Pitkin County Energy Use
Utility Data Analysis

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Section 1: Overview

Goal: Review energy data provided by gas and electric utility providers to determine an average energy use per area of residential property. This is an update to a study that REG completed in 2020 and updated in 2023 to include Greenhouse Gas (GHG) impacts. This study update leverages a significantly larger data set to see if a newer and larger set of homes shows different trends or quantities or verifies the previous study.

Key Findings:

- Holy Cross Energy provided data from **2,275 meters over 5 years**, and Black Hills Energy provided data from **945 meters over 4** years for a total of **over 15,000 data points**. Approximately 84% of the residential properties in unincorporated Pitkin County were included in this study.
- **General trends and observations from the previous study of 2014-2017 utility data are confirmed and supported by this larger and more current data set**.
- We see that, as home size increases, the energy consumed and GHG impacts escalate disproportionately on a per area basis. This creates a compounding effect **where a 13,000 ft^2 home uses 41.5 times more energy than a 1,000 ft^2 home (and has a roughly 21.5 larger GHG impact)**, rather than the 13 times –or even less– that might be expected. This is contrary to expectations because small homes tend to have more occupants per area and tend to be occupied year-round rather than a fraction of the year.
- For homes 5,000 ft^2 and smaller, the **newer data set shows a reduction of 21% to 39% in energy used per ft^2 of home relative to the previous data**. This improvement declines with increasing home size to near zero in larger homes. (The weighted average age of homes in the 2020 study was 1985. In this study the average age is 1997, 12 years newer.) We would expect that, as homes are built and/or remodeled under newer more efficient versions of the code that energy use is lowered, and the data confirms that for homes below 6,000 ft^2.

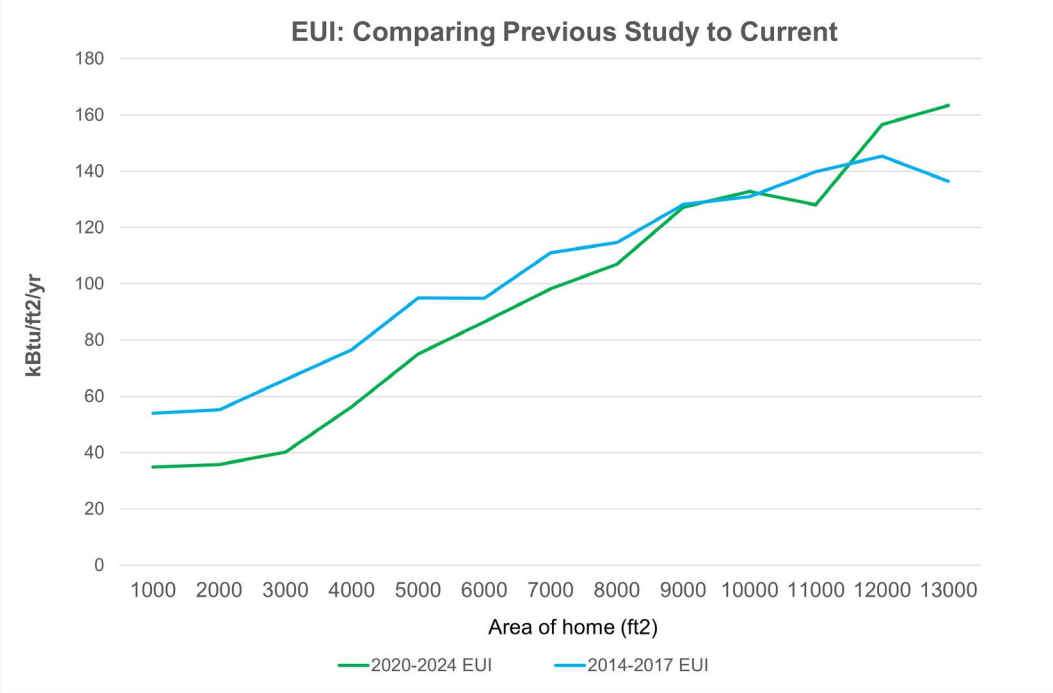
- Average energy for **homes in Pitkin County that are near the national average of 2,200 ft^2 have an Energy Use Intensity (EUI) of approximately 35 kBtu/ft^2/yr**. This is below the national average of 44 kBtu/ft^2/yr. (EUI, or Energy Use Intensity, is the total energy use per square foot.)
- Pitkin County homes 4,000 ft^2 and larger are generally well above the national average of 44 kBtu/ft^2/yr with **4,000 ft^2 homes at 56 kBtu/ft^2/yr, increasing to 163 kBtu/ft^2/yr for the average Pitkin County home in the 13,000 ft^2** category. The EUI of the average **10,000 ft^2 home is 3.8 times higher than the EUI of the average 1,000 ft^2** home in Pitkin County.
- **The trends for GHG per home and per ft^2 are similar to those for energy**, although not identical due to the varying mix of natural gas versus electric for the different home sizes and the GHG impact of each fuel type. The GHG impact in this study is limited to the GHG associated with gas and electric use and does not consider effects such as embodied carbon.
- As the local electric grid continues to lower the operational eCO_2, there is a stronger push for electrification to reduce the eCO_2 impact of operating buildings. (City of Aspen electrical utility is effectively 100% renewable and zero eCO2. Holy Cross Energy is over 75% renewable and is on target for 100% renewable by 2030). However, this also opens the question: is eCO_2 a metric that tells the fully story of the impacts of energy use? Or is eCO_2 an incomplete representation of the impacts of a modern electrical grid?
- The large increase in energy use per ft^2 for larger homes indicates that these homes include additional energy uses that are not found in typical American homes. These additional uses are often referred to as “luxury amenities,” or amenity loads. An incomplete list of these amenities includes: snowmelt, pools, spas, outdoor heating of occupied spaces, roof and gutter melt, humidification, audio visual systems, precise thermal control, oxygen systems, wine rooms, steam showers, etc. REG has recently completed a companion study of electrical and mechanical system plans “Electrical Service Sizing Study” which is in final editing and expected to be released by end of July 2025. This study can be referred to for a more in-depth discussion of this topic.

Section 2: Graphs & Discussion

The data from the four years studied is relatively consistent from year to year. We have presented the average of the data set in graphs below. The electrical data included 2020 through 2024, while natural gas data is for the 4 years from 2021 through 2024. We have elected to use the 4 years of complete data. The data from the two utility companies is aggregated into groups of 1,000 ft^2 each to allow for anonymity of the properties studied. For example, any home between 1,000 ft^2 and 2,000 ft^2 will be in the 1,000 ft^2 bin, any home between 2,000 ft^2 and 3,000 ft^2 is in the 2,000 ft^2, and so on. Homes in the 13,000 ft^2 bin are between 13,000 ft^2 and 14,000 ft^2. The x-axis for all graphs shows the home size bins.

Each of the sections below charts each of the data sets based on home size, illustrating the energy, GHG, and EUI use for different home sizes in unincorporated Pitkin County.

1. **EUI: Comparing Previous Study to Current:** Overall, the EUI is generally consistent over time. In the chart below, total energy use per square foot, aka Energy Use Intensity (EUI), is plotted against home size for the previous study (2014-2017) and the current study (2020-2024). The trend is similar in both data sets, but there is a significant reduction in EUI for homes 5,000 ft^2 and smaller in the newer study, and the average 13,000 ft^2 home use increased. The improvement in the smaller home is most likely related to the average home age in the newer data set being 12 years newer. The increase in use at the highest end of the size spectrum is likely from amenity loads, but neither can be concretely determined from the available data.

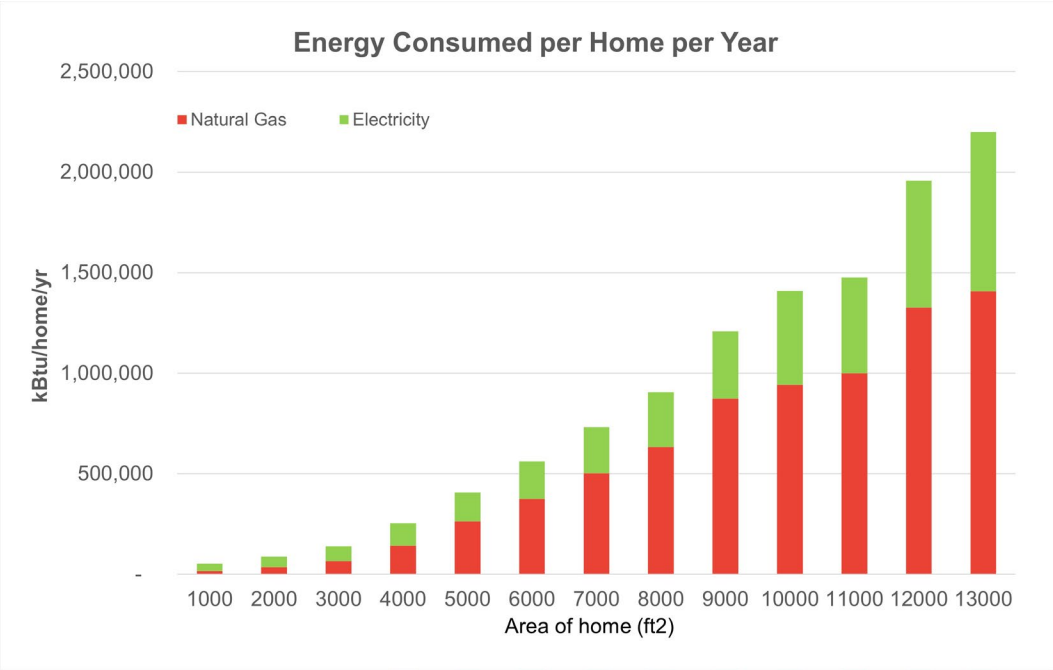


2. **Data Summary Table:** This table details the number of homes per size category (aka "bin"), average size, age of home and the % all-electric in each size category. Approximately 80% of homes in the 1,000 and 2,000 ft^2 homes are all-electric. This accounts for 1,070 of the 2,275 electric meters. The percentage of all-electric homes decreases with size. The higher fraction of electric homes at the smaller end of the size scale is likely comprised of homes using electric resistance heating for reduced construction costs rather than modern heat pumps to reduce energy use. Yet these homes can be seen to use dramatically less energy per home and per area in graphs further down in the report.

Data Summary

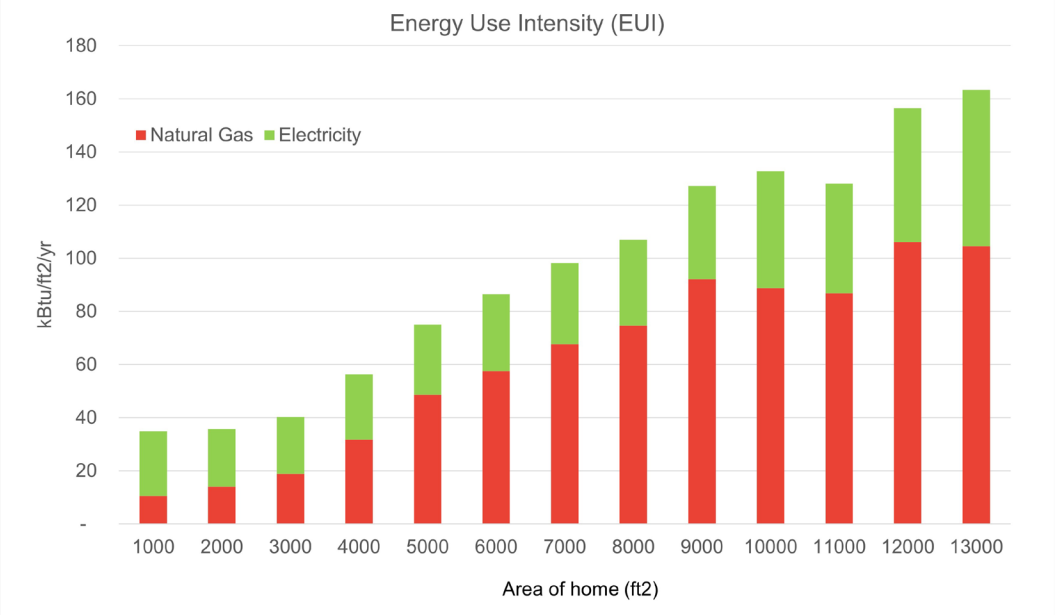
ID used	Size Range (ft2)	Home Counts	Average Size (ft2)	Average Year Built	Electric only home (%)
1,000	1,001 to 2,000	495	1,521	1991	81%
2,000	2,001 to 3,000	575	2,472	1992	78%
3,000	3,001 to 4,000	376	3,456	1996	66%
4,000	4,001 to 5,000	220	4,516	2001	51%
5,000	5,001 to 6,000	174	5,429	2004	33%
6,000	6,001 to 7,000	103	6,506	2003	31%
7,000	7,001 to 8,000	79	7,444	2005	22%
8,000	8,001 to 9,000	68	8,478	2003	4%
9,000	9,001 to 10,000	52	9,490	2007	5%
10,000	10,001 to 11,000	38	10,602	2005	18%
11,000	11,001 to 12,000	29	11,518	2008	6%
12,000	12,001 to 13,000	17	12,495	2011	0%
13,000	13,001 to 14,000	18	13,464	2009	8%
14,000	>14001	32	17,944	2007	0%
Total homes in study		**2276**			
Average weighted age		**1997**			
Average weighted size		**3,980**			

3. **Energy Consumed per Home per Year**: This graph shows total energy with the natural gas and electricity portions shown. The average 13,000 ft^2 home uses 41 times more energy than the average 1,000 ft^2 home, and a 10,000 ft^2 home uses 26 times more.



4. **Energy Use Intensity (EUI):** EUI is a metric that is commonly used in the US to compare the relative energy intensity of buildings. The average EUI for American homes is 44 kBtu/ft^2/yr and the average home size in the EUI database is 2,200 ft^2. For this Pitkin County data set, the EUI of the average 10,000 ft^2 home is 3.8 times higher than the EUI of the average 1,000 ft^2 home. Average EUI per bin, with natural gas and electric portions shown, is in the chart below.

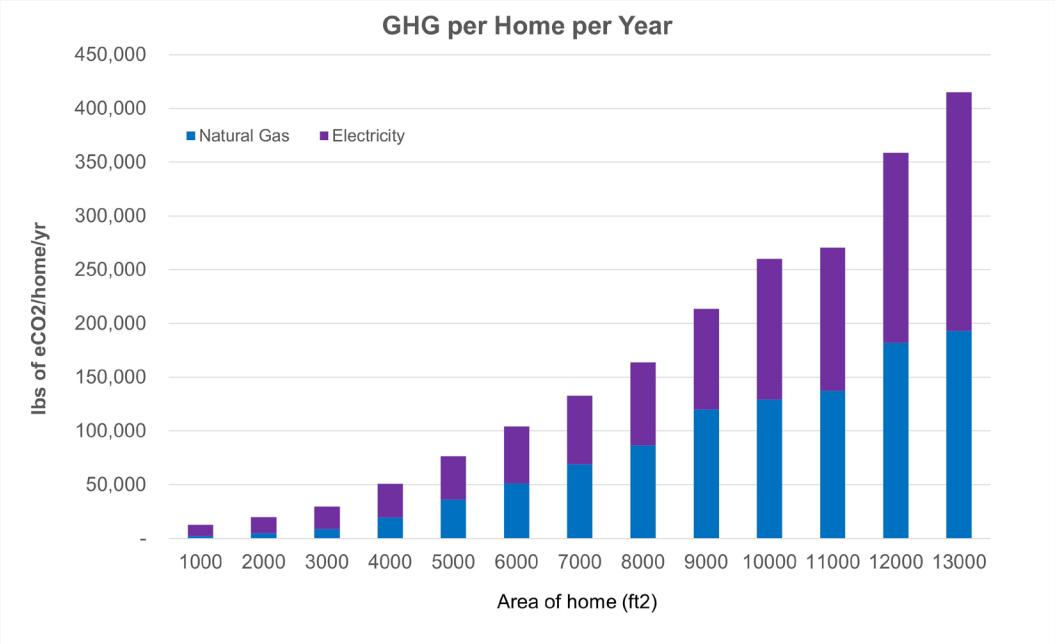
   By analyzing the energy consumed on a per square foot basis per year (kBtu/ft^2/yr) we can see the relative energy consumption of a property in a way that allows us to compare buildings of varying size for intensity rather than just size. For buildings that have a similar function, we would expect the energy intensity to be similar. For example, one hotel compared to another should in theory have a similar EUI. Similarly, we would intuitively expect residential properties to have similar energy used per area. Possibly, homes that are often unoccupied or have larger area per person might have a lower EUI, however here we see the opposite effect; larger homes use more energy, not just because they are bigger, but also on a per area basis. In our analysis in the companion study (Electrical Service Sizing Study) this effect is driven in large part by luxury amenities such as snowmelt, humidification, audio visual systems, etc. (more on this below). Note also that electricity makes up a larger fraction of the energy use in smaller homes. Approximately 80% of homes in the 1,000 and 2,000 ft^2 homes are all-electric. This accounts for 1,070 of the 2,275 homes in the study. The percentage of all-electric homes decreases with size.



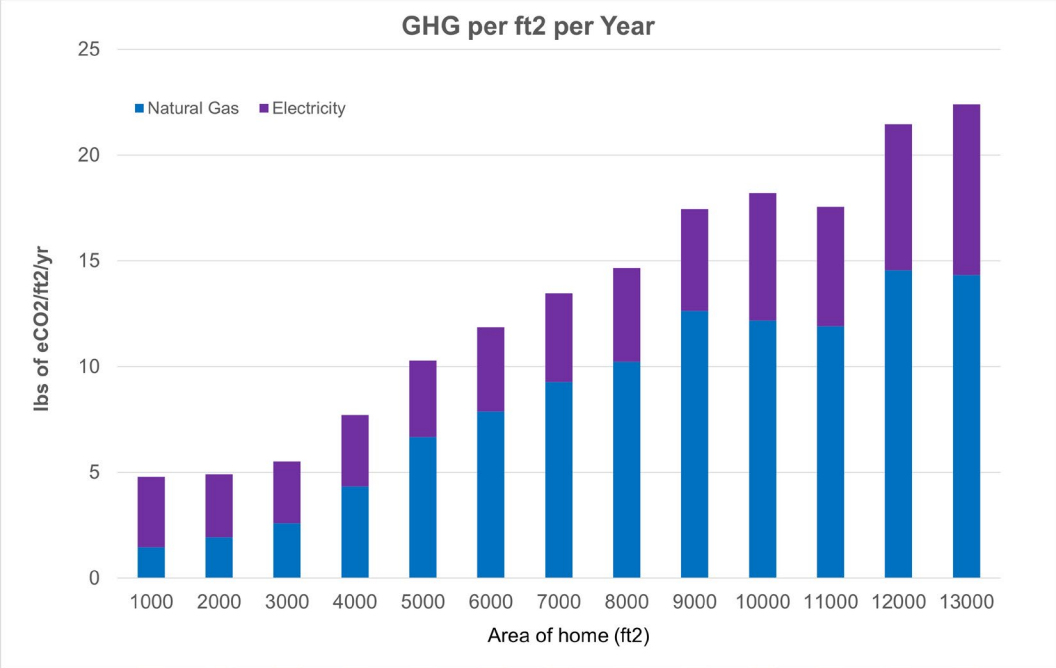
5. **GHG per Home per Year:** The graph below shows the Greenhouse Gas (GHG) emissions per home, including the relative portions attributable to natural gas and electricity. Larger homes have an outsized impact, similar to the graph for energy. For example, the 13,000 ft^2 home has 33 times higher GHG impact than a 1,000 ft^2 home.

   For this analysis, the eCO_2 used for electricity is 0.434 mt CO_2/MWh for current utility grid mix (per communication between Pitkin County Staff and Holy Cross Electric). Converted to a common unit for this comparison, this represents **0.2804 lbs of eCO2/kBtu**. Per talks with Holy Cross Electric (HCE) this is thought to be a fairly comprehensive eCO_2 value. The GHG value for natural gas provided by Black Hills Energy is 0.00531 mt eCO_2/therm. This value represents only the impacts of combustion of natural gas, not including impacts of methane (natural gas) leakage or energy consumption in transportation of gas from extraction to consumption. This is also known as "up stream" impacts and is not accounted for by Black Hills Energy, whereas Holy Cross Electric's published eCO2 does attempt to account for upstream impacts. In recent analysis used in the Aspen Business As Usual report ("Aspen BAU"), a value of **0.1371 lbs of eCO2/kBtu** has been used.

   The graphs below use this value to estimate the GWP impacts of natural gas. This value includes impacts of combustion and an assumed increase in equivalent CO2 of approximately 20%, which is consistent with Environmental Protection Agency (EPA) and International Energy Agency (IEA) studies. However, in a study published July 31st of 2024 by MethaneSAT using airborne measuring equipment from plane and satellite equipment, actual leakage ratios from Colorado natural gas fields have been measured at 5 to 7 times the data previously published by the EPA. If this additional leakage is accounted for, the GWP of natural gas will be double or higher for the values presented in the graphs below.


GHG per Home per Year
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
lbs of eCO2/home/yr
Natural Gas
Electricity
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
Area of home (ft2)

6. **GHG per ft^2 per Year**: The following graph shows the GHG emissions per area including the relative portions attributable to natural gas and electricity. Again, the larger homes have an outsized impact. For example, per square foot of home, the 13,000 ft^2 home has 4.7 times higher GHG impact than a 1,000 ft^2 home. On a per area basis, the larger homes use a higher fraction of natural gas. Per the discussion in the bullet above, if newer methane leakage estimates are accounted for the GWP for natural gas represented here will approximately double.



Section 3: Methodology

Methodology:
The Pitkin County Assessors Office and Community Development Department worked closely with Holy Cross Energy and Black Hills Energy to provide cross-referenced data for specific service locations. The locations were kept anonymous by aggregating data into size categories of 1,000 ft^2 increments. Only locations they could together verify as having a single gas and/or electric meter were used. Locations using propane were not included. Electrical data was provided in kWh, and gas in therms. All units were converted to kBtus for consistency and to allow easier comparisons against national data. The average home size in each bin was used as the area for all data in that bin.