

ALASKA FUEL PRICE PROJECTIONS 2014-2040

prepared for:

Alaska Energy Authority

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Background

The Alaska Fuel Price Projections are developed annually for the Alaska Energy Authority (AEA) for the purpose of *estimating the potential costs and benefits of renewable energy projects*. Project developers submit applications to AEA for grants awarded under the Alaska Renewable Energy Fund (REF) program. These fuel price projections are used to evaluate the economic feasibility of project applications; economic feasibility is only one of many factors of the project evaluation process. Economists at the Institute of Social and Economic Research (ISER), University of Alaska Anchorage (UAA) have completed seven previous Alaska Fuel Price Projections since 2008 (all available at: <http://www.iser.uaa.alaska.edu/>). In this report we present the methodology for the most recent fuel prices projection.

In addition to their use for the REF review, ISER researchers use the projections for other economic research and energy project evaluations. The fuel price projections also fulfill an important need for price information and are used by many stakeholders in addition to AEA. As a result of their broad use among the public, we expanded what used to be cursory notes on methodology. Our intent is to provide more detailed information to the report's readers and users of the fuel price projections.

Projection vs. Forecast

The fuel price projections are not price forecasts. Projections are statistical estimates based on a data sample that systematically adjusts the data using statistical estimation procedures. A projection provides an estimate of future values based on a statistical assessment of past relationships under specific assumptions, but they are not a prediction that these specific assumptions will happen, nor state a probability that the projection will happen. In contrast, forecasts speculate future values with a certain level of confidence, based on current and past values as a 'prediction' or likelihood of what will happen in the future. In short, projections are based on historic relationships and their implicit assumptions; whereas, forecasts are based on assumptions that represent expectations of actual future events. For example, in our rural fuel price projections for western Alaska villages, we implicitly assume that future sea ice patterns will remain similar to previous patterns and will have a similar effect on the cost and timing of fuel deliveries to the region. We do not attempt to forecast when seasonal ice patterns will change, and build that assumption into a forecast of fuel prices under diminished sea ice conditions.

Data Sources

Crude oil price data are collected from three data sets made available by the U.S. Energy Information Administration. Fuel oil price data are collected from a variety of Alaska based data sources through local programs and surveys. All data sources used in the Alaska Fuel Price Projections are discussed in detailed below.

U.S. Energy Information Administration

The U.S. Department of Energy, Energy Information Administration (EIA) publishes historic crude oil spot price data for the West Texas Intermediate (WTI) and Brent terminals. The WTI is a point of reference, a 'marker' of pricing for a crude stream produced in Texas and southern Oklahoma, and Brent is one for crude oil produced in the North Sea.

Additionally, price, production and consumption projections of a variety of energy products are published every year by EIA in the *Annual Energy Outlook (AEO)*, including crude oil and natural gas prices. This publication includes a range of projection scenarios based on varying assumptions. The reference, high, and low crude oil price scenarios of the Brent Spot Price and the West Texas Intermediate are used in the Alaska Fuel Price Projections. In the 2014 AEO crude oil prices are projected to 2040. The EIA projections "focus on the factors that shape the U.S. energy system over the long term" and assume that "current laws and regulations remain unchanged".

It is important to note there are many inherent and significant uncertainties associated with price projections, which are exacerbated with increasing time horizons. EIA's projections take into consideration many important factors and are used by governments, researchers and others around the world. However, EIA's crude price projections are not infallible and have been less accurate in recent years. Over the last ten years the crude oil price projections have consistently underestimated the price of crude oil. Major factors affecting the less than stellar performance of the EIA projections are the many unexpected structural changes in, and shocks to, energy markets in recent years. Crude oil prices have become increasingly volatile. According to a comprehensive study on "*Forecasting the Price of Oil*" by the Board of Governors of the Federal Reserve System, "there has been no pronounced trend in the real price of oil since 1974 but considerable volatility". This makes the ability to project prices into the future an extremely difficult task.

Power Cost Equalization Program

The Power Cost Equalization (PCE) program was created in 1984 when the Alaska Legislature enacted the Statutes 44.83.162-165. The PCE program provides economic assistance to rural electric utility residential and community facility customers. Rural communities have historically faced relatively higher electric rates. The intent of the program is to bring greater parity between electric rates in rural Alaska communities and Alaska's urban centers of Anchorage, Fairbanks and Juneau. The program is administered in part by the AEA which calculates and disburses PCE payments. Utilities participating in the PCE program file a monthly report with AEA which contains basic information of utility operations and sales including fuel prices. Since the inception of the PCE program, AEA publishes an annual statistical report (fiscal year) summarizing operational data of participating utilities. The historic fuel prices from 1990 to 2013 published in these reports are used in the Alaska Fuel Price Projections. Additionally, monthly fuel prices reported to the PCE program are stored by AEA in a proprietary

database system called NAVISION. Monthly data from the PCE NAVISION system is available from 2002 to present.¹

Regulatory Commission of Alaska

Regulated utilities may file for a Cost of Power Adjustment (COPA) with the Regulatory Commission of Alaska (RCA). COPA is a way by which a regulated power company can adjust its rates to coincide with changes in fuel costs. These filings are public and available through the RCA website (<http://rca.alaska.gov>). Electric sector fuel price information from these filings was gathered for the non-PCE communities of Anchorage, Fairbanks and Juneau.

Additionally, data and information from tariff letters and accompanying documentation from Chugach Electric Association (CEA) are used in the natural gas projection.

Fuel Oil Price Data

The Alaska Department of Commerce, Community, and Economic Development (DCCED), Division of Community and Regional Affairs (DCRA) and the Alaska Housing Finance Corporation (AHFC) conduct semiannual surveys of retail prices for home heating fuel (No.1 and No. 2 fuel oil) from vendors serving communities around the state. Both agencies collaborate in the survey efforts. The price information is used in AHFC's energy programs and stored in the AkWarm database. DCRA makes this and other community data available in the Community Database Online (CDO) (<http://commerce.alaska.gov/cra/DCRAExternal>). Fuel price data from these surveys is also available through the Alaska Energy Data Gateway (AEDG) (<https://akenergygateway.alaska.edu>).

Also, the University of Alaska Fairbanks (UAF) Cooperative Extension Service (CES) conducts the Alaska Food Cost Survey. The survey includes quarterly retail fuel price data of selected communities. All food cost survey data are available in the CES website (<http://www.uaf.edu/ces/hhfd/fcs/>) and fuel price data is also available in the AEDG.

Fuel price data from these surveys are used in the Alaska Fuel Price Projections for the non-PCE communities of Anchorage, Fairbank, Juneau, Kenai, Ketchikan, Kodiak, Palmer, Petersburg, Sitka and Wrangell.²

Projections

The Alaska Fuel Price Projections are a statistical estimation of potential utility avoided fuel prices from 2014 to 2040, based on historic relationships between utility fuel prices and crude oil prices reported by

¹ PCE monthly data is available through the Alaska Energy Data Gateway at <https://akenergygateway.alaska.edu/>

² Additionally, fuel price data made available to the authors from the City of Sitka and from Homer Electric Association.

the U.S. Department of Energy, Energy Information Administration (EIA).³ These statistically estimated relationships are used to project potential future fuel prices based on EIA's published *Annual Energy Outlook* crude oil price projections. In short, the Alaska Fuel Price Projections are based on EIA projections. We use the historic relationships between actual crude oil and actual community utility fuel prices to project each community's future fuel prices based on the EIA crude oil price projection. 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.***

Based on the EIA reference case and low oil price and high oil price projection scenarios, the Alaska Fuel Price Projections also provide three possible scenarios: low, medium and high fuel price projections. In addition, estimates of the social cost of carbon (previously included as estimates of potential carbon taxes), and a price differential for home heating fuel are provided and are incorporated into the REF benefit-cost model for evaluating potential projects.⁴ Previously, a five cents premium for low sulfur diesel was added to the fuel oil price projections in anticipation of the implementation of low sulfur diesel air quality requirements. However, the low sulfur diesel requirement was implemented in 2010; hence recent prices reflect the effects of the rule and a premium is no longer necessary.

The ranges of values between the low, medium (reference), and high projections are based on the assumptions implicit in the EIA crude oil price projections. Readers are encouraged to directly review the EIA *Annual Energy Outlook 2014* at: <http://www.eia.doe.gov/oiaf/aeo/index.html>

We also recommend that readers and users of the model read that EIA *Annual Energy Outlook Retrospective Review* available at: <http://www.eia.gov/forecasts/aeo/retrospective/>

This latter publication evaluates the accuracy of EIA projections since 1993.

We generated low, medium, high case fuel price projections for the years 2014-2040 for the following fuels:

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

This technical report provides documentation of the assumptions and methods used to develop these projections. It is accompanied by a fully documented workbook that contains the detailed projections as

³ Avoided fuel costs are the marginal cost for a utility to produce one more unit of power. The projections presented in this report are based on the potential fuel prices a utility would have to pay if it needed to produce one more unit of power.

⁴ There are differences in the fuel prices different customers pay. Utilities commonly pay lower prices than retail customers (what a household may pay). Also, there is a difference in the price of fuel used for electricity and fuel used for space heating.

well as links to many of the referenced data sources (<http://www.iser.uaa.alaska.edu/publications.php>). Our intent is to provide the user with the ability to reproduce or modify these projections to test the impacts of different assumptions.

Methods and Assumptions

Base Year and Time Horizon

Our projections run from 2014 to 2040. They are computed and reported in inflation-adjusted year 2013 dollars. Because the projections are statistical estimates of annual prices, they may differ from actual prices. In addition, our sample data sets do not include pricing data for 2014. We recognize that a “projection” for 2014 is unlikely to match actual 2014 data. However, much of the data we rely on is published only through 2012 and 2013.

Carbon Pricing

We continue to use the federal government’s estimates for the social cost of carbon (SCC) that are used in benefit-cost analyses for federally funded projects. In this update, we continue to use the SCC estimates as explained by a working paper from the National Bureau of Economic Research.⁵ However, technical updates were published in May and November 2013 by the Interagency Working Group on Social Cost of Carbon, so we updated accordingly.⁶ For the High case, we use the cost of \$62.92 (2013\$) per ton of CO₂ emissions in 2014. For the Medium case, we use the cost of \$40.45 (2013\$) per ton of CO₂ emissions in 2014. For the Low case, we use the cost of \$12.36 (2013\$) per ton of CO₂ emissions in 2014. All three estimates are inflated over time at 3%, which is the average inflation rate of the U.S. Consumer Price Index (CPI) from 1985 to 2013.⁷ The carbon pricing methods were modified to reflect current 2013 data. The social cost of carbon is included separately in the benefit-cost model developed to evaluate proposed projects.⁸ However, the flexibility of adding SCC to the price projections remains. Figure 1 summarizes the assumed carbon price trajectories. These assumptions are parameters that can be changed in the model workbook.

⁵ 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>.

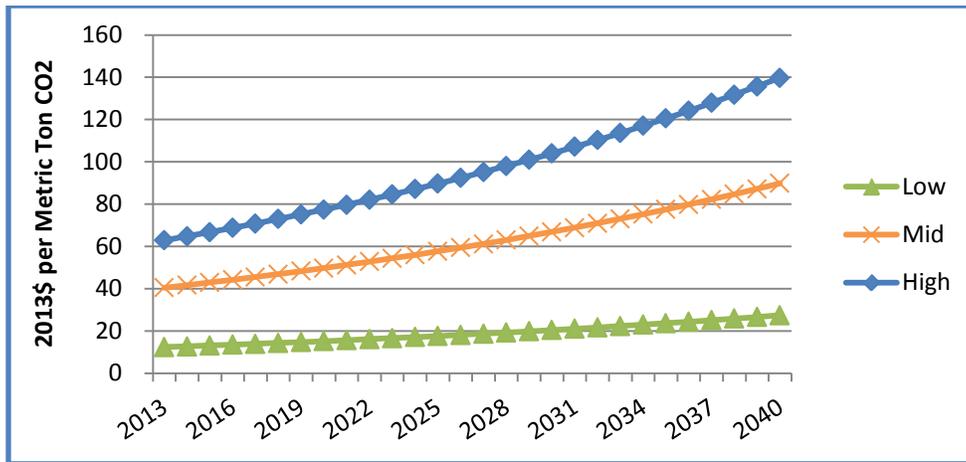
⁶ Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government. May 2013, revised November 2013. Available at: <http://www.whitehouse.gov/sites/default/files/omb/assets/infocoreg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf>

Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government. May 2013. Available at: http://www.whitehouse.gov/sites/default/files/omb/infocoreg/social_cost_of_carbon_for_ria_2013_update.pdf

⁷ Consumer Price Index All Urban Consumers, All items. U.S. Department of Labor, Bureau of Labor Statistics. Available at: <ftp://ftp.bls.gov/pub/special.requests/cpi/cpiat.txt>. The average CPI from 1985 to 2012 is 2.83%, we use a rounded rate of 3.0%.

⁸ In fuel price projections prior to the June 2011 update, the cost of carbon was introduced in the model using the estimates developed by the Massachusetts Institute of Technology (MIT) *Future of Coal* study (Massachusetts Institute of Technology. 2007. *The Future of Coal: Options for a Carbon-Constrained World*. (March 2007). Available at: <http://web.mit.edu/coal/>).

Figure 1. Carbon price trajectories (year 2013\$ per metric ton CO2)



Sources: Authors' calculations based on Greenstone (2011 and 2013 updates).

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 signals of value. Instead, all natural gas sales are agreed upon in contracts negotiated between natural gas producers and a limited number of buyers. As a result, the contract prices negotiated between natural gas producers and utilities 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 on to the utilities' customers who do not directly participate in price contract negotiations; the utilities purchasing the natural gas are also not regulated. The Regulatory Commission of Alaska (RCA) is tasked with protecting the utilities' customers by ensuring that rates are fair and reasonable, which they do through review of natural gas contracts. 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 relatively low natural gas prices until dramatic increases in oil prices drove up the price of Cook Inlet natural gas purchased on these contracts.

When Cook Inlet natural gas prices were especially low, there were concerns regarding future availability of Cook Inlet natural gas because significant capital investment on behalf of the natural gas producers would be necessary to meet growing demand. In the past, producers 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 needed the Southcentral Alaska price to more closely resemble Lower 48 prices to spur continued investments in field development and production. 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 natural gas spot prices.⁹

However, with the sudden rapid increase of shale gas supplies in the Lower 48, natural gas prices dropped significantly. As a result, Cook Inlet became a more appealing natural gas production location given the now relatively higher prices, available infrastructure and ready but less competitive market. This increased exploration and optimism regarding development of Cook Inlet natural gas. In fall 2011, Escopeta Oil company announced that it discovered a large deposit (estimated at 3.5 trillion cubic feet) of Cook Inlet natural gas modifying expectations and assumptions about future Cook Inlet natural gas development and availability. Though there has been no new development in Cook Inlet, exploration has continued and there are positive expectations about future development. However, prices continued to decrease. In 2009, Cook Inlet gas reached its highest average annual price of \$7.88 per Mcf (2013\$). Prices fell 30% between 2009 and 2013 when the price of Cook Inlet gas was \$5.58 per Mcf (2013\$).¹⁰ Currently, the price of Cook Inlet gas was \$5.79 (2013\$) for the third quarter of 2014. Still optimism about Cook Inlet supply continues to grow. After the purchase of Marathon's assets, Hilcorp external affairs manager, Lori Nelson, commented to the Alaska Journal of Commerce that they (Hilcorp) were "confident they can quickly add production" and that they aim to satisfy demand for the coming years. Moreover, Hilcorp stated that they had a 160% increase in gas production in their fields since January 2012.

Assumptions

As we mentioned earlier, in Alaska the RCA must approve prices and contracts between natural gas suppliers and utilities. Hence, some contract information is publicly available (Table 1). In 2012 and 2013, Chugach Electric Association submitted purchase agreements to the RCA for approval from various suppliers where natural gas prices were no longer indexed to Lower 48 prices.

The projection in this report assumes CEA is the marginal supplier of electricity in Southcentral Alaska. CEA fulfills its needs of natural gas for its base load through two firm supply contracts:

⁹ For more information on Southcentral Alaska natural gas prices and contracts, see the RCA website: <http://rca.alaska.gov/RCAWeb/home.aspx>

¹⁰ Please note that the 2013 average is partial and only includes two quarters of data. The CI NG average price for 2012 was \$5.64 per Mcf.

1. A base contract with Conoco Phillips Company and Conoco Phillips Alaska Inc. dated as of May 12, 2009.
2. A base contract with Hilcorp Alaska, LLC (previously Marathon Oil Company¹¹) dated as of March 31, 2010.

The gas supply from these two contracts meets 100% of CEA’s gas requirements in 2013 and 2014.

Moreover, CEA negotiated a new RCA-approved contract with Hilcorp Alaska, LLC as of July 1, 2013. Per the 2013 Hilcorp contract CEA will meet about 30% of its gas requirements in 2015, 65% in 2016 and 100% in 2017 and through the first quarter of 2018 (Figure 2).

Also in November 2013, RCA approved a Sale and Purchase Agreement between Cook Inlet Energy, LLC and CEA dated as of September 30, 2013. This contract for non-firm gas provides interruptible and optional gas purchases up to 10,000 Mcf per day from 2014 to 2018.

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 by a new renewable energy resource. This is appropriate for the projection of prices because the most recently purchased energy is a better indicator of future energy prices than previously purchased energy.

Because the CEA’s natural gas purchases from Cook Inlet Energy is an optional agreement and even if gas is purchased it would meet a negligible share of CEA’s gas purchases, the price projection assumes the 2013 Hilcorp contractual relationship to be the marginal supply of gas for electric power generation.

Table 1. Chugach Electric Association Natural Gas Contracts

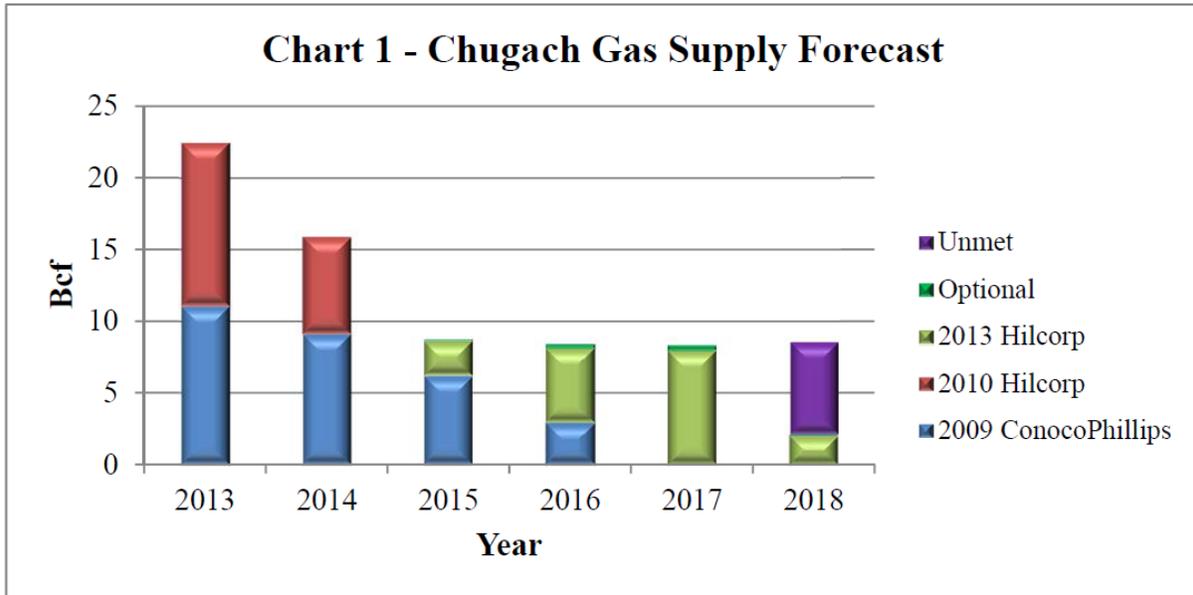
Gas Supplier	Contract Label (Figure 2)	Contract Period
Conoco Phillips	2009 Conoco Phillips	1/1/2010 - 12/31/2016
Hilcorp Alaska, LLC	2010 Hilcorp	4/1/2011 - 12/31/2014
Hilcorp Alaska, LLC	2013 Hilcorp	1/1/2015 - 3/31/2018
Cook Inlet Energy, LLC*	Optional	4/1/2014 - 3/31/2018

Source: RCA Chugach Electric Association Tariff Advice Letter 377-8.

**The gas purchase agreement does not provide a commitment to purchase any volume of gas, instead the parties confer on the possible volumes of gas that could be delivered over an agreed period of time; it provides CEA with potential supply source of natural gas to meet system load requirements.*

¹¹ In February 2013, Hilcorp took ownership of most of Marathon’s Cook Inlet assets. Hence, it is now Hilcorp who fulfills the gas supply agreement. The fields acquired by Hilcorp include: Ninilchik, Kasilof, Kenai, Cannery Loop, Beaver Creek, Wolf Lake, Trading Bay and McArthur Rivers.

Figure 2. Chugach Electric Association Natural Gas Supply Forecast



Source: Image reproduced from RCA Tariff Advice Letter 377-8. Gas Sale and Purchase Agreement effective July 1, 2013 between CEA and Hilcorp Alaska, LLC. (pg. 3).

Natural Gas Price Projection

First, it is important to mention that this natural gas projection is not included in the Renewable Energy Fund Model 2014 update. Instead the REF Model to evaluate REF project applications uses a gas projection provided by the Alaska Energy Authority. The natural gas projection discussed here is provided for the reader’s general reference and use.

As previously mentioned, the natural gas projection assumes that Hilcorp Alaska, LLC is the marginal natural gas supplier for electricity generation. In the 2013 Gas Sale and Purchase Agreement, CEA and Hilcorp agreed to set prices for the gas supply from 2015 to 2018 (Table 2).

Table 2. Chugach Electric Association and Hilcorp Alaska, LLC Natural Gas Contract Prices

Year	Gas Sales Price (\$/Mcf)			Annual Contract Quantity (MMcf)
	Base Load	Swing Load	Emergency Load	
2015	\$7.13	\$8.91	\$10.70	2,427.25
2016	\$7.42	\$9.28	\$11.13	5,215.50
2017	\$7.72	\$9.65	\$11.58	7,975.25
2018	\$8.03	\$10.04	\$12.04	2,009.25

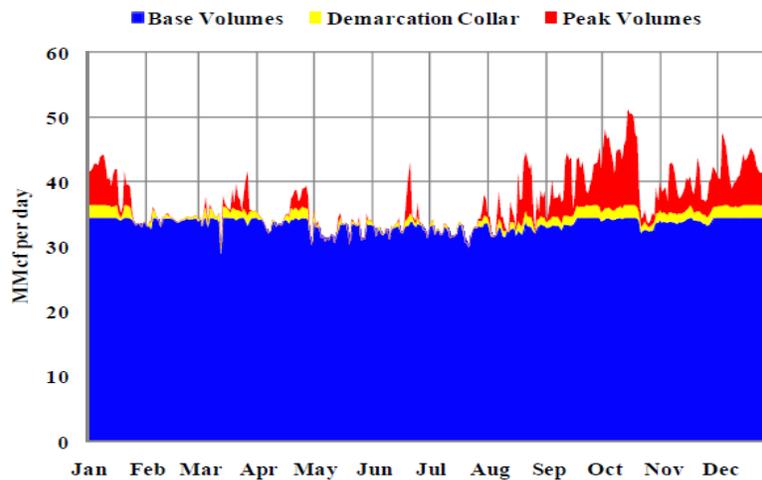
Source: RCA Chugach Electric Association Tariff Advice Letter 377-8. Gas Sale and Purchase Agreement effective July 1, 2013 between CEA and Hilcorp Alaska, LLC. (pg. 4, Appendix A pg. 12).

The 2013 Hilcorp contract sets and reveals the price of gas for the next four years. The base load prices escalate at a 4% annual rate. CEA has a relatively flat load profile; therefore it is able to procure most of its gas needs, about 90% in previous years, through firm supply contracts (Figure 3). However, CEA’s need for gas declines until 2015 and then stabilizes at a new and lower gas requirement (Figure 2, pg. 12) due to a combination of factors including: a) Homer Electric Association and Matanuska Electric Association ceased to be wholesale customers of CEA in 2014; b) efficiencies from the operation of the new and more efficient Southcentral Power Project which achieved commercial operation in February 1, 2013; and c) purchases of energy produced by the Fire Island Wind Project.

Figure 3. CEA’s Base and Peaking Volumes of Gas in 2007

Chart 5 illustrates the proportion of Variable Gas Quantities relative to the Firm Fixed Quantities for a representative year:

Chart 5 – Base and Peaking Volumes with Demarcation Collar

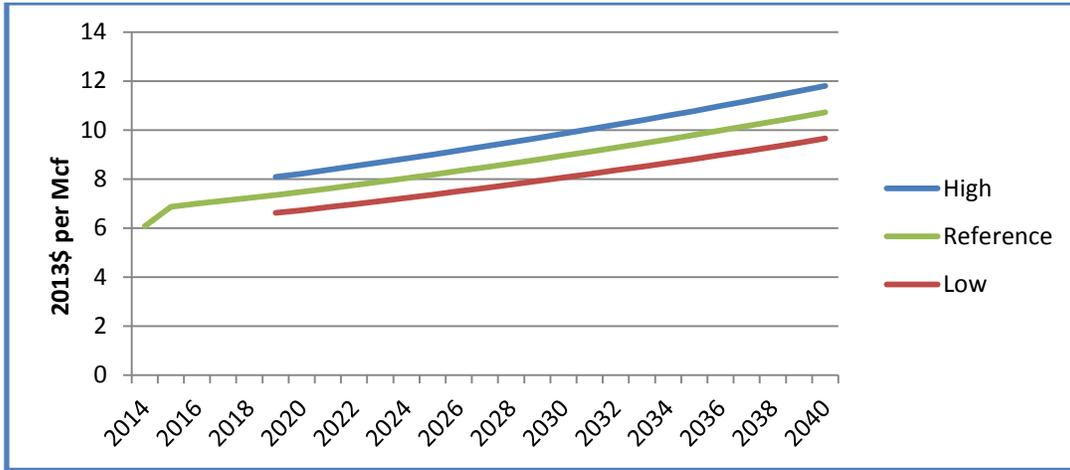


Source: Chugach 2007 Daily Gas Volume

Source: 2009 CEA and Conoco Phillips Gas and Purchase Agreement (pg. 9).

Hence, in the natural gas projection, prices from 2014 to 2018 represent the current and contract ‘actual’ base load prices rather than projected prices. Starting in 2019, prices are projected under the assumption that they will continue to escalate at a 4% annual rate. Contract prices are set in nominal dollars. In the projection, prices are adjusted to ‘real’ or constant 2013 dollars meaning the real assumed growth rate of gas prices is 2%. Because of the uncertainty of future contract prices between CEA and Hilcorp or other potential gas supplier, or whether the nominal contract price growth rate will continue to be about 4%, a low and high scenarios (defined as +/- 10% of the reference case) are also provided to account for the fact that future contract prices may escalate or decline at different rates. The low scenario is 90% of the reference case, while the high scenario is 110% of the reference case. In the reference scenario, natural gas prices rise from \$6.07 per Mcf in 2014 to \$10.72 per Mcf (2013\$) in 2040. In the low scenario, gas prices drop to \$6.61 per Mcf in 2019 and then rise to \$9.65 per Mcf by 2040. In the high scenario, natural gas prices increase to \$8.08 per Mcf in 2019 and then rise to \$11.80 per Mcf by 2040 (Figure 4).

Figure 4. Southcentral Natural Gas Prices, 2013 - 2040



Source: RCA Chugach Electric Association Tariff Advice Letter 377-8. Gas Sale and Purchase Agreement effective July 1, 2013 between CEA and Hilcorp Alaska, LLC. (pg. 4, Appendix A pg. 12) and authors' estimates

Fuel Oil

Background

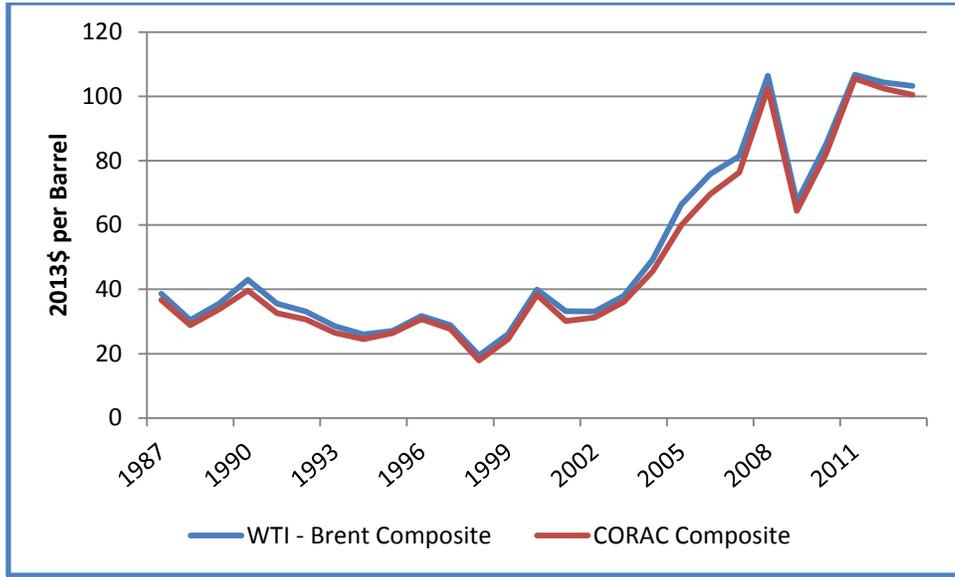
Projecting fuel oil prices requires a different methodology than natural gas prices because there are no existing complex contracts that must be approved by RCA. Each utility negotiates individually (or as a group with other utilities or communities) with individual private fuel suppliers that compete for their business. Our projections are based on U.S. EIA *Annual Energy Outlook (AEO) 2014* projections for crude oil. In the AEO publications prior to 2013, EIA projection of crude oil prices was for imported crude oil. Starting in 2013, the projected prices of crude oil are for the WTI and Brent spot prices.

In the Fuel Price Projections from 2008 to 2012, the fuel price projections were based on the historical U.S. total Crude Oil Refiner Acquisition Cost (CORAC) and the AEO imported crude oil projections from EIA. However, given that the EIA crude oil price projections are now available for the WTI and Brent data series, we now use the WTI and Brent historical crude oil price data.

This is not a consequential change, though it is a technical improvement.¹² In the projections, we use the average of the WTI and the Brent crude oil prices as the basis for the fuel oil projections. Historically, there are negligible differences between the WTI – Brent composite and the CORAC composite annual crude oil prices (Figure 5).

¹² In technical terms, it is an improvement because the same data series is now used for both the historical and projected data.

Figure 5. Historic WTI – Brent and CORAC Crude Oil Prices



Source: U.S. Energy Information Administration and authors' calculations.

Rural Fuel Prices

This projection update follows the same methodology as the projection update of July 2013 with some improvements. Please refer to Appendix A for added detailed methodology.

The rural regression model assumes that the price of fuel oil¹³ to a particular utility receiving Power Cost Equalization assistance bears a stable linear relationship to the price of crude oil. This assumption is based on the statistical analysis that shows that historic fuel oil and crude oil prices are almost perfectly correlated (Table 3); meaning an almost perfect positive linear relationship exists between fuel oil and crude oil prices (Figure 6).¹⁴

Table 3. Correlation Coefficients between Crude Oil and Fuel Oil Prices

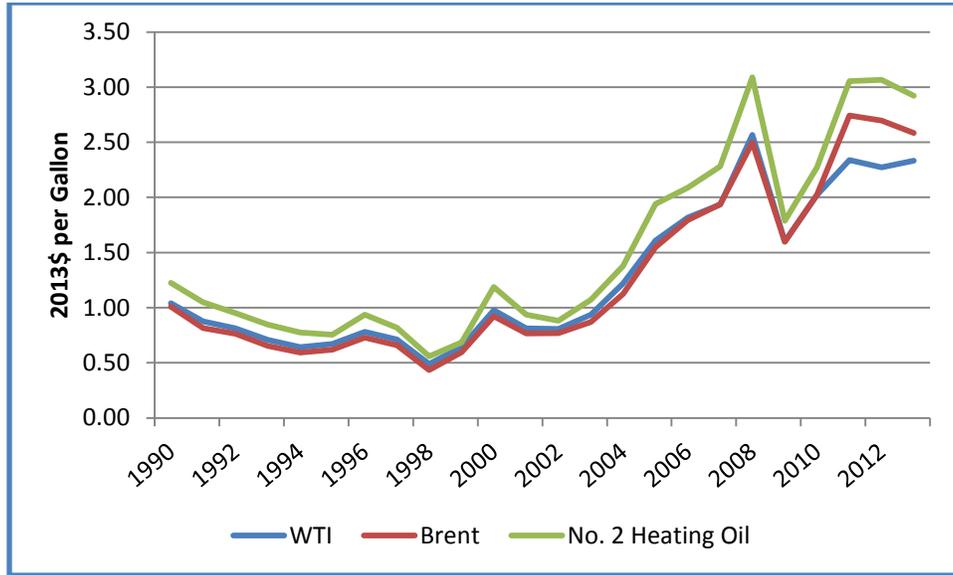
Crude Oil Data Series	Fuel Oil
WTI	0.993
Brent	0.997
WTI – Brent Composite	0.998

Source: U.S. Energy Information Administration and authors' calculations.

¹³PCE prices collected from PCE statistical reports.

¹⁴Correlation is a coefficient that measures the strength and direction of a linear relationship between two variables.

Figure 6. Historic Crude Oil and Fuel Oil Prices



Source: U.S. Energy Information Administration and authors' calculations.

Similar to previous fuel price projections (2011 to present), we ran individual linear regressions for each community, which provides a unique slope and intercept for each community that represents how each community is directly affected by crude oil prices. The fuel price projection model provides estimates of how much the price of fuel oil in each community would increase for every \$1 increase in the price of crude oil. Another important factor includes how access to purchased fuel is affected by each community's geographic location. In particular, the frequency of fuel deliveries appears to be a major factor influencing specific community fuel prices. To build a more accurate projection, in the June 2011 update we ran two sets of regressions for each community. In one projection, we lagged the crude oil price by one year, while in the other no lag was allowed. The testing of the potential of lagged prices to better explain some community utility fuel oil prices was based on our research on "components of rural fuel prices" that we completed from 2008 through 2011.¹⁵

Informed by the regressions, we analyzed which community fuel prices were better explained with a year lag versus those that were not. We used the R-squared and P-values, statistical indicators of the precision of the regression equation's ability to "explain" the historic data, to select the intercept and slopes for each community appropriately. As expected, the scenario without a lag in crude prices better

¹⁵Szymoniak, 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.
 Fay, Ginny, Ben Saylor, Nick Szymoniak, Meghan Wilson and Steve Colt. 2009. *Study of the Components of Delivered Fuel Costs in Alaska: January 2009 Update*. Anchorage: University of Alaska Anchorage, Institute of Social and Economic Research. Prepared for the Alaska State Legislature, Senate Finance Committee, 22 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. Prepared for the Alaska Energy Authority, 70 pages.

explained the crude and fuel price relationships for communities in the Southeast, Southcentral and Southwest regions where communities have more flexibility in sourcing their fuel and can purchase fuel more frequently. As anticipated, the lagged crude price better reflects the fuel prices for most rural PCE communities where importing fuel is complicated due to their remoteness, and seasonal conditions such as winter sea ice, which allows only one or two fuel deliveries per year. Thus, crude oil price changes have a lagged effect on these communities. Based on that analysis, in the current update, regressions with and without a year lag were run accordingly (Table 4). The communities that were subject to the No-Lag regression are:

Table 4. Communities without a Lagged Relationship to Crude Oil Prices

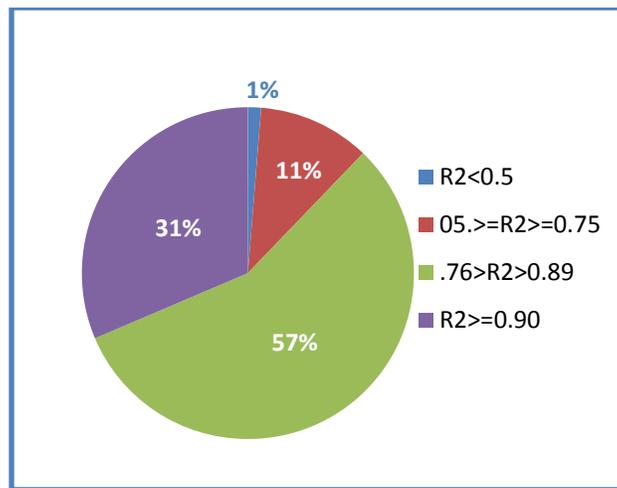
Community ID	Community Name	Census Area
14	Craig	Prince of Wales-Hyder (CA)
28	Hydaburg	Prince of Wales-Hyder (CA)
65	Skagway	Skagway
73	Tok	Southeast Fairbanks (CA)
95	Chalkyitsik	Yukon-Koyukuk (CA)
103	Cordova	Valdez-Cordova (CA)
150	Pelican	Hoonah-Angoon (CA)
151	Perryville	Lake and Peninsula
159	Saint George	Aleutians West (CA)
175	Unalaska	Aleutians West (CA)

Some utilities do not report fuel prices every month or year, which results in missing values in the historic data. To provide a more robust projection, we statistically impute missing values, using the statistical software program STATA. Our analysis indicates that adding imputed values improves the robustness of the fuel price projection.

Given the variation of the original number of observations and of the data quality for each community, some projections may appear to be 'better' than others. In statistical terminology, the coefficient of determination in our model, the Adjusted R-squared, indicates how well observed outcomes are replicated by the model; or in other words, how well the independent variable (crude oil prices) explains the dependent variable (fuel oil prices). The Adjusted R-squared coefficient ranges from 0 to 1; the higher the coefficient value and the closer to 1, the better the goodness of fit of the model.

We ran regressions for 156 rural communities that experience the lag phenomena. Of these 156 communities, 49 community projections have an Adjusted R-squared value above 0.90; 88 community projections have an Adjusted R-squared value between 0.76 and 0.89; 17 community projections have an Adjusted R-squared between 0.5 and 0.75; and only 2 communities have an Adjusted R-squared value below 0.5 (Figure 7). Most communities with low Adjusted R-squared values are communities for which limited data are available or are located in the North Slope Borough, which has a fuel subsidy program which lowers variability in fuel prices over time and impacts the estimates' reliability.

Figure 7. Distribution of Adjusted R² Values for Rural Community Fuel Price Projections



Source: Authors' fuel price analysis.

In addition, we ran regressions for ten communities that do not experience the lag phenomena. Nine communities had Adjusted R-squared values of over 0.90 and one had an Adjusted R-squared value of 0.88.

Urban Fuel Prices

Finally, regressions and projections were also performed for larger communities in Alaska that are not part of the Power Cost Equalization program: Anchorage, Fairbanks, Juneau, Kenai, Ketchikan, Kodiak, Palmer, Petersburg, Sitka, and Wrangell. Projections of fuel prices for these communities are also based on the same underlying model described above and do not include a lag. However, public data regarding utility fuel prices are less available for these communities. Electric sector fuel prices are available for Anchorage, Fairbanks and Juneau collected from Cost of Power Adjustment (COPA) utility filings with the Regulatory Commission of Alaska (RCA). Additionally, we obtained electric utility diesel prices directly from some utilities. There are also two primary sources of retail fuel price data: 1) data collected by the Alaska Housing and Finance Corporation (AHFC) and 2) the University of Alaska Fairbanks Cooperation Extension Service Food Survey (UAF CES). A dataset was created from AHFC prices that supplemented CES prices for missing AHFC prices.

As can be expected, retail prices can be significantly higher than the wholesale prices utilities pay. The Energy Information Administration also collects utility fuel price data but these data are not available for all Alaska utilities, primarily due to their smaller size. For those smaller urban Alaska utilities, we collected data directly from utilities via an information request by AEA.

For communities with available electric sector fuel price data (Anchorage, Fairbanks and Juneau), we ran regression analyses of the electric sector fuel price with respect to crude oil prices for each community. We then used EIA crude oil projections and the regression output to create fuel price projections for these communities.

If electric sector historic data were not available for a regression analysis (Kenai, Ketchikan, Kodiak, Palmer, Petersburg, Sitka and Wrangell), we estimated price differentials between electric utility and retail diesel prices for each community based on additional data collected and analyses conducted. We ran regression analyses of the retail fuel prices with respect to crude oil prices. We used the EIA crude projections and retail fuel price regression output to create retail fuel price projections. Then, we use the analysis of price differences between retail and electric sector prices to create the electric sector fuel price projection. If no electric utility data were available, we used the price differential estimate from a proxy community to estimate electric sector projection. This is an improvement in methodology from prior years when the average difference was applied to all urban communities.

Home Heating Fuel Prices

We were not able to rigorously determine a home delivery surcharge by statistical methods. However, there is some evidence of a relationship between residential home heating fuel prices, crude oil prices and PCE utility fuel prices (Table 5).

Table 5. Correlations between Residential Home Heating Fuel, PCE Utility Fuel and Crude Oil Prices

	Residential home heating fuel (rural)	PCE utility fuel	Crude oil
Residential home heating fuel (rural)	1.0000		
PCE utility fuel	0.5825	1.0000	
Crude Oil	0.5845	0.5844	1.0000

The average difference between PCE fuel and Alaska Housing Finance Corporation (AHFC) fuel survey prices (retail-heating) between years 2008 to 2013 was \$1.40 (2013\$). As a result, we suggest that the community utility fuel price plus \$1.40 (2013\$) per gallon be used as the avoidable cost of home delivery when small amounts of home-delivered fuel are being avoided. However, when substantial amount of delivered fuel is avoided (e.g., a community district heating system or mass retrofit for biomass heating), 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 6 below. These are the amounts applied in the Renewable Energy Fund project economic review model.

Table 6. Suggested Fuel Premiums per Gallon of Displaced Fuel Oil

Gallons of Displaced Heating Fuel	Heating Fuel Premium (2013\$)
<1,000	\$1.40
1,000 < 25,000	\$0.94
25,000 > 100,000	\$0.47
>100,000	\$0.00

Source: PCE program data, AHFC fuel price survey, UAF CES food survey, and authors' 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 since 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 and retail fuel prices. These factors include: the varying time intervals between the placement of orders, the timing of departures of fuel deliveries from refineries, and fuel storage inventories in communities, as well as distances between refineries, fuel distributors and community storage facilities.¹⁶ However, due to data limitations these factors are not represented in our simple statistical regression.

¹⁶ 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.

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Appendix A. Projection methodology

Fuel Oil Prices – Rural Communities

The fuel oil price projection is based on crude oil price forecasts from EIA's *Annual Energy Outlook 2014* (AEO).

1. Access the EIA's Annual Energy Outlook 2014. Available at:
<http://www.eia.gov/forecasts/aeo/index.cfm>
2. Obtain the forecast for Crude Oil Price, Brent and West Texas, from Table 1 for the Reference, Low Oil Price, and High Oil Price cases.
3. Obtain the historical monthly West Texas Intermediate and Brent crude oil prices from the following URL: http://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm
4. For each month, adjust crude prices to 2013 dollars ("real crude price") using the appropriate average CPI-U (U.S. Consumer Price Index for All Urban Consumers). Available at:
<http://www.bls.gov/CPI/>.
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 1990 – 2013. The PCE Statistical Reports for fiscal years 2002 through 2013 can be obtained from the following URL:
<http://www.aidea.org/aea/programspce.html>.¹⁸ For this fuel price update, obtain PCE fuel prices from the Alaska Energy Data Gateway (AEDG) from the following URL:
<https://akenergygateway.alaska.edu/>
7. Calculate the average CPI-U by fiscal year, and adjust PCE prices to real dollars based on the average CPI-U.
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:

¹⁸ 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 2011.

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

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 average Crude Oil Price per gallon of the Brent and West Texas forecasts (lagged by one year or not, as appropriate) for each year from 2013 to 2040.
11. Continuing with changes implemented in the June 2011 projection, the 'CO₂ Equivalent Allowance Cost' is no longer added to allow flexibility in the use of these projections. We now appropriately add the 'CO₂ Equivalent Allowance Cost' in the benefit-cost model rather than directly into the fuel price projection.
12. Take the moving average three (MA₃) to smooth out the projections for all three cases.

Fuel Oil Prices – Urban Communities

1. For urban communities: Anchorage, Fairbanks, Juneau, Kenai, Ketchikan, Palmer, Wasilla, Sitka, Wrangell, Kodiak and Petersburg; obtain prices for heating oil from Alaska Housing Finance Corporation's annual fuel price surveys conducted in years 2000 through 2014 (obtain data through the Alaska Energy Data Gateway, <https://akenergygateway.alaska.edu/>). 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/>). The Alaska Food Cost Survey includes data from 1996 to 2014. However, even after combining data from both datasets there will be missing data points. Adjust prices to real dollars.
2. Collect fuel price data for urban communities from the U.S. Energy Information Administration Survey Form 923 data file, Schedule 5 as well as directly from electric utilities. Calculate the wholesale-retail price difference (percentage) for each community (when data are available) between EIA and AHFC and CES prices.
3. Collect electric sector fuel prices for Anchorage, Fairbanks and Juneau using RCA COPA filings. For other communities, collect data via the Alaska Energy Authority and/or direct requests to utilities.

4. Collect historic crude oil prices from the U.S. Energy Information Administration (EIA) (Brent and WTI prices, use simple average).
5. Create data set including historic electric sector, retail fuel prices and historic crude oil prices. Run regressions for electric and retail sector models if possible.
6. Collect EIA crude oil forecast from Annual Energy Outlook.
7. Use the regression coefficients to project heating diesel prices as a function of the simple average of Brent Spot and West Texas Intermediate forecast prices per gallon (Low, Medium, and High cases) for each year from 2014 to 2040 for each community.

Natural Gas Projection

1. Collect gas prices from most recent Chugach Electric Association contract with gas supplier for base gas. Available through Tariff Advice Letters to the Regulatory Commission of Alaska.
2. Calculate nominal growth rate.
3. Project gas prices using the calculated growth rate.
4. Collect CPI coefficients
5. Adjust gas prices to constant dollars
6. Create low and high projections by adjusting the reference case by an estimated reasonable percentage (+/- 10% was used in the 2014 projection)

Home Heating Fuel Adder

The calculated prices are for utilities. Calculate the correlation between AHFC and PCE prices. Since no clear relationship was found between AHFC surveyed home heating oil prices and PCE utility fuel prices, estimate the average difference (\$1.40, 2013\$).