Alaska Fuel Price Projections 2011-2035

prepared for:
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Contents

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Introduction

This and previous Alaska fuel price projections were developed for the Alaska Energy Authority (AEA) for the purpose of estimating the potential benefits and costs of developing renewable energy projects applied for through the Alaska Renewable Energy Fund program process. The projections are not price forecasts but a statistical estimation of potential future utility avoided fuel costs based on the relationships between historic utility fuel prices and crude oil and refinery prices reported by the Energy Information Administration (EIA). These statistically estimated relationships are used to project potential future fuel prices based on EIA's *Energy Outlook* oil price forecasts.

In addition to developing these low, medium and high fuel price projections, estimates of the social cost of carbon (previously included as estimates of potential carbon taxes), a premium for low sulfur fuels, and a price differential for home heating fuel are provided and are incorporated into the Renewable Energy Fund benefit-cost model for evaluating potential projects. The settings of these parameters are public policy considerations selected for project reviews by the AEA. The fuel price projections are limited in their applicability to the modeling of project benefits and costs and should not be considered fuel price forecasts.

The ranges of values between the projections are based on the assumptions implicit in the EIA oil price forecasts. Readers are encouraged to directly review the EIA Energy Outlook 2011 at: http://www.eia.doe.gov/oiaf/aeo/index.html

We generated Low, Medium, and High case fuel price projections for the years 2011-2035 for the following fuels:

- Incremental natural gas in Southcentral Alaska delivered to a utility-scale customer
- Incremental diesel delivered to a PCE community utility tank
- Incremental diesel delivered to a home in a PCE community
- Incremental home heating oil purchased in Anchorage, Fairbanks, Juneau, Kenai, Ketchikan, Palmer, and Wasilla

This memorandum provides documentation of the assumptions and methods that we used. A companion Excel workbook contains the detailed projections.

General methods and assumptions

Base year and time horizon

Our projections run from 2011 to 2035. They are computed and reported in inflation-adjusted year 2010 dollars. We recognize that a "projection" for 2011 is unlikely to match actual 2011 data. However, much of the data that we rely on is published only through 2010.

Ultra low sulfur diesel premium

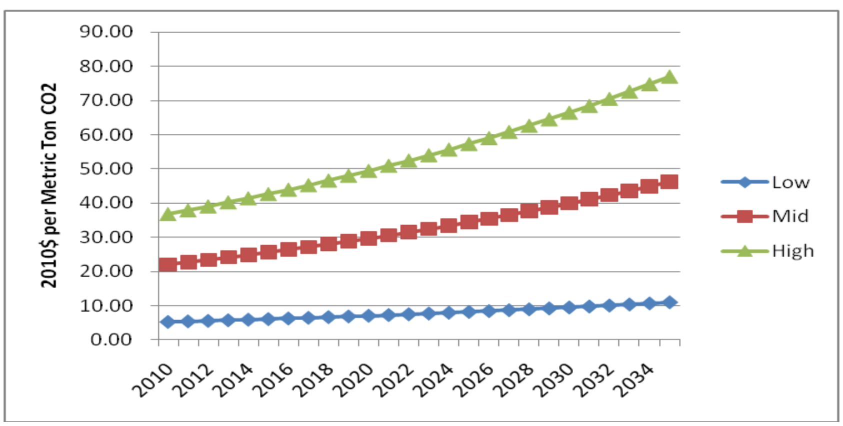
We continue to include a five cent additional cost starting in year 2008 for rural areas only, to account for the additional refining costs of ultra low sulfur diesel. This value can be quickly changed within the workbook.

Carbon pricing

In past fuel price projections, the cost of carbon was introduced in the model using the estimates developed by the Massachusetts Institute of Technology (MIT) *Future of Coal* study.[1] The MIT group described their "High CO2 Cost" case as a $25 per metric ton CO2 allowance cost measured in 1997$, imposed in 2015 and increasing at 4% (which we increased to 5%) per year above inflation thereafter. We adjusted the 1997$ for inflation through 2010 and also assumed that the price trajectory begins in 2010 at a lower level that passes through the MIT benchmark in year 2015. The $25 benchmark price converted to 2010 dollars is $33.97. The Low case parameters used the "Low CO2 Cost" case from the MIT study, with $9.51 ($7 in 1997$ adjusted to 2010$) starting in 2010, increasing by 5% per year. Finally, the Medium case was set (somewhat arbitrarily) in the middle, at $15.25 (2010$) starting in 2010 increasing by 5% per year.

The federal government developed estimates for the social cost of carbon (SCC) to be used in benefit-cost analyses. In this update, we introduce the SSC estimates as explained by a working paper from the National Bureau of Economic Research titled, *"Estimating the Social Cost of Carbon for Use in the U.S. Federal Rulemakings: A summary and Interpretation"*.[2] For the High case, we use the cost of $35 (2007 dollars) per ton of CO2 emissions in 2010. For the Medium case, we use the 'central value' of $21 (2007 dollars) per ton of CO2 emissions in 2010. For the Low case, we use the cost of $5 (2007 dollars) per ton of CO2 emissions in 2010. All three estimates were converted to 2010 constant dollars and inflated over time at 3% which is the average inflation rate of CPI from 1985 to 2010. A couple of reasons why the carbon pricing methods have been modified are that the SSC estimates reflect current data (2011) and are used in benefit-cost analyses by the federal government. The social cost of carbon is no longer added to the fuel price projections, but rather included separately in the benefit-cost model. However, the flexibility of adding SCC to the price projections remains. Figure 1 summarizes the assumed carbon price trajectories. Similar to the ultra low sulfur diesel premium, these assumptions are parameters that can be changed in the workbook.

Figure 1. Carbon price trajectories (year 2010$ per metric ton CO2)



Sources: ISER calculations based on Greenstone (2011).

[1] Massachusetts Institute of Technology. 2007. *The Future of Coal: Options for a Carbon-Constrained World*. (March). Available at: http://web.mit.edu/coal/

[2] Greenstone, M., Kopits, E., and Wolverton, A. 2011. *Estimating the social cost of carbon for use in U.S. federal rulemakings: a summary and interpretation*. NBER Working Paper 16913, available at: http://www.nber.org/papers/w16913

Natural Gas

Background

The Cook Inlet natural gas market is structurally different from the Lower 48 natural gas markets because it is not connected to a large pipeline network and has relatively few buyers and sellers of gas. As a result, Cook Inlet does not have a natural gas spot market to reveal the true market value of natural gas. In Lower 48 natural gas markets, the market value of gas is revealed by market forces as thousands of buyers and sellers bid on natural gas spot markets. Most natural gas used by Lower 48 utilities is not purchased on the spot market but the physical access to spot markets ensures the price utilities pay for gas reflects the true value of the gas. Public utility regulators in these markets generally do not have to regulate the price utilities pay for natural gas because the price is largely determined by local and regional markets.

In contrast, the Cook Inlet natural gas market has no spot market and thus no clear market value. Instead, all natural gas sales are based on indexed prices agreed upon in contracts negotiated between natural gas producers and a limited number of buyers. These contract prices are negotiated between natural gas producers and utilities and may not reflect the true value of the gas because utilities do not actually bear the cost of the gas. Instead the entire natural gas cost is passed onto the utilities' customers who do not directly participate in negotiations. The Regulatory Commission of Alaska (RCA) is tasked with protecting the utilities' customers by ensuring that rates are fair and reasonable. Unlike its Lower 48 counterparts, the RCA must determine what merits a fair and reasonable natural gas price in the absence of a natural gas market price.

Historically, natural gas prices, as determined by RCA approved contracts, pegged the price of natural gas to a basket of Lower 48 price indexes including natural gas, crude oil, and heating fuel. This pricing method resulted in low natural gas prices until recently when a dramatic increase in oil prices drove up the price of Cook Inlet natural gas purchased on these contracts.

Cook Inlet natural gas is now believed to be relatively scarce, necessitating significant capital investment on behalf of the natural gas producers to meet growing demand. In the past, producers have argued that the return on capital for Cook Inlet natural gas investments needed to be competitive with capital investments in other markets and indicated that they need the Southcentral price to more closely resemble Lower 48 prices. Under this reasoning the Cook Inlet producers, local utilities, and the RCA began to agree to and approve contracts with the Cook Inlet natural gas price indexed to Lower 48 spot prices.[3] However, with the sudden advent of shale gas supplies in the lower 48, natural gas prices have dropped significantly. As a result, Cook Inlet may be becoming a more appealing natural gas production location given the now relatively higher prices, available infrastructure and ready but less competitive market. This natural gas projection attempts to take all these factors into consideration, though the market is clearly in flux and difficult to predict.

[3] For more information on Southcentral Alaska natural gas prices and contracts, see the RCA website: http://rca.alaska.gov/RCAWeb/home.aspx

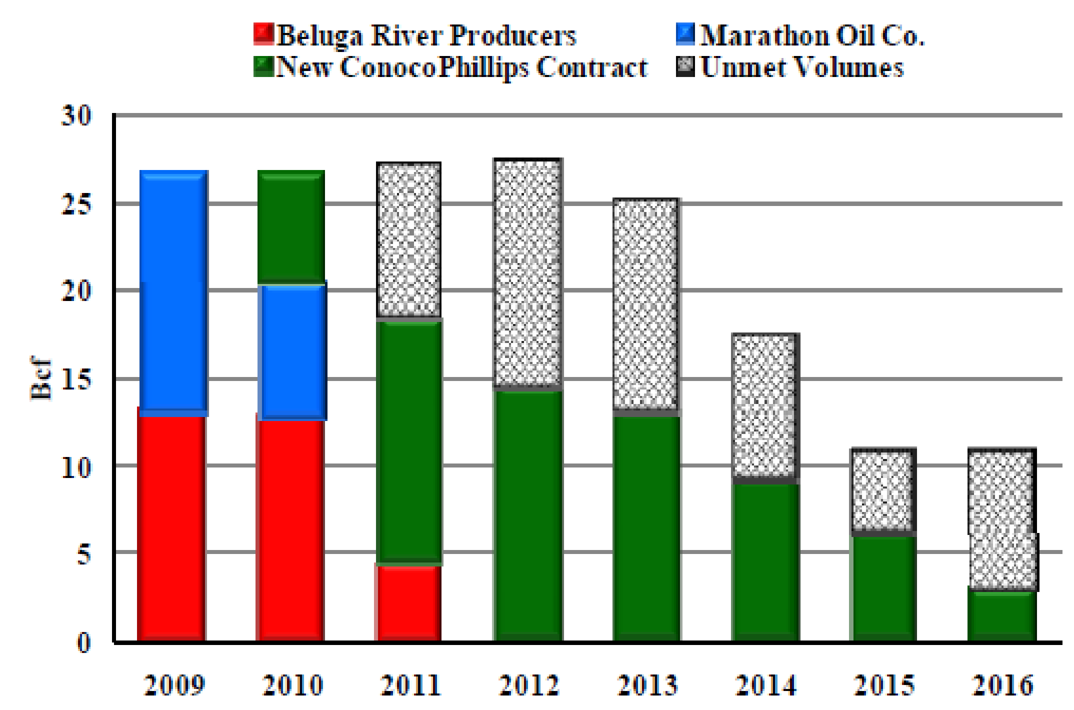
Assumptions

The analysis in this report assumes that Chugach Electric Association (CEA) is the marginal supplier of electricity in Southcentral Alaska. Also, it is assumed that the recently approved supply contract between CEA and ConocoPhillips is the marginal supply of gas for electric power generation.

The concept of marginal supply in this context refers to the most recently purchased energy to supply electricity, not to the energy supply that would first be disrupted or offset in the case of new renewable energy. This is appropriate for forecast prices because the most recently purchased energy is a better indicator of future energy prices than previously purchased energy.

The contract between CEA and ConocoPhillips, filed May 12, 2009 (http://rca.alaska.gov/RCAWeb/Certificate/CertificateDetails.aspx?id=7eefd8ff-1630-4ed0-80f6-59e1aed8e391), states that ConocoPhillips will supply natural gas sufficient for CEA to meet 100% of unmet gas requirements through April 2011, roughly 50% of Chugach's unmet gas requirements from June 2011 through 2015, and about 25% of Chugach's unmet needs in 2016 (Figure 2).

Figure 2. Chugach Electric Association natural gas supply, 2009-2016



Source: Chugach Long-Term Natural Gas Volume Forecast, April 2009 Update

Image reproduced from Chugach Electric Association, Gas Supply Contract with ConocoPhillips, 2009.

The majority of the gas to be supplied to Chugach Electric Association for base load electric generation is termed "Firm Fixed Gas." The price of this gas is based on an index of natural gas spot markets from natural gas producing areas. This index is termed "Production Area Composite Index," or "PACI." The PACI consists of:

- El Paso, Permian Basin; under the heading Permian Basin Area

- Waha; under the heading Permian Basin Area
- ANR, Oklahoma; under the heading Oklahoma
- Columbia Gulf, Louisiana; under the heading Louisiana-Onshore South
- Agua Dulce Hub: under the heading South-Corpus Christi

In recent history, the price of PACI has been 90% that of Henry Hub[4] and the prices of both have been highly correlated (Figure 3).

Figure 3. Relationship between PACI and Henry Hub natural gas prices, 2005-2009

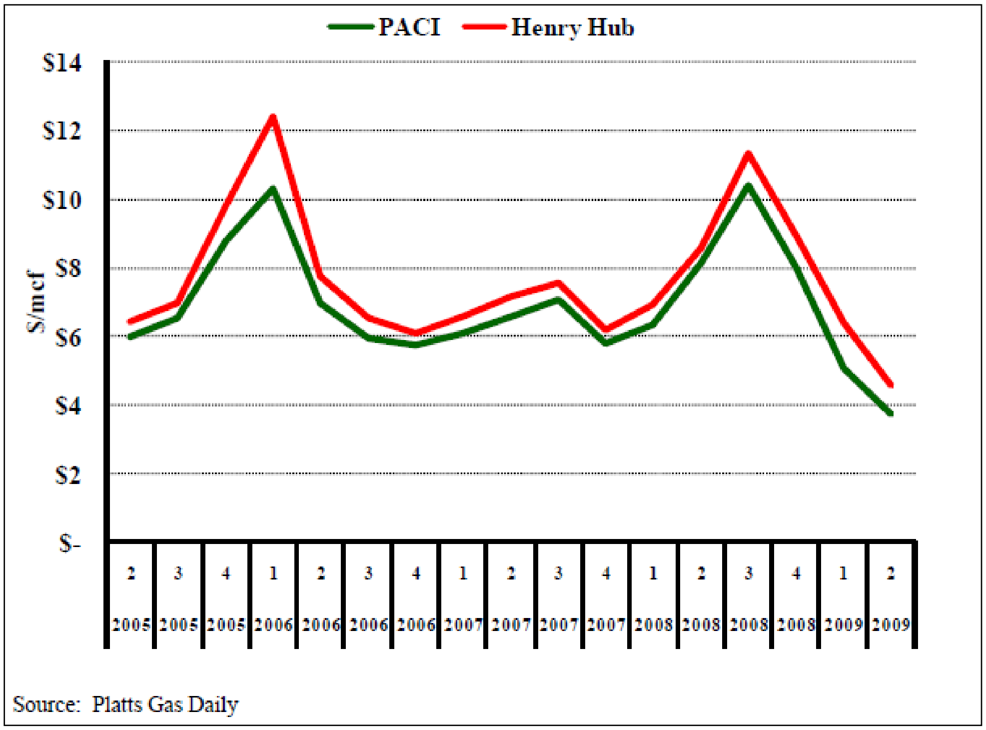


Image reproduced from Chugach Electric Association, Gas Supply Contract with ConocoPhillips, 2009.

Price Projection

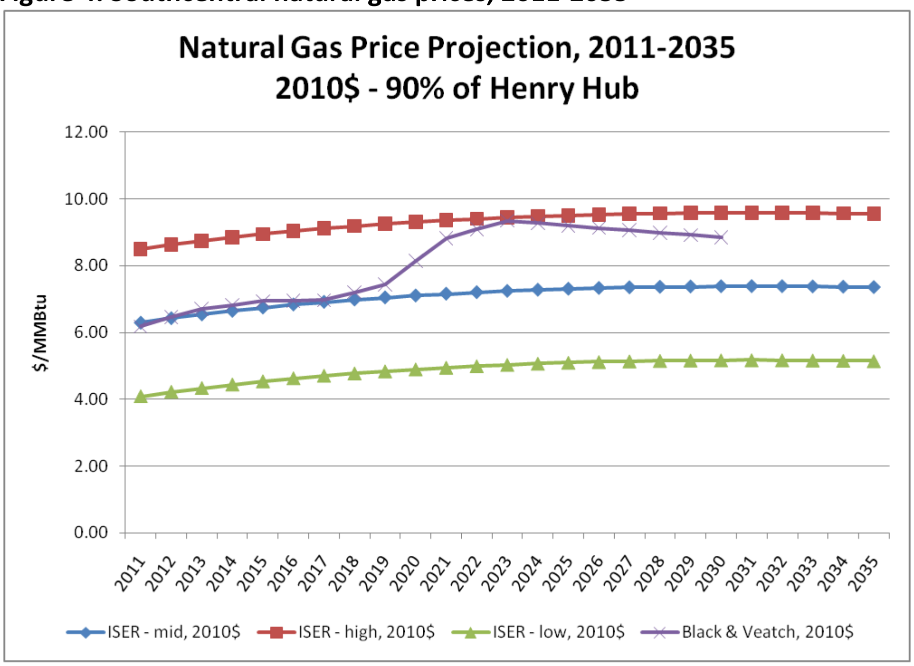
The Chugach contract assumes one mcf (one thousand cubic feet) of natural gas equals one mmBtu (million British thermal units) of natural gas. The Energy Information Administration (EIA) forecasts the Henry Hub price in dollars per mmBtu but the Chugach Electric Association gas is priced in dollars per mcf. In previous forecasts, we used the same assumption that the Southcentral Alaska natural gas price in dollars per mcf equals 90% of the forecast Henry Hub price in dollars per mmBtu. However, in the lower 48 markets there is abundant shale gas resulting in low natural gas prices while demand continues to put pressure on Cook Inlet supplies. To address this decoupling, in the previous forecast we assumed a 90% relationship continued through 2014, becoming 100% in 2015 through 2020, and exceeding by 10% the EIA Henry Hub price forecast from 2021 through 2030.

[4] Henry Hub is the pricing point for natural gas futures contracts traded on the New York Mercantile Exchange (NYMEX). It is a point on the natural gas pipeline system in Erath, Louisiana.

Nonetheless, both Cook Inlet and national markets are undergoing major structural changes which impact our ability to forecast with high confidence levels. We believe that over time the overall relationship will stabilize so we base our forecast following the Henry Hub historical trend line.
To forecast the Henry Hub spot price in 2010 dollars ($/MMBtu), we used a linear regression of historical monthly Henry Hub spot price data from 1997 to 2010 over time, and used that regression model for the reference case. To derive the high and low projections, we used the standard deviation (+/-SD) to scale the Henry Hub Price (Y-intercept) while the slope still remains the same. The linear equation we used for the reference case is *HHPrice= (0.298*Year)-592*, where HHPrice is the Henry Hub spot price in 2010 dollars. Once we calculated the projections from 2011 to 2035 with this equation, we then added one standard deviation to build the high projection and subtracted one standard deviation to build the low projection. We then adjusted the projections of the historical PACI and Henry Hub relationship where the PACI price is 90% of Henry Hub.

As a point of comparison, we also showed the natural gas price forecast prepared for the Railbelt Integrated Resource Plan (RIRP, see this publication for details on the forecast methodology).[5]

Figure 4. Southcentral natural gas prices, 2011-2035



Sources: EIA, Report: Annual Energy Outlook 2011, ISER calculations; Black and Veatch, 2010.

Fuel Oil

Background

Fuel oil prices are simpler (although not easier) to project because there are no existing complex contracts with formulas to be followed. Our projections are based on EIA AEO projections of crude oil. We use the Composite Refiner Acquisition Cost of crude oil (CORAC) as the basis for the fuel oil projections.

[5] Black & Veatch, 2010, *Alaska Railbelt Regional Integrated Resource Plan (RIRP) Study*, Final Report, prepared for the Alaska Energy Authority, February 2010.

Key Assumptions

Due to greater data availability we were able to improve some key assumptions.

Assumption 1. The price of diesel[6] to a particular PCE utility bears a stable linear relationship to the RAC crude price. In the previous projection, parameters were calculated using a pool regression in where the coefficient was allowed to be different from 1.0 and **not** allowed to vary by community.[7] A coefficient above 1.0 indicated "percentage markup pricing" as opposed to a straight pass-through of a crude price increase/decrease dollar for dollar.

In contrast, in the current update we were able to run individual linear regressions for each community, which provided a unique slope and intercept for each community. This better represents how communities are affected individually by the crude oil price differently. In addition, access to purchase fuel is affected by each community's geographic location; hence some communities have more frequent deliveries of fuel than others. To build a more accurate forecast we ran two regressions; in one we lagged the crude oil price by one year and in the other one no lag was allowed. Informed by the regressions, we used the R-squared and P-values to select the intercept and slopes for each community appropriately. As expected, the scenario without a lag in crude prices better explained the crude and fuel price relationships for some communities in the Southeast, Southcentral and Southwest regions which have more flexibility in sourcing their fuel and can purchase fuel more frequently. However as we anticipated, the lagged crude price better illustrates the fuel prices for most of the rural PCE communities as they have more challenging access to purchase fuel due to their remote locations and winter conditions, primarily ice that allows only one or two fuel deliveries per year. Crude oil price changes have a lagging effect on these communities. The communities that were subject to the No-Lag regression are:

Community ID	Community Name	Census Area
14	Craig	Prince of Wales-Hyder (CA)
23	Hollis	Prince of Wales-Hyder (CA)
28	Hydaburg	Prince of Wales-Hyder (CA)
65	Skagway	Skagway
73	Tok	Southeast Fairbanks (CA)
103	Cordova	Valdez-Cordova (CA)
159	Saint George	Aleutians West (CA)
175	Unalaska	Aleutians West (CA)

Assumption 2. We were not able to rigorously determine a home delivery surcharge by statistical methods—there appears to be no consistent relationship between residential home heating fuel prices and crude oil and PCE utility fuel prices. However, the average difference between the 2009 PCE fuel price and Alaska Housing Finance Corporation (AHFC) fuel survey price was $1.00. As a result, we suggest that the community utility fuel price plus $1.00 per gallon be used as the avoidable cost of home delivery when small amounts of home-delivered fuel are being avoided. However, when substantial

[6] PCE prices collected from PCE statistical reports.
[7] Fay, G. and Saylor, B. 2010. *Alaska Fuel Price Projections 2010-2030*, Available at: http://www.iser.uaa.alaska.edu/Publications/oil_price_projection_aea07_2010_v1.xls

amount of delivered fuel is avoided (e.g., a community district heating system or mass retrofit for biomass heating), then we suggest that the appropriate credit for avoided delivery charges is zero. The suggested heating fuel premium based on the amount of fuel is shown in Table 1 below. These are the amounts applied in the Renewable Energy Fund project economic review models.

Table 1. Suggested fuel premiums per gallon of displaced fuel

Gallons of Displaced Heating Fuel	Heating Fuel Premium
<1,000	$1.00
1,000 < 25,000	$0.50
25,000 > 100,000	$0.25
>100,000	$0.00
Gallons of Displaced Transportation Fuel	
All	$1.00

Source: ISER fuel price analysis.

Determining the value of an avoided gallon of fuel oil for space heating by renewable energy projects is complex because a substantial portion of the costs that ultimately determine the price per gallon of village home heating fuel are fixed. In addition, specific community circumstances, such as whether a bulk fuel storage facility was recently upgraded or will soon need to be, influence actual potential avoided costs; most of the costs of storage and delivery can only be avoided in “lumps.” More analysis of community non-utility fuel use and prices will be necessary as more energy projects displace space heating diesel fuel.

Other important factors besides crude oil prices affect the final community wholesale fuel price. These factors include: the varying time intervals between the placement of orders, departures of fuel deliveries from refineries, and fuel storage inventories in communities, as well as distances between refineries, fuel distributors and community storage facilities.[8] However, due to data limitations these factors are not represented in our simple statistical regression. All of these factors may contribute to sticky downward movement of fuel prices, so when crude oil prices decline, wholesale fuel prices in rural communities may not decline in proportion to the decline of crude oil prices.

Projection method

The fuel oil price projection is based on the imported crude oil price projection from EIA’s Annual Energy Outlook 2011 (AEO).

1. Obtain EIA’s Annual Energy Outlook 2011 Early Release from the following URL: http://www.eia.gov/oiaf/aeo/tablebrowser/

2. Obtain the forecast Imported Crude Oil Price from Table 1 for the Reference, Traditional Low Oil Price, and Traditional High Oil Price cases.

[8] Szymoniak, Nick; Fay, Ginny; Villalobos-Melendez, Alejandra; Charon, Justine; Smith, Mark. 2010. *Components of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices*. University of Alaska Anchorage, Institute of Social and Economic Research. Prepared for the Alaska State Legislature, Senate Finance Committee, 78 pages.
Wilson, Meghan, Ginny Fay, Ben Saylor, Nick Szymoniak, and Steve Colt. 2008. *Components of Delivered Fuel Prices in Alaska*. Anchorage: University of Alaska Anchorage, Institute of Social and Economic Research.

3. Obtain the monthly “U.S. Crude Oil Imported Acquisition Cost by Refiners (Dollars per Barrel)” (CORAC) from the following URL:
http://tonto.eia.doe.gov/dnav/pet/pet_pri_rac2_dcu_nus_m.htm

4. For each month, convert the crude price from step 3 to 2010 dollars (“real crude price”) using the CPI-U for that month and the average CPI-U (U.S. Consumer Price Index for All Urban Consumers, http://www.bls.gov/CPI/) for 2010.

5. Calculate the average real crude price by fiscal year. Divide by 42 to obtain real crude price per gallon.

6. Obtain PCE fuel prices from fiscal years 1985 – 2010. The PCE Statistical Reports for fiscal years 2002 through 2010 can be obtained from the following URL: http://www.aidea.org/aea/programspce.html.[9]

7. Calculate the average CPI-U by fiscal year, and convert the PCE prices to 2010 dollars based on the average CPI-U for that fiscal year and the average CPI-U for 2010.

8. Perform an ordinary least squares regression for each community where the real fuel price per gallon is the dependent variable and real crude price per gallon lagged by one year is the independent variable. Then repeat the regression without lagging the crude oil price. Evaluate the regression output (R-square and P-value) to select the parameters that better explain the crude-fuel relationship for each community. The constant term of the regression represents the intercept of each community and the beta of the crude oil price represents the slope.

9. Some communities with little or no data require using data from other communities as a proxy. The proxy communities suggested by AEA, listed with the original community first, then the proxy, are as follows:

- **For** Dot Lake: **Substitute**: Tok
- Hollis: Craig
- Klawock: Craig
- Thorne Bay/Kasaan: Craig
- Kasigluk: Nunapitchuk
- Pitkas Point: St. Mary’s

Make the following additional substitutions:

- Chignik Lake: Chignik Lagoon
- Klukwan: Kake
- Kobuk: Shungnak
- Napakiak: Napaskiak

Perform these substitutions not by copying data points from the proxy community into the missing slots, but by copying the regression coefficients from the proxy community.

[9] Data from prior years were obtained from printed copies of statistical reports, but are not available through the AEA website. The forecast workbook includes a worksheet with a list of communities and their respective prices from year 1985 to 2010.

10. Apply the slope and intercepts from the regression to the EIA Annual Energy Outlook forecasts (Low, Reference, and High cases) to predict fuel oil price per gallon for each PCE community as a function of Imported Crude Oil Price per gallon (lagged by one year or not as appropriate) for each year from 2011 to 2035.

11. Add the 'Incremental Cost of Ultra Low Sulfur Diesel' to the projected price for all three cases (low, medium, and high). In previous projection the 'CO_2 Equivalent Allowance Cost' was also added at this step. However, to allow flexibility in the use of these projections, we now appropriately add the 'CO_2 Equivalent Allowance Cost' in the benefit-cost model rather than directly into the fuel price projection.

12. Take the moving average three (MA_3) to smooth out the projections for all three cases.

13. The above prices are for utilities. For avoided use of home-delivered fuel, add $0/gallon if a significant amount of fuel is avoided. Add $1.00 if a small amount is avoided (no clear relationship was found between AHFC surveyed home heating oil prices and PCE utility fuel prices, but the average difference was about $1.00). See assumption 2 and Table 1 above for more details.

14. For urban places (Anchorage, Fairbanks, Juneau, Kenai, Ketchikan, Palmer, Wasilla), obtain prices for heating oil from Alaska Housing Finance Corporation's annual fuel price surveys conducted in years 1999 through 2009 (contact ISER or AHFC to obtain this data). Use the average of #1 and #2 heating oil. Where prices are missing, use the price included in the Alaska Food Cost Survey conducted for December (http://www.uaf.edu/ces/fcs/) (there will still be some missing data points).

15. To obtain crude oil prices corresponding to the time frame of the heating oil prices, calculate the average CORAC per gallon for October through December of each year from 1999 to 2010 in nominal dollars.

16. For each place and year, subtract the average CORAC just calculated for that year from the fuel price for that place and year. Put this difference into real 2010 dollars using the same CPI as above. Put the average CORAC numbers in real 2010 dollars as well.

17. For each place, do a linear regression with the price difference as the dependent variable and CORAC as the independent variable, each year being one observation for that place consisting of a fuel-crude price difference and a crude oil price.

18. Use the regression coefficients to predict the difference between fuel price and CORAC for each place and year as a function of Imported Crude Oil Price per gallon (Low, Medium, and High cases) for each year from 2011 to 2035. Add to these the projected CORAC to obtain a projected heating oil price.

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Alaska Food Cost Survey, http://www.uaf.edu/ces/fcs/

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