)

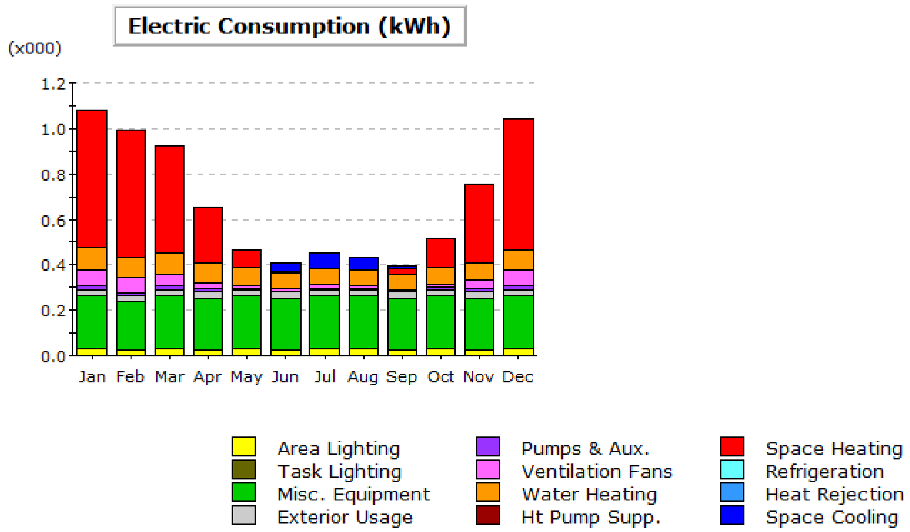


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	0.00	0.04	0.06	0.05	0.00	-	-	-	0.16
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.72	0.64	0.49	0.19	0.05	0.00	0.00	-	0.02	0.10	0.30	0.64	3.16
HP Supp.	0.01	-	-	-	-	-	-	-	-	-	-	-	0.01
Hot Water	0.09	0.09	0.09	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.08	0.09	0.96
Vent. Fans	0.07	0.06	0.05	0.03	0.01	0.01	0.02	0.02	0.01	0.02	0.04	0.06	0.39
Pumps & Aux.	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.06
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.23	0.21	0.23	0.22	0.23	0.22	0.23	0.23	0.22	0.23	0.22	0.23	2.74
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.34
Total	1.19	1.05	0.93	0.60	0.44	0.41	0.44	0.42	0.39	0.49	0.70	1.08	8.15

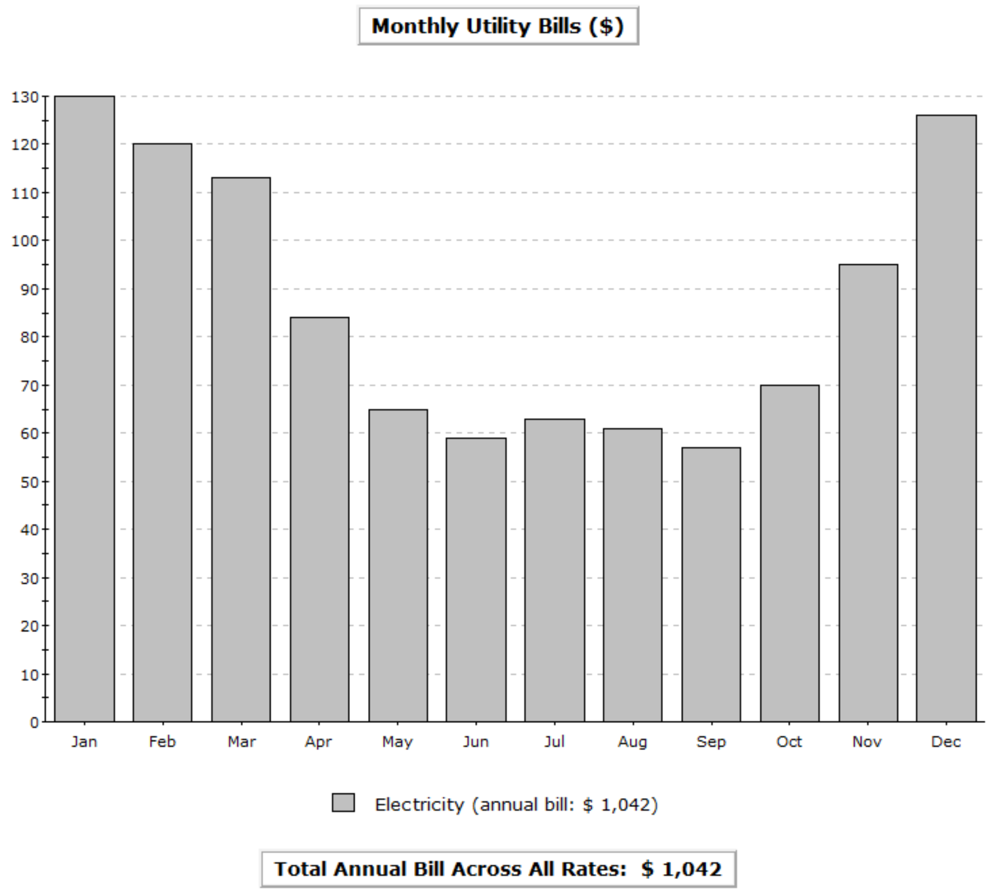

Monthly Utility Bills ($)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 1,045)
Total Annual Bill Across All Rates: $ 1,045

Townhouse (Mid Unit) - Ground Source Heat Pump (GSHP)

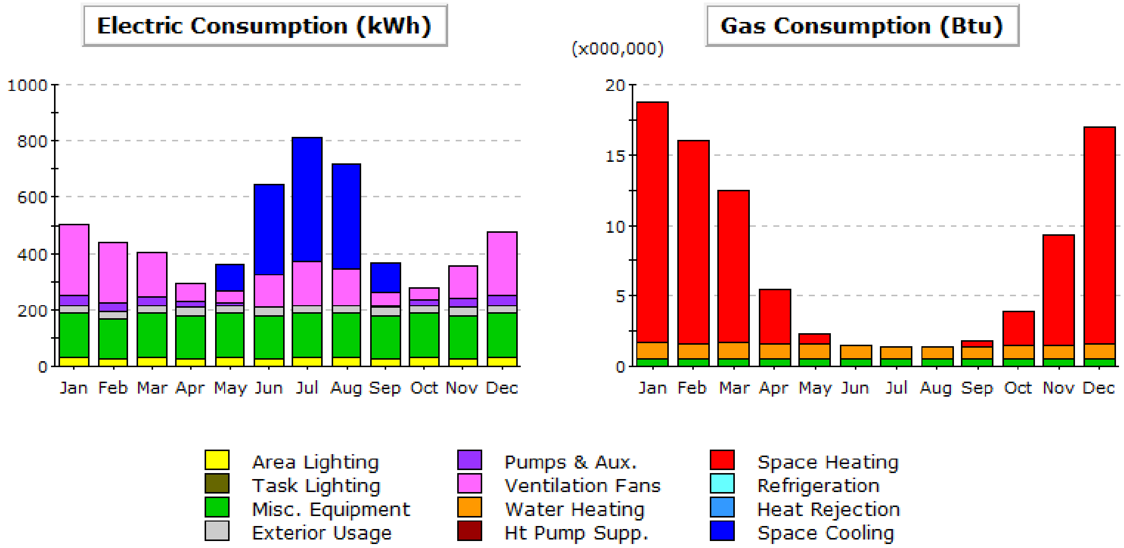


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	0.00	0.04	0.07	0.06	0.01	-	-	-	0.18
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.61	0.56	0.47	0.25	0.07	0.00	0.00	-	0.03	0.13	0.34	0.58	3.04
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.10	0.09	0.09	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.08	0.09	0.96
Vent. Fans	0.07	0.07	0.05	0.03	0.01	0.01	0.02	0.01	0.01	0.02	0.04	0.07	0.41
Pumps & Aux.	0.02	0.02	0.02	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.02	0.13
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.23	0.21	0.23	0.22	0.23	0.22	0.23	0.23	0.22	0.23	0.22	0.23	2.74
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.34
Total	1.08	0.99	0.93	0.65	0.47	0.41	0.45	0.43	0.39	0.52	0.75	1.05	8.12


Monthly Utility Bills ($)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 1,042)
Total Annual Bill Across All Rates: $ 1,042

Townhouse (End Unit) - Condensing Gas Furnace and Air Conditioning System

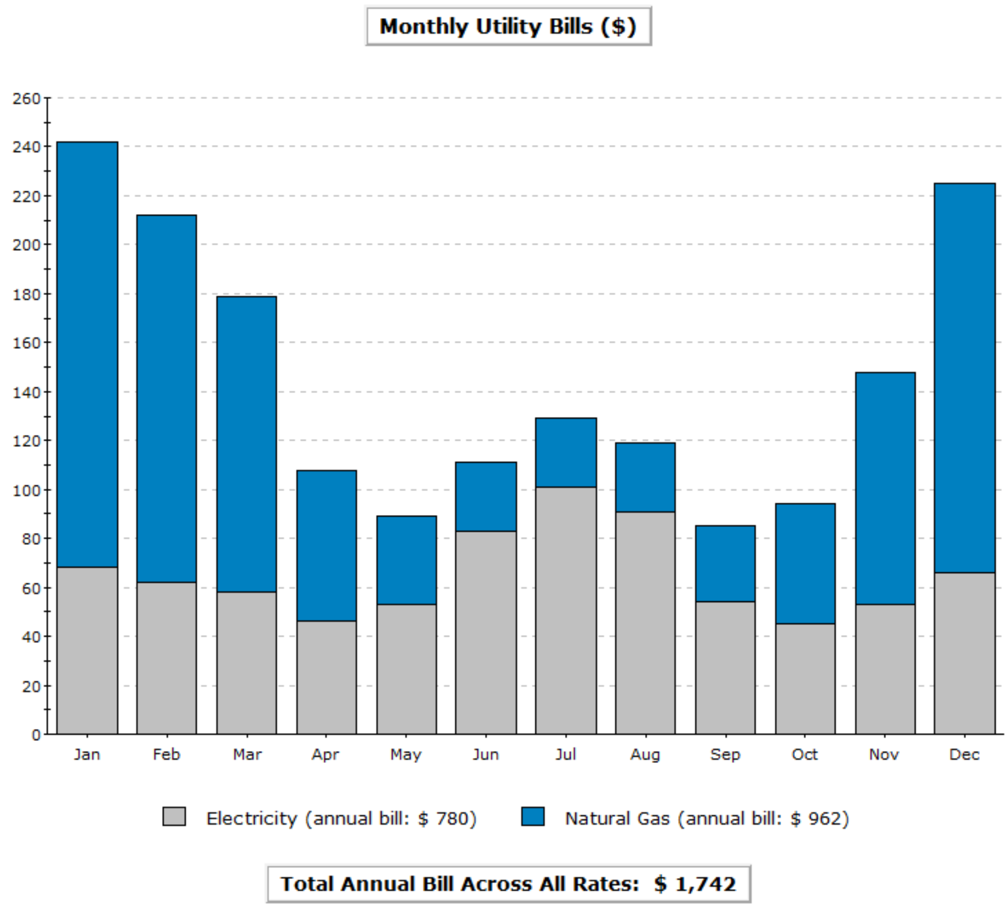


Electric Consumption (kWh)

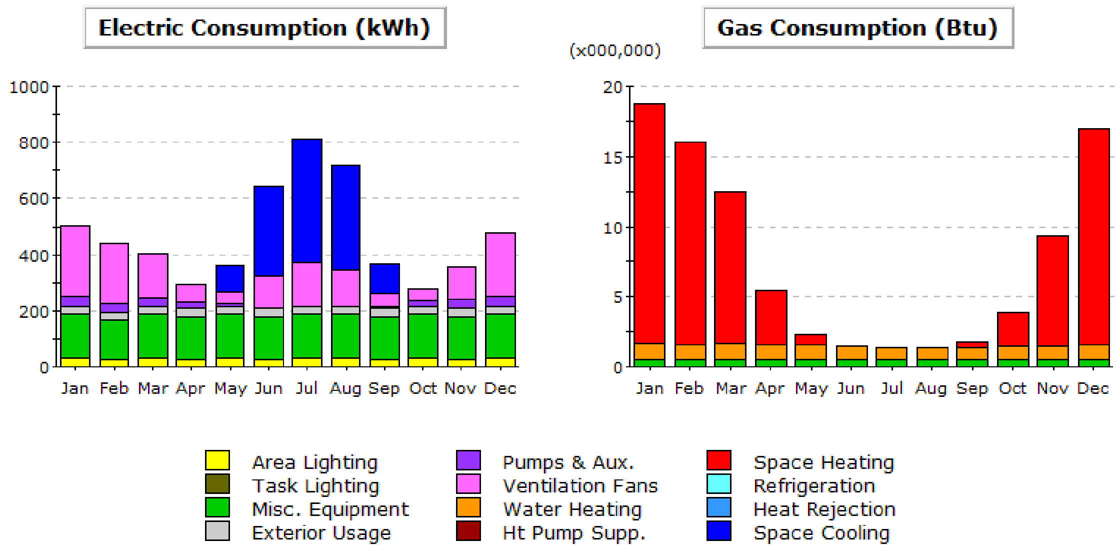
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	0.1	3.0	91.4	319.7	440.8	368.3	103.8	2.2	-	-	1,329.1
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	250.6	210.6	157.7	59.7	46.4	113.5	155.4	132.6	47.8	40.5	115.3	224.4	1,554.5
Pumps & Aux.	37.2	33.6	32.8	25.6	8.4	2.2	0.9	0.1	8.9	21.1	31.4	36.9	239.2
Ext. Usage	27.9	25.2	27.9	27.0	27.9	27.0	27.9	27.9	27.0	27.9	27.0	27.9	328.5
Misc. Equip.	157.3	142.1	157.3	152.2	157.3	152.2	157.3	157.3	152.2	157.3	152.2	157.3	1,852.1
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	29.1	26.3	29.1	28.1	29.1	28.1	29.1	29.1	28.1	29.1	28.1	29.1	342.2
Total	502.1	437.7	404.8	295.6	360.5	642.7	811.3	715.3	367.9	278.1	354.1	475.5	5,645.6

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	17.09	14.44	10.79	3.79	0.73	0.01	-	-	0.47	2.51	7.88	15.42	73.12
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	1.08	1.02	1.13	1.06	1.01	0.88	0.84	0.79	0.77	0.84	0.89	1.01	11.32
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.57	0.52	0.57	0.56	0.57	0.56	0.57	0.57	0.56	0.57	0.56	0.57	6.75
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	18.75	15.97	12.49	5.40	2.31	1.45	1.41	1.37	1.79	3.92	9.32	17.00	91.20


Monthly Utility Bills ($)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 780)
Natural Gas (annual bill: $ 962)
Total Annual Bill Across All Rates: $ 1,742

Townhouse (End Unit) - Propane Furnace and Air Conditioning System

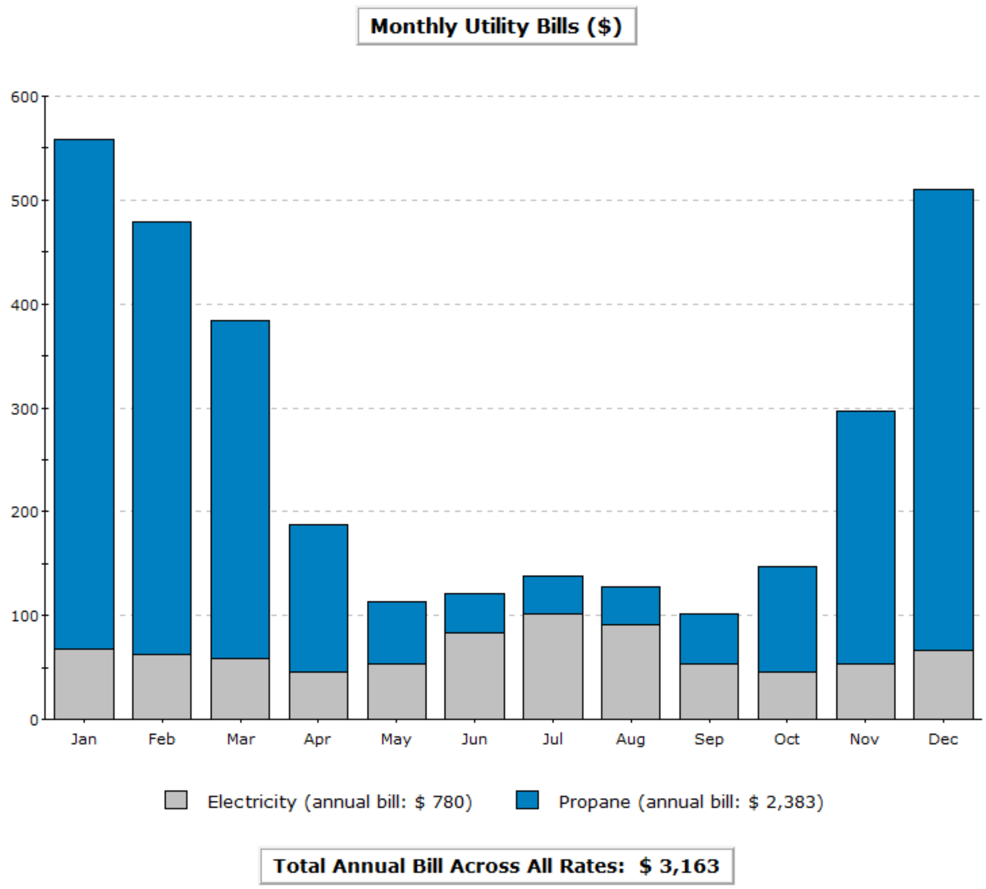


Electric Consumption (kWh)

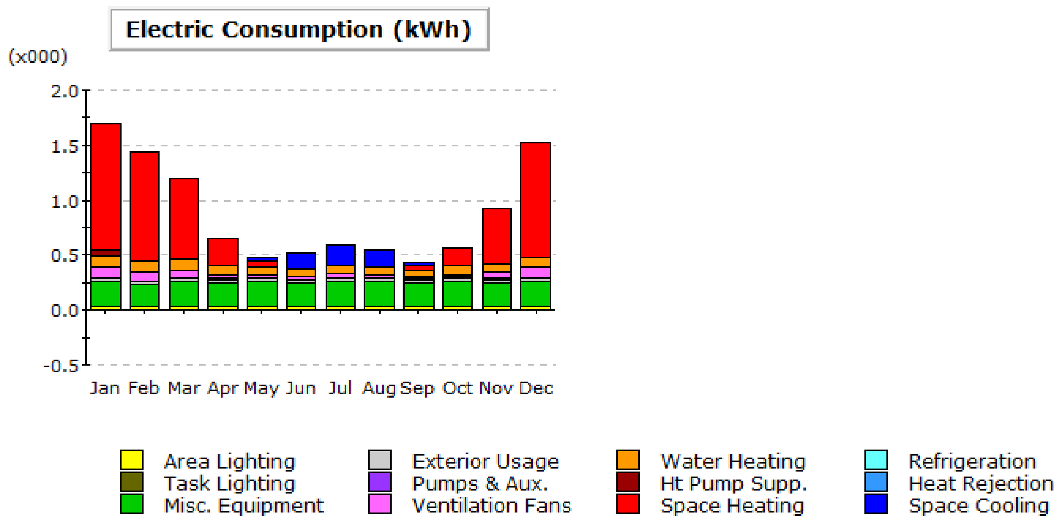
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	0.1	3.0	91.4	319.7	440.8	368.3	103.8	2.2	-	-	1,329.1
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	250.6	210.6	157.7	59.7	46.4	113.5	155.4	132.6	47.8	40.5	115.3	224.4	1,554.5
Pumps & Aux.	37.2	33.6	32.8	25.6	8.4	2.2	0.9	0.1	8.9	21.1	31.4	36.9	239.2
Ext. Usage	27.9	25.2	27.9	27.0	27.9	27.0	27.9	27.9	27.0	27.9	27.0	27.9	328.5
Misc. Equip.	157.3	142.1	157.3	152.2	157.3	152.2	157.3	157.3	152.2	157.3	152.2	157.3	1,852.1
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	29.1	26.3	29.1	28.1	29.1	28.1	29.1	29.1	28.1	29.1	28.1	29.1	342.2
Total	502.1	437.7	404.8	295.6	360.5	642.7	811.3	715.3	367.9	278.1	354.1	475.5	5,645.6

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	17.09	14.44	10.79	3.79	0.73	0.01	-	-	0.47	2.51	7.88	15.42	73.12
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	1.08	1.02	1.13	1.06	1.01	0.88	0.84	0.79	0.77	0.84	0.89	1.01	11.32
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.57	0.52	0.57	0.56	0.57	0.56	0.57	0.57	0.56	0.57	0.56	0.57	6.75
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	18.75	15.97	12.49	5.40	2.31	1.45	1.41	1.37	1.79	3.92	9.32	17.00	91.20

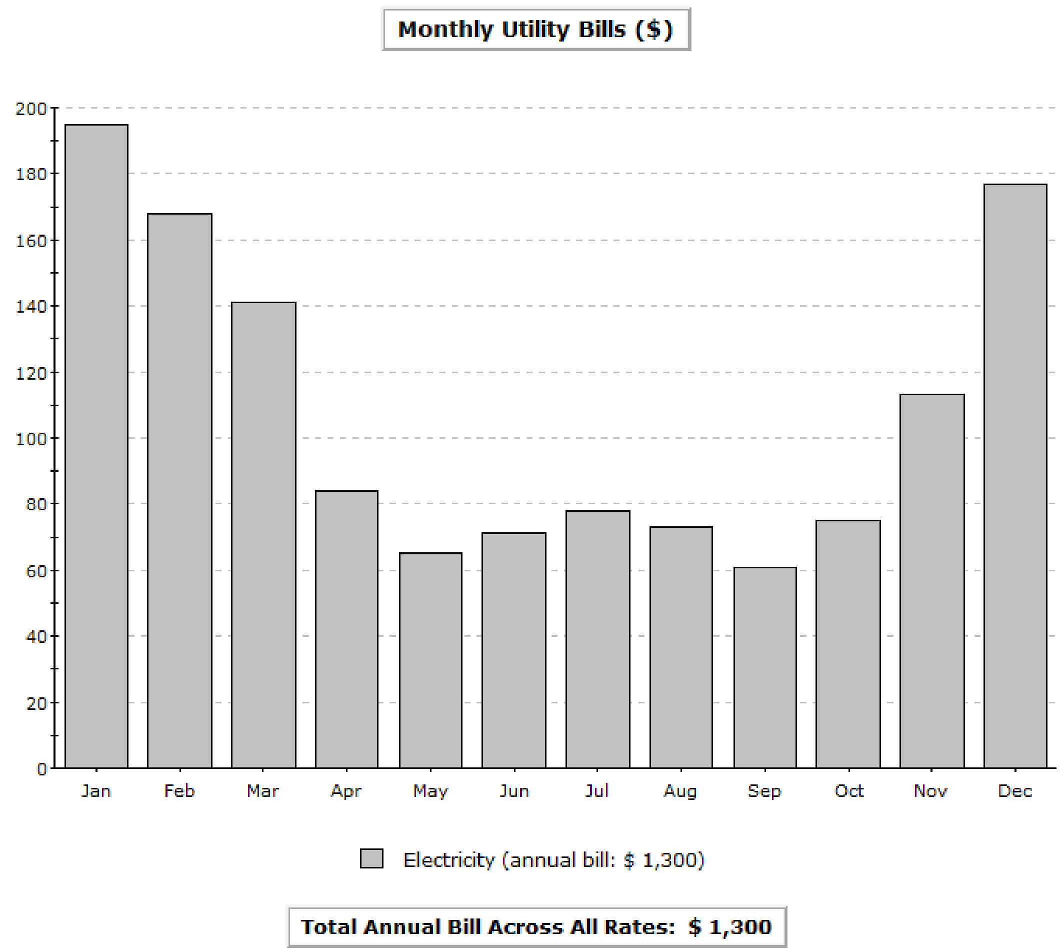

Monthly Utility Bills ($)
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 780)
Propane (annual bill: $ 2,383)
Total Annual Bill Across All Rates: $ 3,163

Townhouse (End Unit) - Air Source Heat Pump (ASHP)

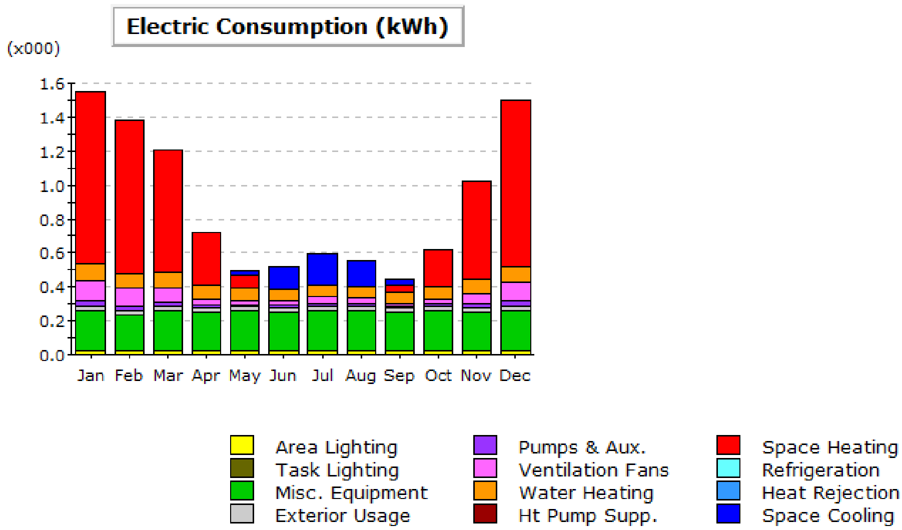


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	0.03	0.14	0.20	0.15	0.03	-	-	-	0.55
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.15	1.00	0.73	0.24	0.05	0.00	0.00	-	0.03	0.17	0.50	1.05	4.92
HP Supp.	0.06	0.00	-	-	-	-	-	-	-	-	-	-	0.06
Hot Water	0.10	0.09	0.09	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.08	0.09	0.95
Vent. Fans	0.10	0.09	0.07	0.03	0.02	0.03	0.04	0.03	0.02	0.02	0.06	0.10	0.62
Pumps & Aux.	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.07
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.23	0.21	0.23	0.22	0.23	0.22	0.23	0.23	0.22	0.23	0.22	0.23	2.73
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.34
Total	1.70	1.44	1.19	0.65	0.47	0.52	0.60	0.54	0.43	0.56	0.92	1.52	10.56

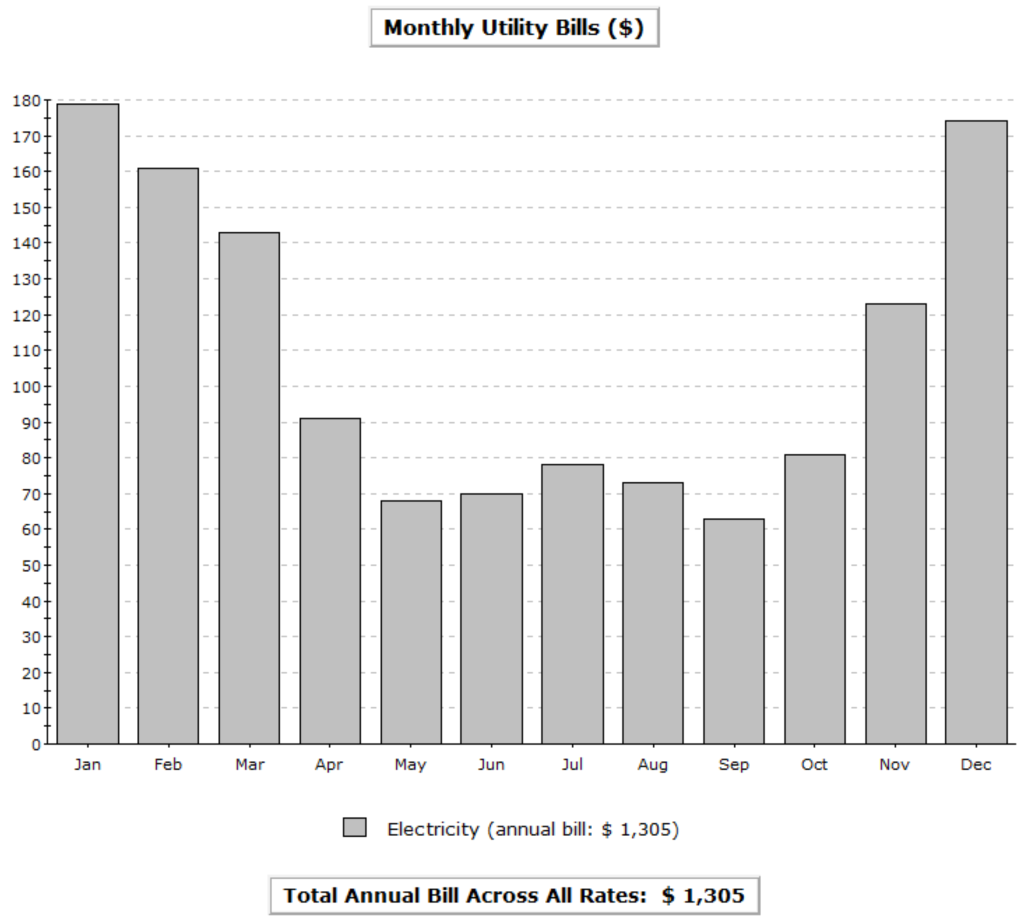

Monthly Utility Bills ($)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 1,300)
Total Annual Bill Across All Rates: $ 1,300

Townhouse (End Unit) - Ground Source Heat Pump (GSHP)

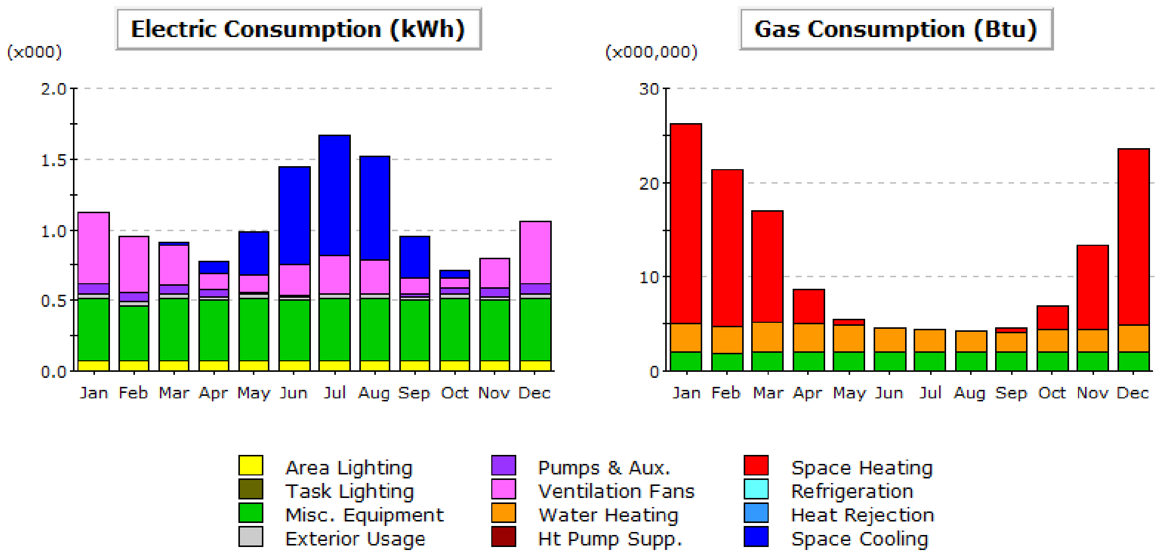


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	0.00	0.03	0.13	0.19	0.15	0.03	0.00	-	-	0.54
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.01	0.90	0.72	0.30	0.07	0.00	0.00	-	0.05	0.22	0.58	0.98	4.83
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.10	0.09	0.09	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.08	0.09	0.95
Vent. Fans	0.12	0.11	0.08	0.03	0.02	0.03	0.04	0.03	0.02	0.02	0.06	0.11	0.68
Pumps & Aux.	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.21
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.23	0.21	0.23	0.22	0.23	0.22	0.23	0.23	0.22	0.23	0.22	0.23	2.73
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.34
Total	1.55	1.38	1.21	0.72	0.50	0.52	0.60	0.55	0.45	0.62	1.02	1.50	10.60


Monthly Utility Bills ($)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 1,305)
Total Annual Bill Across All Rates: $ 1,305

Custom /Luxury House - Condensing Natural Gas Furnace and Air Conditioning System

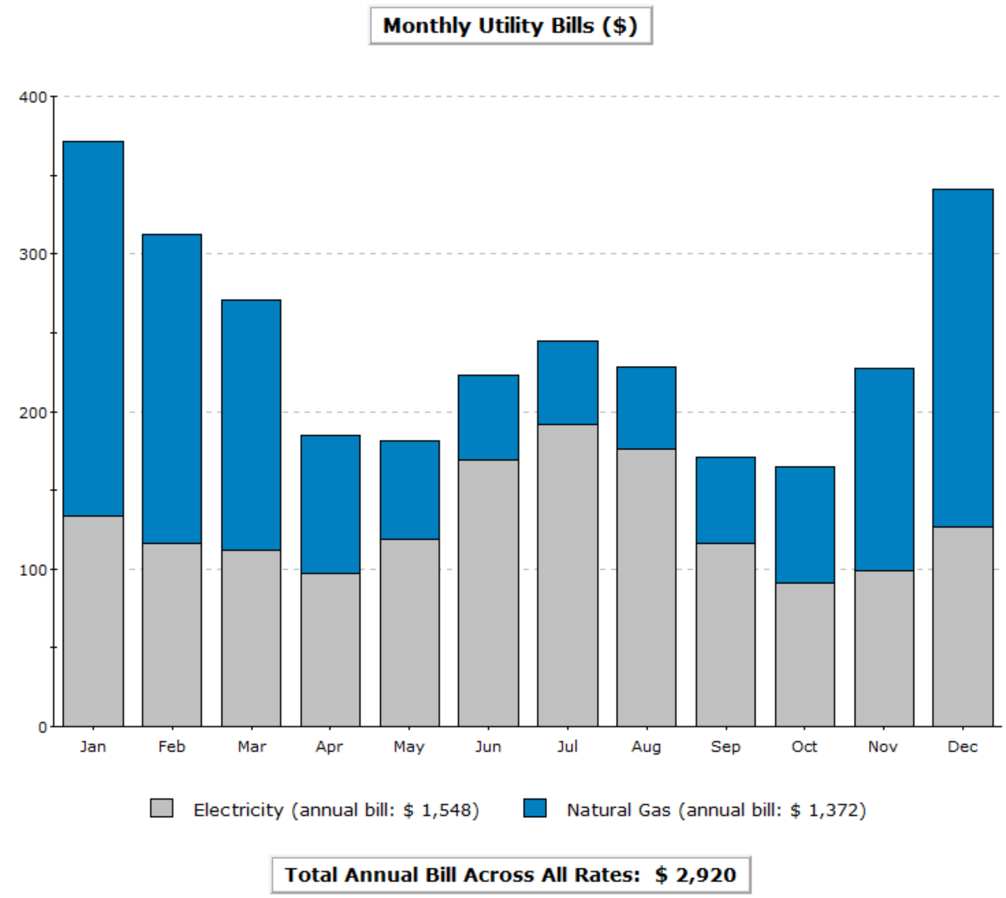


Electric Consumption (kWh x000)

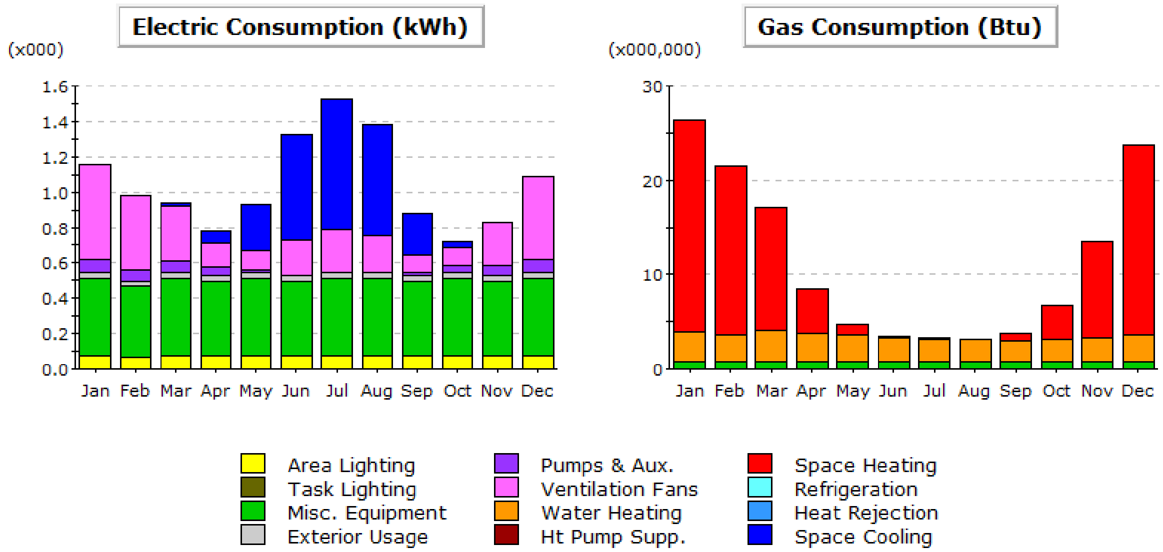
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	0.02	0.08	0.30	0.69	0.85	0.73	0.29	0.05	0.00	-	3.01
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0.50	0.39	0.29	0.12	0.12	0.23	0.28	0.24	0.11	0.08	0.21	0.44	3.01
Pumps & Aux.	0.07	0.07	0.07	0.05	0.02	0.00	0.00	0.00	0.02	0.04	0.06	0.07	0.48
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.44	0.40	0.44	0.42	0.44	0.42	0.44	0.44	0.42	0.44	0.42	0.44	5.15
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.91
Total	1.12	0.95	0.91	0.77	0.98	1.45	1.67	1.51	0.95	0.72	0.79	1.06	12.89

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	21.16	16.63	11.81	3.60	0.55	0.02	-	-	0.44	2.49	8.82	18.63	84.15
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	3.05	2.87	3.18	3.01	2.85	2.51	2.38	2.24	2.17	2.36	2.49	2.83	31.95
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	2.03	1.83	2.03	1.97	2.03	1.97	2.03	2.03	1.97	2.03	1.97	2.03	23.91
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	26.24	21.34	17.02	8.58	5.43	4.51	4.41	4.27	4.57	6.88	13.27	23.49	140.01


Monthly Utility Bills ($)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 1,548)
Natural Gas (annual bill: $ 1,372)
Total Annual Bill Across All Rates: $ 2,920

Custom /Luxury House - Propane Furnace and Air Conditioning System

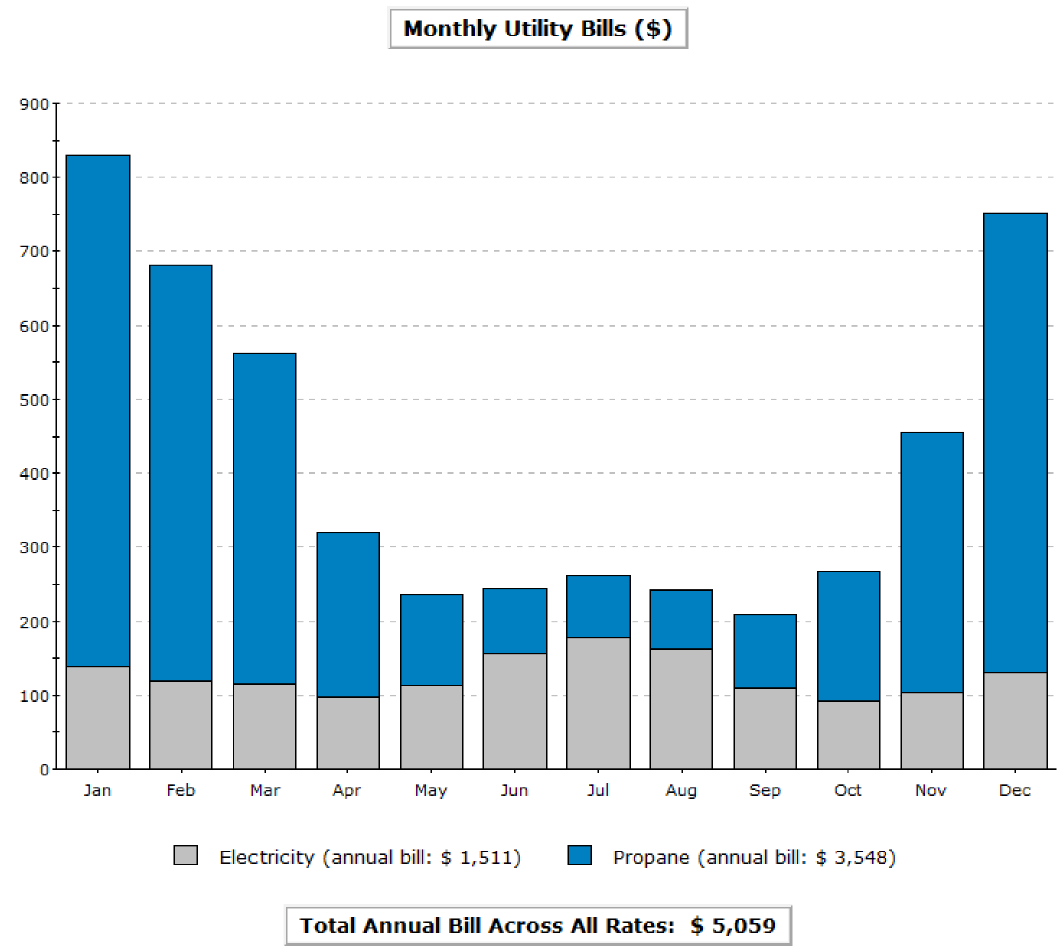


Electric Consumption (kWh x000)

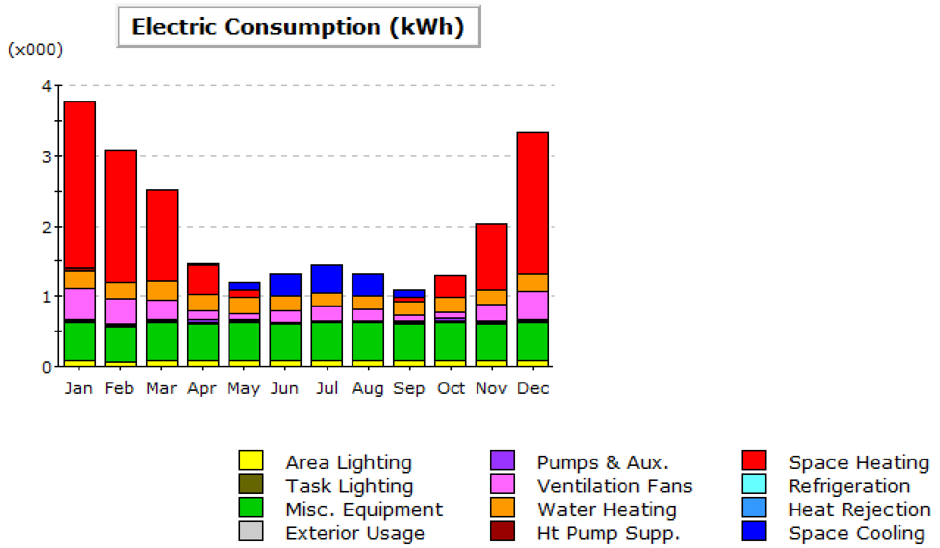
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	0.01	0.06	0.25	0.60	0.74	0.63	0.24	0.04	-	-	2.58
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0.54	0.43	0.32	0.14	0.11	0.20	0.24	0.21	0.10	0.10	0.24	0.48	3.10
Pumps & Aux.	0.07	0.07	0.07	0.05	0.02	0.00	0.00	0.00	0.02	0.04	0.06	0.07	0.48
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.44	0.40	0.44	0.42	0.44	0.42	0.44	0.44	0.42	0.44	0.42	0.44	5.15
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.91
Total	1.16	0.98	0.94	0.78	0.93	1.33	1.53	1.38	0.88	0.72	0.83	1.09	12.55

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	22.56	17.90	13.14	4.71	1.07	0.07	0.01	-	0.82	3.54	10.19	20.06	94.08
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	3.05	2.87	3.18	3.01	2.86	2.52	2.38	2.24	2.17	2.36	2.49	2.83	31.95
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.83	0.75	0.83	0.80	0.83	0.80	0.83	0.83	0.80	0.83	0.80	0.83	9.79
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	26.44	21.52	17.16	8.53	4.76	3.39	3.22	3.08	3.79	6.73	13.49	23.72	135.82

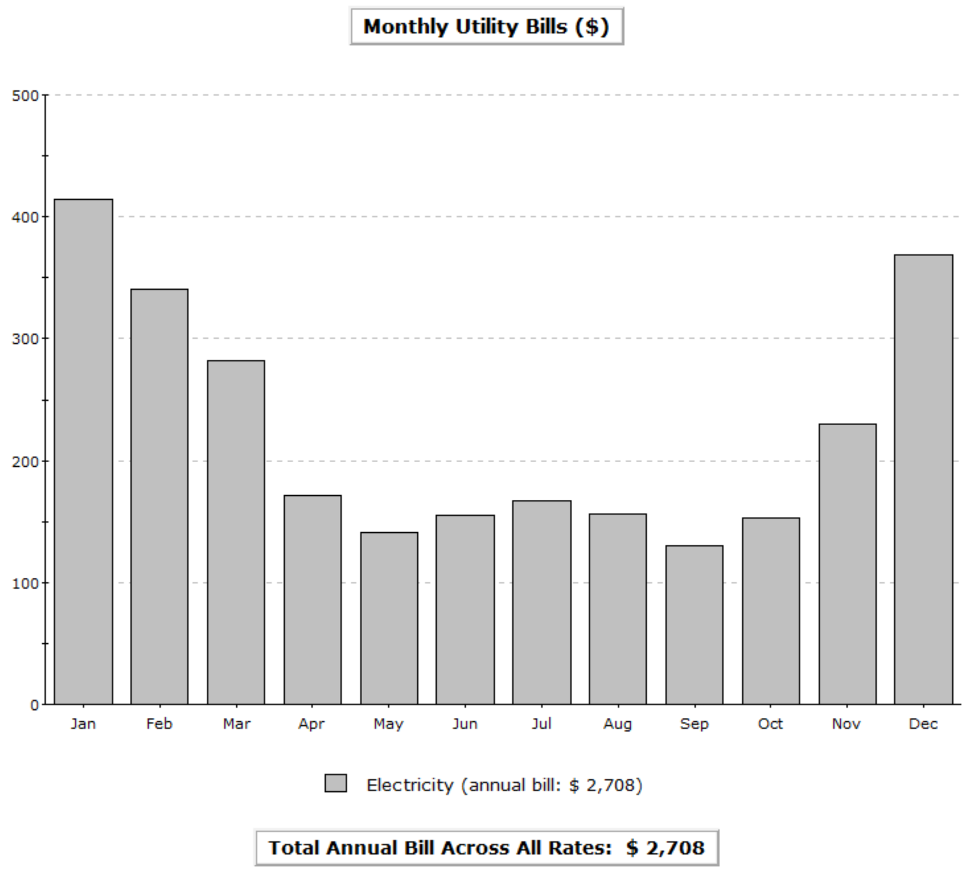

Monthly Utility Bills ($)
900
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 1,511)
Propane (annual bill: $ 3,548)
Total Annual Bill Across All Rates: $ 5,059

Custom /Luxury House - Air Source Heat Pump (ASHP)

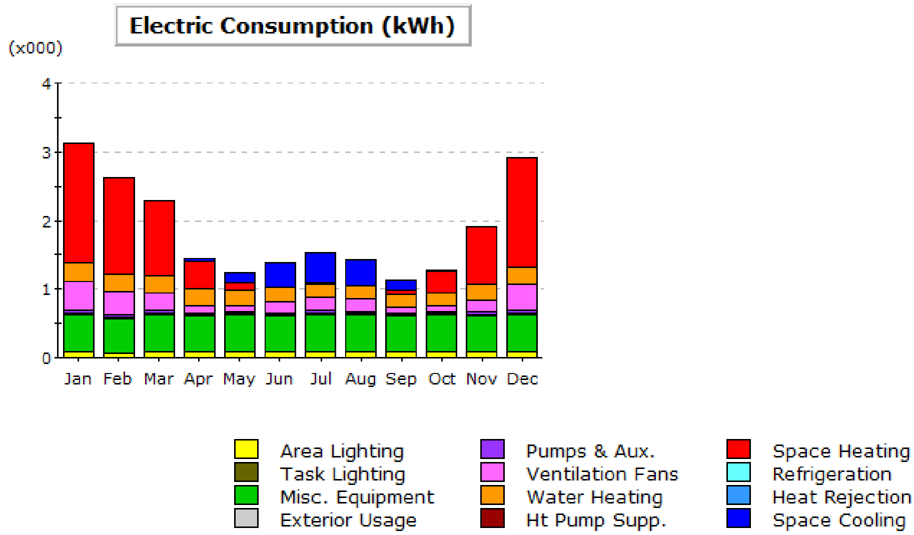


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	0.00	0.02	0.11	0.31	0.38	0.32	0.10	0.01	-	-	1.24
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.37	1.87	1.31	0.42	0.09	0.01	0.00	-	0.07	0.32	0.93	2.03	9.41
HP Supp.	0.02	-	-	-	-	-	-	-	-	-	-	-	0.02
Hot Water	0.26	0.24	0.26	0.24	0.23	0.20	0.20	0.19	0.18	0.20	0.22	0.25	2.66
Vent. Fans	0.44	0.35	0.27	0.13	0.10	0.17	0.21	0.18	0.09	0.09	0.22	0.40	2.65
Pumps & Aux.	0.02	0.02	0.03	0.04	0.02	0.00	0.00	0.00	0.02	0.03	0.03	0.02	0.24
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.54	0.49	0.54	0.52	0.54	0.52	0.54	0.54	0.52	0.54	0.52	0.54	6.37
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.91
Total	3.77	3.07	2.52	1.47	1.19	1.32	1.44	1.33	1.08	1.30	2.02	3.34	23.84

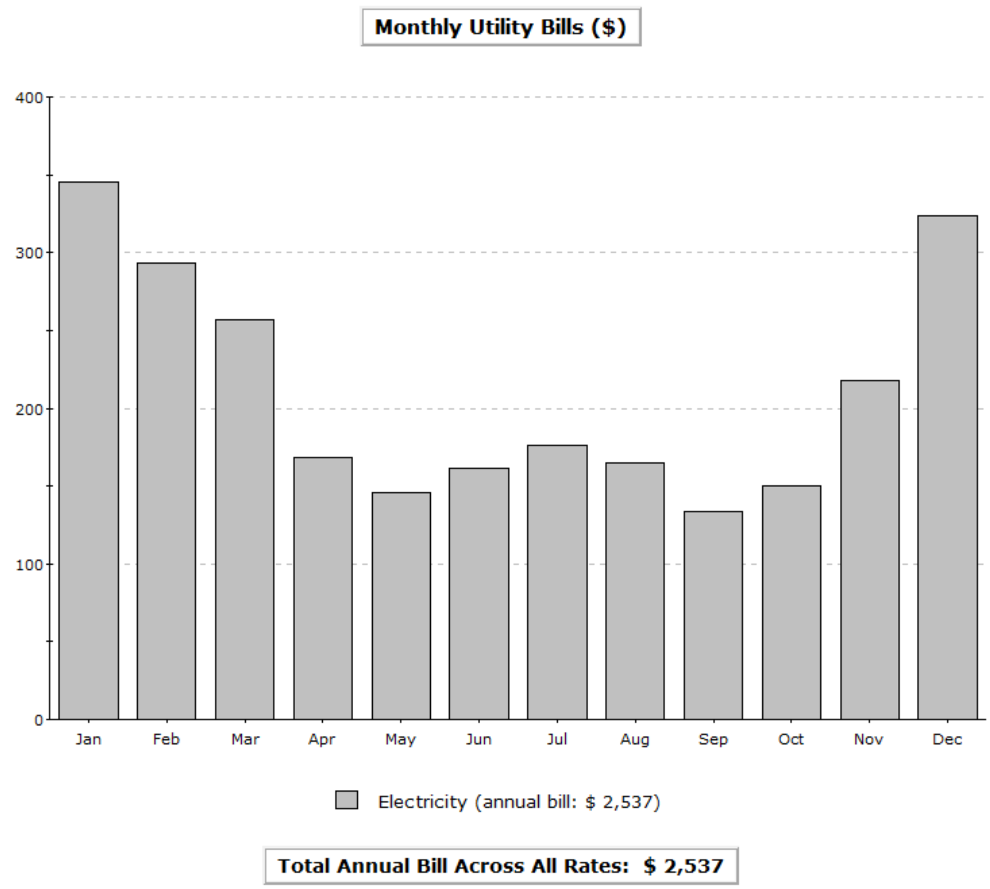

Monthly Utility Bills ($)
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 2,708)
Total Annual Bill Across All Rates: $ 2,708

Custom /Luxury House - Ground Source Heat Pump (GSHP)



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	0.01	0.04	0.15	0.36	0.44	0.38	0.14	0.02	-	-	1.54
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.73	1.41	1.08	0.40	0.09	0.01	0.00	-	0.07	0.30	0.85	1.60	7.55
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.26	0.24	0.26	0.24	0.23	0.20	0.20	0.19	0.18	0.20	0.22	0.25	2.66
Vent. Fans	0.42	0.34	0.25	0.11	0.09	0.16	0.20	0.17	0.08	0.08	0.18	0.37	2.46
Pumps & Aux.	0.05	0.04	0.04	0.03	0.02	0.03	0.04	0.03	0.02	0.02	0.04	0.05	0.41
Ext. Usage	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Misc. Equip.	0.54	0.49	0.54	0.52	0.54	0.52	0.54	0.54	0.52	0.54	0.52	0.54	6.37
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.91
Total	3.11	2.62	2.28	1.44	1.23	1.38	1.52	1.42	1.12	1.27	1.91	2.91	22.22


Monthly Utility Bills ($)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity (annual bill: $ 2,537)
Total Annual Bill Across All Rates: $ 2,537