ALASKA COMMUNITY FUEL USE

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Introduction

The goal of this project was to estimate the amount of fuel used for space heating and electricity production by communities in Alaska. No comprehensive Alaska fuel use data exist at the community level. Community fuel consumption by type of fuel and end use is needed to estimate the potential economic benefits from demand- and supply-side investments in fuel use reduction projects. These investments include weatherization and housing stock improvements; improved lighting, appliance and space heating efficiencies; waste heat capture; electric interties, and alternative energy supply options such as wind and hydroelectric generation. Ultimately the Alaska Energy Authority (AEA) and others can use this information to rank and select a suite of projects that provide the largest gains in fuel reductions at the lowest long-term costs and the highest returns on investment over the life of the projects. Study communities consisted of Power Cost Equalization (PCE) eligible communities. Communities in the North Slope Borough were excluded because fuel subsidies offered by the borough result in different patterns of energy use by households.

Methods

In the absence of reliable community fuel use data, two approaches were used to develop community fuel use estimates. The first was to develop a statistical model to predict the amount of fuel used by communities based on community characteristics. Community data consisted primarily of electric use, bulk fuel storage capacity, climate and heating degree days, demographic, housing stock, and income and employment information. For a sample of 30 communities, fuel use data was collected from a telephone survey of local fuel suppliers. The community characteristics and fuel survey data were combined in a data set for statistical analysis including correlation and regression analyses. The objective was to use the resulting model to estimate the amount of fuel used for the unsampled PCE communities. The amount of fuel used for electricity generation was known from PCE annual reports. The modeling was intended to estimate space heating fuel use. The amount of fuel used by each community for electricity generation and space heating provide a basis for estimating the amount of fuel that could potentially be displaced by renewable energy projects for each community.

The second method used to estimate community fuel use was to collect available secondary energy data. With the exception of PCE data, secondary fuel use data is only available at the state level. The primary intent of the secondary data collection was to help evaluate the reliability of the developed model. This would be done by comparing the aggregate total for the model with secondary source data. Ultimately the secondary data collection was also intended to identify the reliability of current secondary energy data sources, identify data gaps, and suggest improvements in data collection and reporting to address the on-going and long-run need for reliable Alaska energy data.

Fuel Use Model

The tested model was based on fuel survey data for a sample of communities and a set of known community variables for all communities. The statistical population of the analysis was narrowed to PCE communities and the dependent variable was narrowed to the estimated amount of diesel sold in a recent annual time period that was not purchased by the electric utility or school. Data for electric generation fuel use was known from

PCE reports. Most of the schools associated with the sample communities purchase fuel separately; few had the information on quantity used readily available. Therefore, schools were not included in the modeling.

To collect the data on the amount of diesel sold in each community, an open-ended survey questionnaire was administered by phone to 30 communities selected representing regional and demographic characteristics (Table 1). The survey consisted of 11 questions (with several additional sub questions). The survey instrument is contained in Appendix A.

Table 1. Fuel Use Survey Communities

Allakaket	Hydaburg	Perryville
Alatna	Kobuk	Ruby
Angoon	Lime Village	Selawik
Aniak	Manokotak	St. Paul
Chenega Bay	McGrath	Tanacross
Chignik	Mekoryuk	Teller
Chitina	Mountain Village	Toksook Bay
Diomede	Naknek	Unalakleet
False Pass	Nondalton	Venetie
Fort Yukon	Ouzinkie	Yakutat
Gustavus		

All of the 30 communities were contacted by phone during the month of August 2008. Ultimately, the survey was completed in its entirety for 23 communities. If more than one entity purchased and sold fuel, all were contacted. We repeated phone calling until we had exhausted all possibilities of collecting information.

Seven communities did not complete the survey for a variety of reasons:

1. Yakutat – Proprietary fuel information not available from fuel distributor and retailer, Delta Western. Completed most of the survey except for question #2 and #4, which were the primary questions for fuel use modeling.
2. Naknek – Large fuel hub community; too difficult to identify transient fuel used in the community and fuel transferred to smaller outlying communities. Completed most of the survey except for question #2 and #4.
3. Chignik – worked with Trident Seafood's main office in Seattle. Unable to provide detailed fuel use information.
4. Angoon – local fuel retailer was not interested in participating in survey.
5. Hydaburg – Receive fuel from the community of Craig (Petro Marine). Unable to give us proprietary fuel information.
6. Lime Village – Completed most of survey but they were unsure of exact amounts of fuel consumption.
7. Chenega Bay – repeated attempts to contact the fuel retailer were unsuccessful.

Fuel use data for the sample communities was matched with community characteristics to build a predictive model. The community characteristics were collected from a variety of sources, including the 2000 U.S. Census and the AEA PCE data. ISER researchers tested different combinations of community characteristics as explanatory variables in order to determine the most accurate potential models.

Results

We discovered significant errors in the models' ability to predict individual community fuel use, largely because of the small sample of surveyed communities and the difficulty most survey respondents had in estimating total annual fuel use. For most communities surveyed there were a number of fuel buyers and users, each with varying quality of fuel purchase and use records. This was compounded by the individual available to be surveyed having varying access to fuel purchase and use records. Many individuals we contacted had difficulty obtaining the information required to complete the survey. In addition, the individual fuel retailers were not always motivated to complete the survey (we called them during or before the fall orders), and they had to complete some of the survey from memory (not knowing the exact amounts of fuel).

As a result, we do not believe the survey data collected are complete or accurate, which, in combination with a lack of data from fuel distributors, was a major cause of the poor modeling results. The biggest obstacle to collecting survey data was not having support from the major fuel distributors (Crowley, Delta Western, and Petro Marine). We received fuel delivery information from one distributor, but delivery information was needed from all other distributors in order to estimate total fuel delivery to a region. Delivery information was also needed from other distributors to allow aggregation of information in order to maintain the proprietary nature of the information.

However, given the need for fuel use estimates, we used the best model results to develop rough estimates for initial project technical screening analyses. To this end, the results of the three best models were averaged. Averaging the models' results addressed two issues. First, some communities were missing data for the most statistically significant community characteristics. Therefore, if we used one model, some communities had no results. Second, averaging the predictions from the three independent models reduced the variability of the estimates across the models. The average provided an estimate of the non-electricity generating diesel fuel use per study community.

The survey data collected included both heating and transportation fuel because survey respondents were not able to identify the final end uses of fuels. To estimate the share of fuel used for transportation, we used model number three (Appendix B). This model estimated fuel use based on the number of PCE households using heating oil and the number of jobs in a community. The model coefficient for households is 737 gallons of fuel use per year; the job coefficient is 548 gallons of fuel. Total fuel use for each community is the number of households and jobs within a community multiplied by their respective coefficients.

Applying model number three results, we assumed all the diesel fuel associated with "households" is space heating fuel, while half of the diesel associated with "employment" is space heating fuel and the other half is used for transportation. The reasoning behind these assumptions is that all jobs in a community increase household income. This increased income results in increased household fuel use. As a result, each gallon of fuel associated with employment is split between transportation, commercial, and community building space heating and increased residential space heating. As a result, we believe it is reasonable to assume that half of diesel fuel use associated with employment is transportation fuel and the rest is space heating fuel. We then applied this estimate of the proportion of fuel used for transportation by each community to "back out" the transportation portion of the total community fuel use estimate derived from the averaged model results. The amount of total fuel used for electricity generation was taken from PCE data.

Figure 1 shows the estimated diesel fuel by type of use from applying modeling results. The models estimated a total of 64.6 million gallons of fuel used in the study communities—PCE communities, excluding those in the North Slope Borough. The electricity generation portion of fuel use (41%) was from PCE reports. The modeling effort was used to estimate the amount of fuel used for space heating and transportation.

We aggregated the results across study census areas with more than one community in the analysis. Figure 2 shows the diesel use per household by census area. The regions are ranked from left to right by lowest to highest average heating fuel use per household.

These results represent the best available estimate of diesel fuel use in Alaska. Estimates would improve with additional and more accurate community fuel use data.

Figure 1

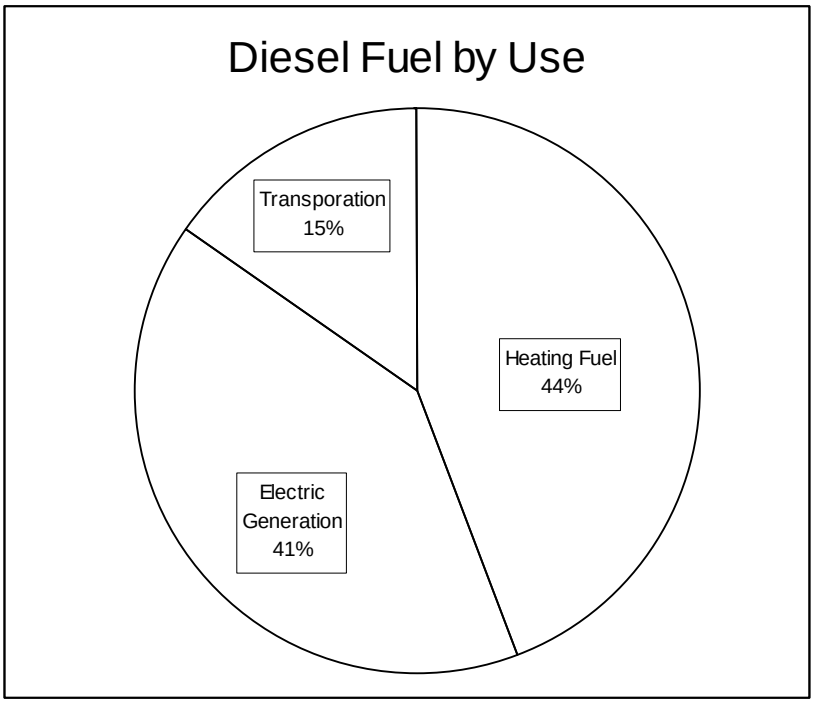
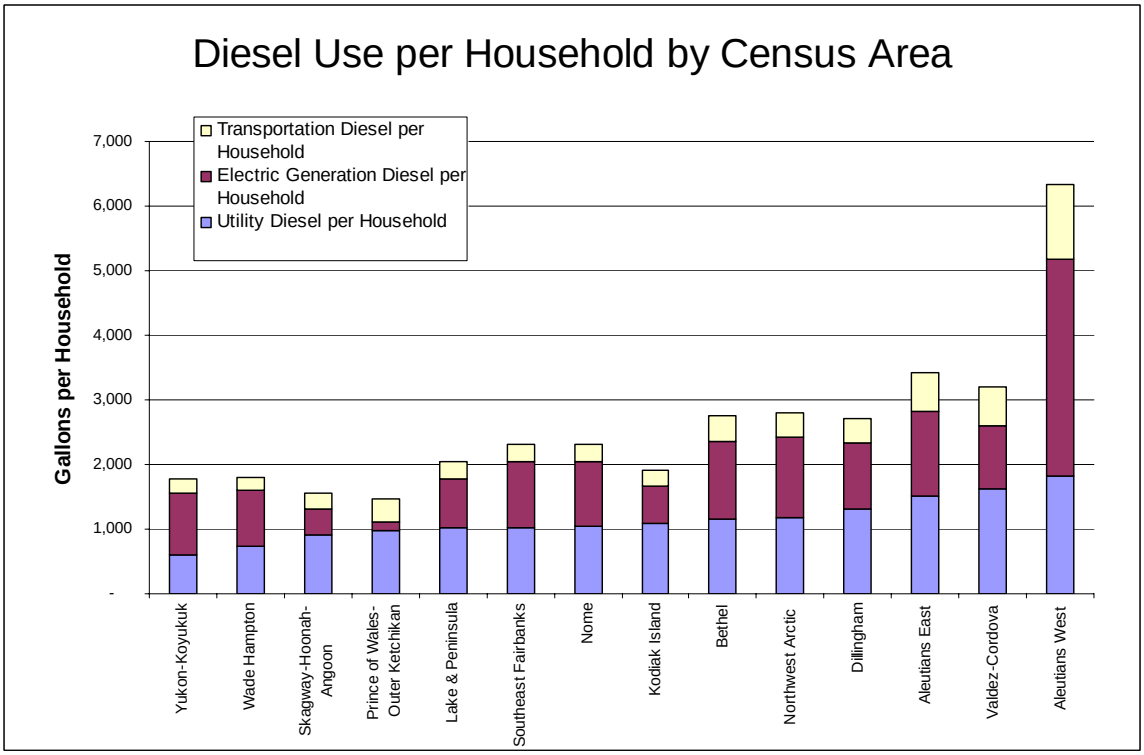


Figure 2



The 14 of 27 census areas are those with more than one PCE community.

Secondary Data

The results of our secondary data collection and analysis are contained in electronic Appendix C. In general, the most reliable data available is from the U.S. Energy Information Administration but most of these data are on a statewide basis only. We found little data available on a community level. Much of what is collected on an ad hoc basis lacks sufficient statistical rigor and sampling methods to be useful. There are a number of potential sources and modifications to collection and reporting methods that would significantly improve the availability and reliability of Alaska energy data.

Discussion

In summary, none of the models developed provided robust results. However, with cooperation from fuel distributors or actual records of fuel deliveries and sales from villages, both of which would provide more reliable data on fuel use, model results might be improved. However, the effort to determine, obtain, and verify the explanatory data would be such that it would probably be more efficient to obtain fuel use information directly for all communities. Even if it were possible to develop a robust predictive model, it would be unlikely to give accurate predictions for all individual communities because of inevitable modeling "noise", outliers, missing variables. Since each community is individually important for screen their perspective energy project, this would pose a recurrent problem. This would also be exacerbated by the fact that conditions and fuel prices and use are currently changing so rapidly. Any explanatory data would have to be very current, and new important factors are likely to surface.

Similarly, secondary data at the community level is lacking in Alaska but opportunities exist to improve data collection and reporting to provide more routine data availability. A dataset for space heating fuel use similar to the PCE database would provide fuel use information for energy project assessment. If a new program is developed to address the high cost of heating fuel in Alaska or the Low Income Energy Assistance Program is amended or expanded, establishing a mechanism or reporting process to track fuel prices and quantities, similar to the PCE program, would be a valuable component.

Appendix A
ISER 2008 Community Fuel Use Survey

Community Name: _____
Contact Name: _____
Business/Company Name: _____
Type of Business (ex – native corporation, private, etc): _____
Phone Number: _____

Contact:

Date	Time	Contact Person	Notes

Hello, my name is Meghan Wilson and I am a researcher with the Institute of Social and Economic Research at UAA. We are doing a research project with the Alaska Energy Authority looking at several communities across the state of Alaska to accurately estimate the consumption of fuel for the most recent calendar year. We aren't looking at prices, just consumption of fuel in various communities.

1. What types of fuel do you sell?
What is the fuel typically being used for by your customers?

	Name	Technical Name	Used for
1			
2			

2. How many deliveries do you get per year?
How much is delivered?
Who delivers your fuel and by what method of transportation?

	Fuel Name	Deliveries/year	How much	Delivery Operator	Transportation Method
1					
2					

3. Do you keep track of how much fuel you sell? (If no, do you know, or could you estimate how much was fuel in the tanks before and after the deliveries or if they can otherwise estimate the amount of fuel sold or consumed).

4. How many gallons were sold and consumed in the last year? What is the timeframe?

	Fuel Name	Sold/Consumed	Timeframe
1			
2			

5. Who are your biggest customers, what are they buying, and what is it being used for?

6. How do your customers pay for the fuel that they purchase from you? Cash, check, credit card, account, etc.?

7. Has the consumption of fuel gone down when the price has gone up?

8. What are people cutting back on? (both on types of fuel and activities)?

9. What impacts are you seeing with the increase in energy costs?

10. What about the other big customers/buildings in the community? What types of fuel are they purchasing, from whom, and a possible contact person?

Customer	Owner/Contact	Fuel Type	Fuel Delivery Contact	Notes
Houses				
Washeteria				
Schools				
State buildings				
Federal buildings (FAA, NPS)				
Commercial buildings/facilities				
Industrial buildings				
Construction Projects				
Airport				
Tribal buildings				
Health Clinics				
Other				

11. Any other comments?

Appendix B
Community Fuel Use Model

Details on the modeling effort are contained in electronic Appendix B (http://iser.uaa.alaska.edu/Publications/AEA_Fuel_Use_Appendix_B_Model.xls) The model file contains the set of community data, from our surveys and other sources, our three best linear regression models, the predicted values from these models and the fuel use estimates by community and type of use. The fourth tab provides information on the variables tested, their definitions and sources.

The results of the model are in the two worksheets with red tabs. The community fuel use estimates are in the sheet titled “Community Results”. The average fuel use by region is in “Regional Results”.

The information on the models used can be found in the worksheets with yellow tabs. The sheets "Model 1", "Model 2", and "Model 3" contain Excel outputs for the model regressions. The sheet “Model Results” shows the community estimates for each model as well as the average estimate. The dependent variable for all three models is the amount of non-utility, non-school diesel sold in the community during the time frame for which the community provided us sales quantities (a very recent full year or heating season), as we were able to interpret from the numbers provided by the community fuel seller.

The worksheets containing calculations and data used to categorize and calculate regional average use are titled “Region Average” and “Community Info”. “Heat Share” contains the calculations used to separate the model results into heating and transportation fuel. The sheet called "All Data" contains all of the community data as well as the model predictions. These worksheets have blue tabs.

Appendix C
Secondary Fuel Use Data

Details on secondary data are contained in electronic Appendix C
(http://iser.uaa.alaska.edu/Publications/AEA_Fuel_Use_Appendix_C_Secondary_Data.xls)

National Sources

U.S. Energy Information Administration State Energy Data System
Geographic level: state
http://www.eia.doe.gov/emeu/states/_seds_updates.html
The 2006 SEDS contains statewide consumption estimates, based primarily on sales data, by fuel type and sector. Documentation of EIA's methodology is available at http://www.eia.doe.gov/emeu/states/sep_fuel/notes/use_petrol.pdf
ISER has extended the estimates, based on more sales data from EIA, to more detailed breakouts by fuel type and end use. Fuel sold in the state but burned elsewhere is included, and fuel sold elsewhere but burned in the state is excluded. Nevertheless, this seems to be the most useful, complete, and reliable source of fuel use data, its only real limitation being that it is not available on a finer geographic level than by state.

Waterborne Commerce Statistics Center
Geographic level: state
http://www.iwr.usace.army.mil/ndc/wcsc/wcsc.htm
WCSC Commodity Movements data by source state and by destination state provide the quantity of crude oil, petroleum products (in a single aggregated category), and coal that moved into, within, and out of the state by water in 2006. ISER has summed the states other than Alaska to obtain total imports, exports, internal movement, and net exports. The data does not differentiate between the various petroleum products. Another problem with the data is that it is reported in tons rather than gallons or barrels for petroleum products, which do not all have the same density (i.e. barrels per ton). We have converted the figures to barrels using approximate conversion factors.

Another dataset called "Waterborne Commerce of the United States (WCUS) Waterways and
Harbors" provides similar information by port. It breaks the "petroleum products" category into eleven types. However, figures are rounded to the nearest 1,000 tons, and the way the source and destination of the freight are specified does not have sufficient detail to determine whether the source and destination were in different states.

U.S. Environmental Protection Agency eGRID
Geographic level: individual electric plants
http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html
"The Emissions & Generation Resource Integrated Database (eGRID) is a comprehensive inventory of environmental attributes of electric power systems. The preeminent source of air emissions data for the electric power sector, eGRID is based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government."

An extract from the eGRID plant-level data for 2004 is included. The columns highlighted in orange -- primary fuel type and annual heat input in MMBtu -- could be used, along with a conversion factor from Btu to an appropriate unit of quantity for the given fuel type, to estimate annual fuel use.

State Sources

Alaska Department of Revenue
Geographic level: state
The Tax Division 2007 Annual Report includes the number of gallons of fuel taxed, in broad categories, under the Motor Fuel Tax. In addition, DoR provided highway and marine fuel broken out into gasoline and diesel quantities, which is not normally provided in the Annual Report. Unfortunately, they were unable to break out the data by community, and cannot provide quantities sold for non-taxable uses, such as heating. Also, it is not clear how accurately the reported taxable quantities sold match the quantities actually purchased for taxable uses: the suppliers who report to the Tax Division, the "qualified" dealers, are not always the final sellers. Therefore, it seems that they may need to base their reports on estimates of taxable quantity.

Alaska Department of Transportation and Public Facilities
Geographic level: state
DoT provided ISER with gallons purchased in FY 2008 for the Alaska Marine Highway System and for state vehicles.

Alaska Department of Environmental Conservation
Geographic level: individual Title V facilities
ADEC Division of Air Quality maintains a database called AIRTOOLS containing data for Title V (stationary source of emissions) facilities. This database is not always complete or up to date, nor is it readily available to the public, but it contains quantity of fuel used. Many of the Title V operating permits require the permittee to report fuel use in periodic Facility Operating Reports, but these are all on paper and not available electronically.

Alaska School Districts
Geographic level: community
The Alaska Department of Education and Early Development requires school districts to keep records of fuel use, but DoE does not collect them. It would be necessary to contact the school districts individually. ISER's effort to do this has had varying degrees of success. The data here are obtained directly from a few of the school districts.

Other Sources

Northern Economics, Inc. Cost Assessment for Diesel Fuel Transition in Western and Northern Alaska Communities
Geographic level: state, study area of Western & Northern Alaska, and community type

This report by Northern Economics and others on the cost of the coming transition to ultra-low sulfur diesel, prepared for ADEC in December 2007, contains estimates of annual fuel use by fuel type, end use, and community type (though not all together).

Potential Sources

The following are potential sources of data on fuel use that we have not successfully obtained and/or have not included in this file.

Alaska Energy Authority's Bulk Fuel Upgrade Program: Conceptual Design ***Reports / Business Plans for bulk fuel tank farms***
Geographic level: community
AEA has conceptual design reports for approximately 60 bulk fuel upgrade projects, which include estimates of annual fuel usage. Some of these provide separate figures for heating and non-heating diesel. These data have not been compiled, nor are most of the reports available in electronic form. The reports were created beginning in the 1990s when the Bulk Fuel Upgrade Program began, so most of the figures are not current. However, they contain what we believe to be the most complete set of community-level fuel use data (aside from the PCE data, which only contains fuel used by PCE electric utilities).

Fuel Delivery Companies
Geographic level: regions defined by suppliers
ISER has contacted Crowley and Delta Western asking for data on fuel delivery quantities. They have been reluctant to share this data, because it is proprietary. Neither company is likely to provide community level data. Crowley has provided region level data, but without similar numbers from Delta Western, which delivers the majority of the remainder of the total quantity of fuel delivered in rural Alaska, Crowley's data is not of much use in estimating total quantity consumed in each region. There has been some recent communication with Delta Western suggesting that they may provide region level data. If this materializes, it may be possible, along with information from the smaller delivery companies, to calculate region-level delivery quantity data.