



## Pitkin County Energy Use Utility Data Analysis

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### Section 1: Goals and Key Findings

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#### Goal:

Review energy data provided by gas and electric utility providers to determine an average energy use per area of residential property. If possible, determine if there is a correlation between home size and energy use per area of home. The common expectation is that as a home increases in size, the energy used per area (per square foot, ft<sup>2</sup>) of home will decrease. Anecdotal evidence has previously shown the opposite.

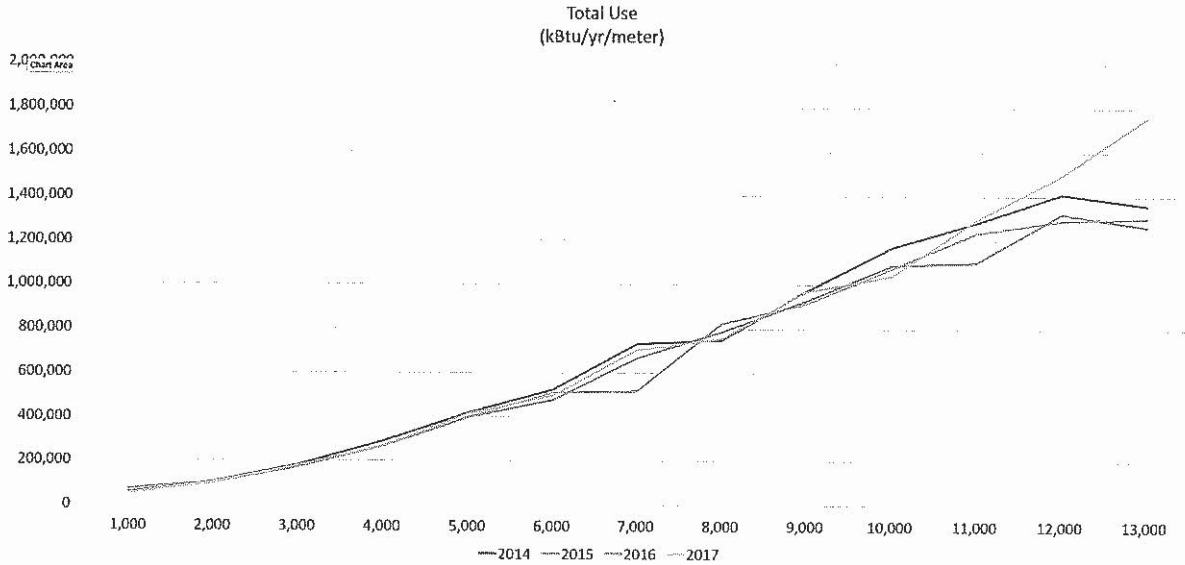
#### Key Findings:

- Holy Cross Energy and Black Hills Energy provided a data from nearly 900 homes spanning 4 years (2014 through 2017), for a total of 3,577 data records. All homes are located in Pitkin County.
- There is a strong correlation between home size and energy use per area (expressed as kBtu/ft<sup>2</sup>/yr). In general, larger homes use more energy per square foot.
- As home size increases from 1,000ft<sup>2</sup> (the smallest homes studied) to 14,000ft<sup>2</sup>, the energy used **per ft<sup>2</sup>** more than triples from an **average of 34 kBtu/ft<sup>2</sup>/yr to 105 kBtu/ft<sup>2</sup>/yr.**
- Average energy used across all homes is 80 kBtu/ft<sup>2</sup>/yr
  - Average for homes from 1,000 to 5,000 ft<sup>2</sup> is 46 kBtu/ft<sup>2</sup>/yr
  - Average for homes from 5,000 to 14,000 ft<sup>2</sup> is 95 kBtu/ft<sup>2</sup>/yr

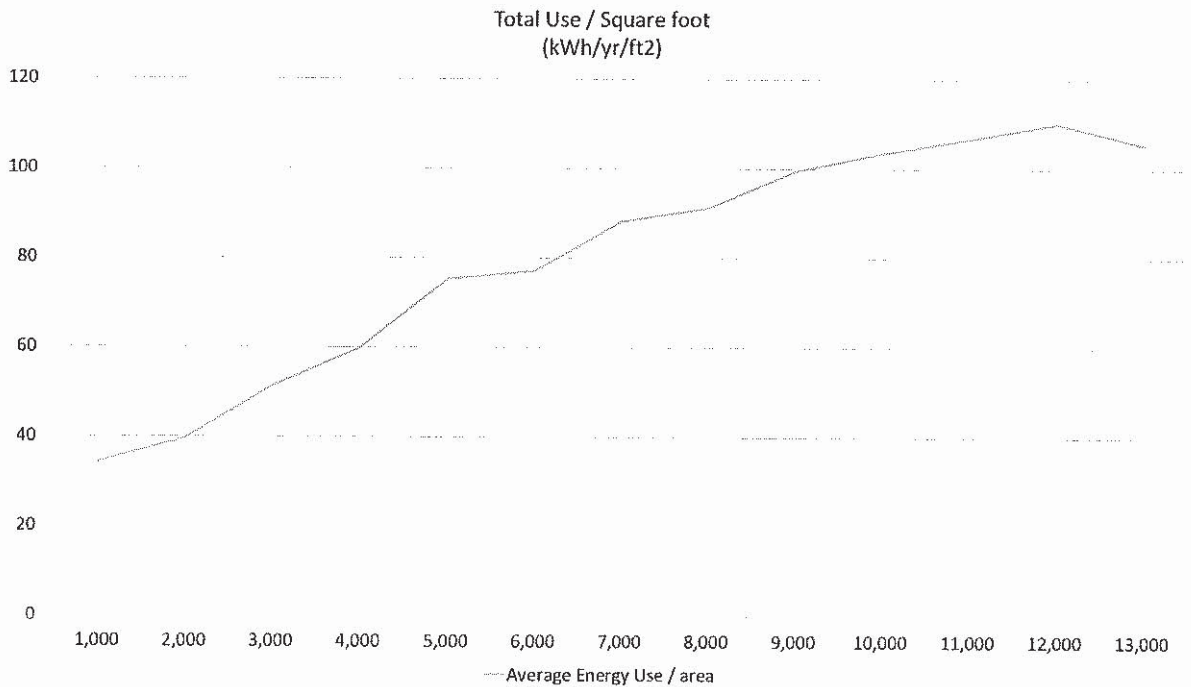
## Section 2: Graphs

The data from all four years is fairly consistent (all four years are shown in Graph #1 to illustrate this). There is a trend showing that as homes increase in size, the energy used per square foot of home increases (for clarity, only the average of the four years is shown in Graph #2).

1. Total energy use per service location plotted against home size.



2. Total energy use per square foot of home, plotted against home size.



## Section 3: Summary

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**Expected results:** Intuitively, most people would expect the energy use per square foot of home to decrease as a home gets larger. Larger homes have more area per occupant and we expect the occupants' habits to be a significant driver of energy used, along with heating and cooling loads through the building shell. Here again, a large home would be assumed to have less wall and roof area per square foot of floor, and therefore lower heating and cooling loads. The expectation and common perception is that the line in graph #2 to be decreasing as home size increases.

**Actual results:** Energy use per square foot of home increases as the home size grows—by 3 times. Put another way, a 10,000 ft<sup>2</sup> home doesn't use 10x more energy than a 1,000 ft<sup>2</sup> home, but instead **uses 30x times more energy.**

- As home size increases from 1,000ft<sup>2</sup> (the smallest homes studied) to 14,000ft<sup>2</sup> (largest homes in this data set), the energy used **per ft<sup>2</sup>** more than triples from an **average of 34 kBtu/ft<sup>2</sup>/yr to 105 kBtu/ft<sup>2</sup>/yr.**
- Average energy used across all meters is 80 kBtu/ft<sup>2</sup>/yr
- Average for homes 1,000 to 5,000 is 46 kBtu/ft<sup>2</sup>/yr
- Average for homes 5,000 to 14,000 is 95 kBtu/ft<sup>2</sup>/yr

**Speculation of causes:** Some possible reasons for the discrepancy between the expected scenario and actual data include: humidification systems, snowmelt systems, roof and gutter melt systems, pools, spas, increased use of complex audio visual and security systems, increased expectations of thermal comfort and therefore higher use of cooling systems, and a liberal use of glass in the high-end residential market. The data also suggests that newer homes are continuing the trend of increased energy use per square foot. Note that the average age of the smaller homes is older than larger homes (increasing from an average year of construction of 1978 to 2005). We would expect newer homes to be more efficient, but on an energy used per square foot basis, the trend is the opposite.

## Appendix: Methodology & Data

### Methodology:

Holy Cross Energy and Black Hills Energy provided cross-referenced data for specific service locations. The locations were kept anonymous. 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 kBtu's for consistency and to allow easier comparisons against national data. Bins of 1,000 ft<sup>2</sup> increments were used to allow for data to be provided anonymously and not able to be correlated to specific sites at a later date. The average home size in of each bin was used as the area for all data in that bin.

### Data:

1. Service locations, average age and average size

Heated Sq Ft		Avg Age	Avg Size
Min	Max	(yr)	(ft2)
1,000	2,000	1978	1,621
2,000	3,000	1982	2,508
3,000	4,000	1982	3,436
4,000	5,000	1979	4,529
5,000	6,000	1988	5,409
6,000	7,000	1989	6,503
7,000	8,000	1995	7,420
8,000	9,000	1996	8,506
9,000	10,000	1998	9,499
10,000	11,000	2002	10,534
11,000	12,000	2000	11,496
12,000	13,000	2000	12,519
13,000	14,000	2005	13,485

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2. Total number of service locations per size and year of data

Size (ft2)	Total Count			
	2014	2015	2016	2017
1,001 to 2,000	143	144	144	144
2,001 to 3,000	250	249	250	250
3,001 to 4,000	152	152	152	152
4,001 to 5,000	85	85	85	85
5,001 to 6,000	55	56	56	56
6,001 to 7,000	62	62	62	62
7,001 to 8,000	19	19	19	19
8,001 to 9,000	22	22	22	22
9,001 to 10,000	30	30	30	30
10,001 to 11,000	23	23	23	23
11,001 to 12,000	22	22	22	22
12,001 to 13,000	12	12	12	12
13,001 to 14,000	18	18	18	18
	<b>893</b>	<b>894</b>	<b>895</b>	<b>895</b>

3. Total average energy use at each service location for each size range

Size (ft2)	Total: Avg kBtu/yr/SrvLoc			
	2014	2015	2016	2017
1,001 to 2,000	52,697	49,967	69,518	49,729
2,001 to 3,000	102,480	98,081	100,207	96,261
3,001 to 4,000	181,026	170,814	174,394	177,743
4,001 to 5,000	287,501	263,376	268,437	263,725
5,001 to 6,000	417,544	396,295	400,808	415,063
6,001 to 7,000	524,504	474,966	509,934	497,669
7,001 to 8,000	730,827	667,965	516,855	705,433
8,001 to 9,000	748,510	785,511	821,496	754,256
9,001 to 10,000	973,436	929,176	916,224	968,810
10,001 to 11,000	1,168,576	1,088,299	1,073,693	1,039,116
11,001 to 12,000	1,280,886	1,102,936	1,235,578	1,297,397
12,001 to 13,000	1,411,491	1,323,423	1,291,654	1,497,012
13,001 to 14,000	1,360,783	1,264,081	1,302,863	1,759,753

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4. Total average energy use per square foot of home for each size range

Size (ft <sup>2</sup> )	Total Avg kBtu/ft <sup>2</sup> /yr				
	2014	2015	2016	2017	AVG
1,001 to 2,000	33	31	43	31	34
2,001 to 3,000	41	39	40	38	40
3,001 to 4,000	53	50	51	52	51
4,001 to 5,000	63	58	59	58	60
5,001 to 6,000	77	73	74	77	75
6,001 to 7,000	81	73	78	77	77
7,001 to 8,000	98	90	70	95	88
8,001 to 9,000	88	92	97	89	91
9,001 to 10,000	102	98	96	102	100
10,001 to 11,000	111	103	102	99	104
11,001 to 12,000	111	96	107	113	107
12,001 to 13,000	113	106	103	120	110
13,001 to 14,000	101	94	97	130	105
<b>average kBtu/ft<sup>2</sup>/yr of all data</b>					<b>80</b>
<b>average of homes less than 5,000 ft<sup>2</sup></b>					<b>46</b>
<b>average of greater than 5,000 ft<sup>2</sup></b>					<b>95</b>