

Spatial Energy Burden Analysis of the Fairbanks North Star Borough



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Summary

Energy burden is the share of gross household income that is spent on residential energy services, such as space heating and electricity. Within the Fairbanks North Star Borough (FNSB), there is considerable interest in estimating the average energy burden for residents given the cold climate, high energy prices, and aging building stock faced by residents. In this brief, the average energy burdens by census tract within the borough are estimated using housing stock, market energy price, and census socioeconomic data. The average annual household energy burden in the FNSB is estimated to be 10%. These estimates indicate that FNSB residents are considered highly energy burdened, which should be taken into consideration by policymakers and regulators when designing programs that determine cost-of-living (COL) adjustments and/or income assistance.

Introduction

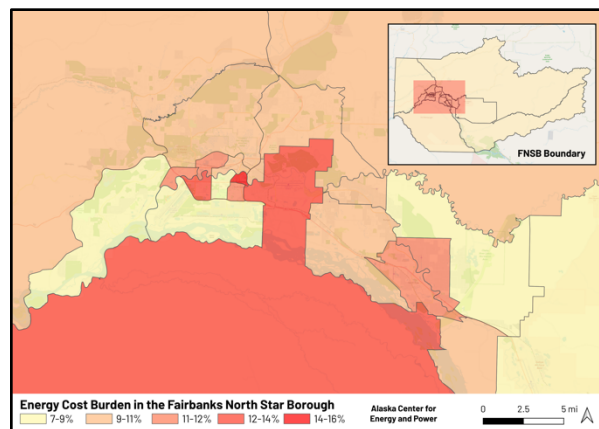
Alaska has the highest per capita energy consumption and expenditures in the nation [1]. The state's cold climate, geographic isolation, limited infrastructure, ageing housing stock, and small energy markets all contribute to these metrics. Given the high energy demand and expenditures, determining the average energy burden is useful for informing equitable assistance and relocation allowance design. Cost-of-living (COL) adjustments should incorporate these higher-than-expected energy costs.

Energy Cost Burden

- Average FNSB Energy Burden: 10.12%
- Lowest: 6.65% (Eielson Air Force Base)
- Highest: 16.33% (Downtown Fairbanks)

The estimated average energy burdens of Fairbanks North Star Borough households at the census tract level are displayed geographically in Figure 1. The map is shaded with colors that correspond to the average household energy burden with lighter colors indicating a lower energy burden and darker colors indicating a higher energy burden. A larger version of this map is presented in Appendix Figure 1. In addition, energy burden estimates for each census tract are presented in Table 1.

Figure 1. Spatial Representation of Energy Cost Burden



The weighted average energy cost burden for FNSB residents is 10.12% of household income. This is a housing unit weighted average of the estimated energy burdens for the census tracts in the FNSB.

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The energy burdens of the individual census tracts range from 6.65% to 16.33%.

The energy burden for a given census tract directly correlates to the age of the housing stock and the median household income in the census tract. The census tract 1 energy burden estimate of 16.33% is an outlier due to a low median household income estimate (relative to other tracts) coupled with the oldest housing stock in the borough, distorting this value. More information on the approach used for calculating energy costs is included in the Methods section of this brief.

Table 1. Energy Cost Burden by Census Tract

Tract	Description	Energy Cost Burden
1	Downtown Fairbanks	16.33%
2	Airport Way Central	7.87%
3	South Fairbanks	10.77%
4	Hamilton Acres	9.72%
5	Johansen/Railroad	9.26%
6	College/Aurora	12.37%
7	Airport Way West	12.62%
8	Geist/University West	10.89%
9	Chena Ridge	7.35%
10	FAI/Van Horn	7.52%
12	Steese Highway	9.33%
13	UAF/Farmers Loop	10.00%
14.01	Badger West/Persinger	10.51%
14.02	Badger West/Bradway	8.98%
15.01	Badger East/Moose Creek Dam	7.40%
15.02	Badger East/Plack	11.31%
16	Greater North Pole	11.04%
17	Salcha	9.16%
19.01	Goldstream/Murphy Dome	9.68%
19.02	Chena River Valley	9.98%
9800	Fort Wainwright	12.52%
9801	Eielson AFB	6.65%

Average household space heating and electricity cost estimates for each census tract are displayed in Appendix Table 1. The annual weighted average energy expenditures are \$4,982 per household for space heating and \$3,284 per household for electricity (weighted by number of occupied units in each tract). This amounts to average annual household energy cost of \$8,266.

The highest estimated space heating cost of \$6,346 per household is associated with census tract 12 (Steese Highway). Census tract 9801 (Eielson Air Force Base), has the lowest estimated average annual space heating cost estimate of \$2,525. These

tracts also correlate to the highest and lowest annual household electricity costs respectively.

Comparisons

The estimated average energy burden in the U.S. is estimated to be 3.1%, and households with an energy burden of 6% or more are classified as high energy burden households [2], [3]. For the Pacific region, which includes Alaska, an even lower average energy burden of 2.3% is estimated. By comparison, the estimated average household energy burden in the FNSB of 10.12% is more than three times greater than the national average and almost 1.7 times the high energy burden classification metric.

It should also be noted that energy cost burden is not constant. Changes in energy efficiency, incomes, or energy prices will affect estimates. For example, the estimated energy costs reported here are higher than estimates found in the Alaska Housing Finance Corporation’s 2018 Housing Assessment due to large increases in energy prices since then [4].

Methods

Estimating energy burden required: 1) an estimation of the heating loads (in millions of British thermal units (MMBtu)) for existing homes in the FNSB, and 2) an estimation of the expenditures for space heating and electricity. The following two sections describe each process in detail.

Heating Load Estimation

A heating load in the context of this study is a representation of the amount of energy required to maintain a particular temperature in a home. Calculating the heating load is an essential aspect of building design and energy efficiency. In cold climate regions like Fairbanks, Alaska, accurate heating load calculations are critical to ensure that buildings are designed to keep occupants comfortable while minimizing energy consumption.

To estimate heating loads in the FNSB geographic information systems (GIS) files and property data were obtained from the Borough [5]. Structures identified as residential living areas, attached garages, and enclosed/finished additions were retained. This data was combined with real estate and tax parcel information for property including building area, age, and physical location. The average heating load for each property was estimated as a function of the square footage and year built using

heat load data from the Alaska Housing Finance Corporation's Alaska Retrofit Information System database [6].

Properties were sorted into census tracts using GIS shapefiles from the U.S. Census and the total heating load of the properties in a tract was summed. Building categories also include attached garages and finished additions, since many are heated in the FNSB.

Energy Burden Estimation

Disclaimer: Energy is defined as the sum of space heating requirements and electricity consumption. This analysis does not examine non-electric energy used for transportation or cooking.

To estimate the energy cost burden, average household expenditures for space heating and electricity were estimated. To estimate space heating expenditures, a weighted average price of \$36.84 per MMBtu was calculated from an index of heating fuel oil [7], cord wood, wood pellets [8], natural gas [9], coal, and district heat (steam) [10] prices specific to the FNSB after controlling for the annual fuel utilization efficiency of the appliances that use a given fuel [10]. The energy prices used for this index are shown in Appendix Table 2. The average price per MMBtu was weighted by the share of appliances using a given fuel in the borough [11]. The weighted average price was multiplied by the annual space heating load for each census tract to obtain total heating load expenditures in the tract. This was then divided by the number of housing units in the tract to obtain the average space heating expenditure per housing unit.

To estimate electricity expenditures, average annual household electricity (MMBtu/year) use was calculated by subtracting space heating energy use from the total energy use estimates for single family homes in the Fairbanks North Star Borough in the Alaska Housing Finance Corporation's 2018 Housing Assessment [4]. Then, average annual household electricity use was multiplied by electricity prices retrieved from the Golden Valley Electric Association to yield average annual household electricity expenditures [12]. Monthly customer charges are not included in this calculation. The summation of the average space heating and electricity expenditures per housing unit divided by the median household income [13] in each tract amounts to the average

energy burden in each tract, which are displayed in Table 1 and Appendix Table 1.

To accurately reflect the average energy burden in the FNSB, a housing unit weighted arithmetic mean was used to down weight tracts with smaller populations and up weight tracts with larger populations resulting in an estimate of 10.12%.

Limitations

This study has several methodological limitations to consider.

1. **Homogenous Housing Stock.** Using the available data, it was not possible to determine whether properties had undergone energy efficiency retrofits or had installed solar panels. Therefore, average heating load expenditures by the home's age and square footage are used for all building types.
2. **Garages and Additions.** It was not possible to identify which garages and additions within the dataset are heated. Additionally, garages and additions do not have construction years associated with them. Garages and additions are treated the same as living spaces for the heat load estimation and assigned the latest year built on the property to the structures without associated years.
3. **Data Year Mismatches.** The most recent data available was used for these estimations resulting in data year mismatches. The GIS data used for housing unit estimates is from 2020. Census statistics are from 2022, and market pricing data for fuels is from 2024. This creates a slight variance in the true estimate for energy burden. Additionally, energy burden estimates will vary with market prices for energy which can change dramatically throughout the year. Our estimates use prices from winter months to capture the reality of energy expenditures which occur the most during these months.

Conclusions

The estimated annual energy burden for households in the FNSB is 10.12% on average. Given that energy expenditures are drastically higher in the FNSB than elsewhere on the Railbelt or in the contiguous United

States, COL adjustments and utility assistance programs should assume higher utility expenditures for FNSB residents and adjust accordingly.

Funding

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Appendix

Appendix Table 1. Energy Cost Burden by Census Tract (Extended)

Tract	Description	Occupied Units	Median Household Income	Annual Electricity Costs	Annual Space Heating Costs	Annual Energy Costs	Energy Burden
1	Downtown Fairbanks	900	27,878	1,808	2,744	4,552	16.33%
2	Airport Way Central	1213	93,156	2,912	4,419	7,331	7.87%
3	South Fairbanks	1926	55,147	2,360	3,581	5,941	10.77%
4	Hamilton Acres	1820	87,115	3,363	5,103	8,467	9.72%
5	Johansen/Railroad	1140	71,649	2,635	3,998	6,633	9.26%
6	College/Aurora	1560	68,580	3,371	5,115	8,486	12.37%
7	Airport Way West	1773	66,467	3,332	5,055	8,386	12.62%
8	Geist/University West	1940	76,557	3,313	5,027	8,340	10.89%
9	Chena Ridge	2431	105,854	3,092	4,692	7,784	7.35%
10	FAI/Van Horn	582	90,938	2,718	4,124	6,842	7.52%
12	Steese Highway	2534	112,809	4,183	6,346	10,529	9.33%
13	UAF/Farmers Loop	2227	104,919	4,169	6,326	10,495	10.00%
14.01	Badger West/Persinger	1035	86,851	3,625	5,499	9,124	10.51%
14.02	Badger West/Bradway	1749	75,586	2,695	4,089	6,785	8.98%
15.01	Badger East/Moose Creek Dam	1654	109,191	3,209	4,869	8,078	7.40%
15.02	Badger East/Plack	1843	96,625	4,340	6,584	10,924	11.31%
16	Greater North Pole	1784	86,910	3,813	5,785	9,598	11.04%
17	Salcha	546	74,708	2,717	4,123	6,840	9.16%
19.01	Goldstream/Murphy Dome	2597	73,750	2,836	4,303	7,139	9.68%
19.02	Chena River Valley	2188	89,980	3,566	5,411	8,977	9.98%
9800	Fort Wainwright	2287	70,102	3,486	5,290	8,776	12.52%
9801	Eielson AFB	792	63,036	1,664	2,525	4,190	6.65%

Appendix Table 2. Energy Prices Used in Study

Fuel	Price	Unit
No. 1 heating fuel oil	\$4.40	gallon
Cord wood	\$425.00	cord
Pellets	\$350.00	ton
Natural gas	\$2.29	CCF
Coal	\$143.00	ton
District heat (steam)	\$19.59	1,000 lbs.
Electricity	\$0.25	kWh

Note: All prices were obtained on February 2, 2024. The following sources were used to obtain price estimates.

No. 1 heating fuel oil, HeatYourWay
 Cord wood, Aurora Energy Solutions
 Pellets, Aurora Energy Solutions
 Natural gas, Interior Gas Utility
 Coal, Fall 2023 FNSB Community Research Quarterly
 District heat (steam), Fall 2023 FNSB Community Research Quarterly
 Electricity, Golden Valley Electric Association

Appendix Figure 1. Spatial Representation of Energy Cost Burden (Extended)

