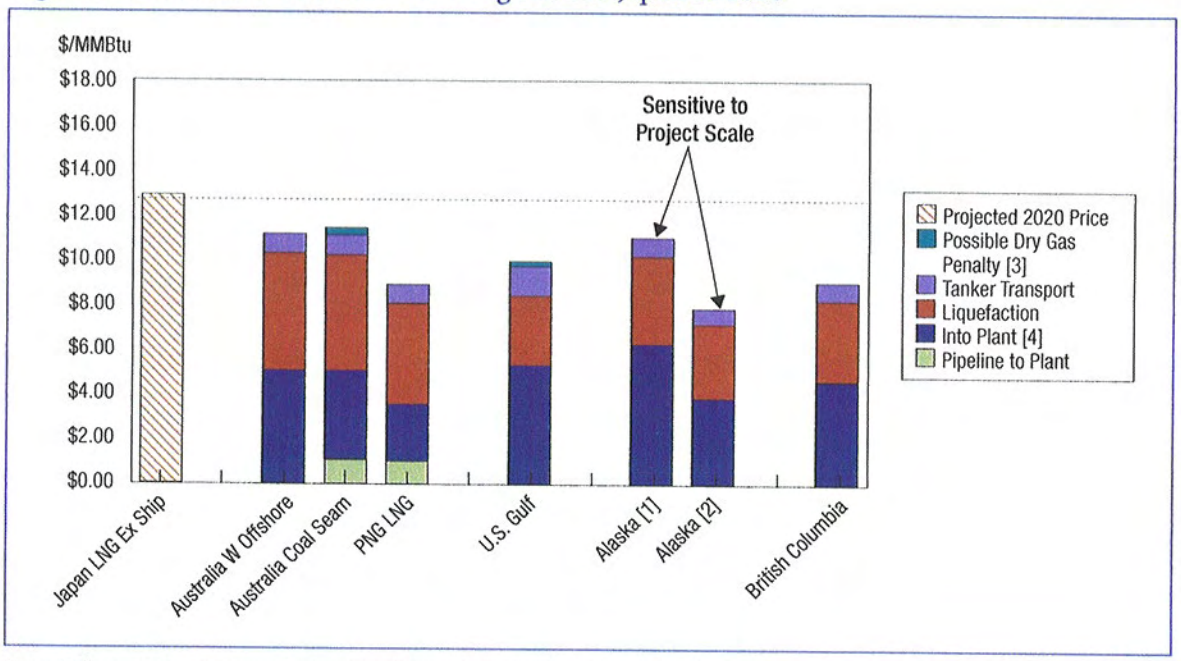
Figure 11: Estimated Costs of Delivering LNG to Japan in 2020



Note: Gulf exports to Asia assume tankers travel through an expanded Panama Canal
[1]: Assumes 1 bcf/day from Valdez, Alaska
[2]: Assumes 3.1 bcf/day from Valdez, Alaska
[3]: Dry gas penalty is assumed at 2 percent
[4]: For Alaska and British Columbia, "Into Plant" refers to the opportunity cost relative to projections of Henry Hub price
Source: From a client presentation by James Jensen, Jensen Associates

2020.) This threshold, expected by many experts to be roughly 6 bcf/day by 2025, is modest in comparison to the roughly 11 bcf/day of Australian LNG export projects that have reached final investment decision and are expected to be online by 2020.

Also, the impact of U.S. LNG exports could be limited by a number of external factors that will have a larger bearing on the future of global LNG prices. For instance, a decision by the Japanese government to phase-out nuclear power would significantly tighten global LNG markets and probably displace any benefit provided by U.S. LNG exports. Conversely, successful and rapid development of China's shale gas reserves would limit the demand of one of the world's fastest-growing natural gas consumers. However, to the extent that U.S. LNG exports can help bring about a more globalized pricing structure, they will have economic and geopolitical consequences.

Geopolitics

A large increase in U.S. LNG exports would have the potential to increase U.S. foreign policy interests in both the Atlantic and Pacific basins. Unlike oil, natural gas has traditionally been an infrastructure-constrained business, giving geographical proximity and political relations between producers and consumers a high level of importance. Issues of "pipeline politics" have been most directly visible in Europe, which relies on Russia for around a third of its gas. Previous disputes between Moscow and Ukraine over pricing have led to major gas shortages in several E.U. countries in the winters (when demand is highest) of both 2006 and 2009. Further disagreements between Moscow and Kiev over the terms of the existing bilateral gas deal have the potential to escalate again, with negative consequences for E.U. consumers.

Alaska Gasline PORT AUTHORITY

Phone: (907) 474-2011
Fax: (907) 474-2001

www.allalaskagasline.com

Bill.walker@walkerrichards.com

August 23, 2012

Dear Mr. LeFebvre:

The Alaska Gasline Port Authority filed an application with the U.S. Department of Energy (DOE/FE) for an export license on July 5, 2012. Attached to this letter you will find a copy of that application, along with the documentation requested in our last correspondence regarding the Anderson Bay lease. Much has occurred since we last had contact regarding this issue. However, Alaska's need for the development of this rich resource remains critical and steadfast. Our intent in submitting these documents is to continue the phased application process.

AGPA first contacted the Department of Natural Resources regarding a lease application for Anderson Bay in May of 2009.[1] There, we noted that applying for the land was a preliminary first step for the contemplated liquefaction plant as part of an instate gasline. We have now moved a step beyond the conceptual phase of this project by applying for an export license. However, the concerns we expressed in our May 21, 2009 letter regarding the corollary requirements of the development plan are raised again as we continue in the application process. We have addressed those requirements and will continue to update the development plan as we proceed with both the export license and this application.

To that end, AGPA suggests a phased approval process as part of the lease application for Anderson Bay. The Department embraced this suggestion in its letter of August 18, 2009 wherein it set out a step-by-step process AGPA would follow in its phased application and approval process.[2]

Our last correspondence was receipt of your letter dated August 28, 2009 wherein you noted: "when you are ready to submit your application please contact me directly and I will accompany you to the appropriate office."[3] In the past several years, we have made substantial progress with the Asian market and continued to move the project forward. Upon receiving significant engagement from the market for a large volume of LNG from Valdez, we began work on the

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[1] See, letter from AGPA to Commissioners Irwin and Rutherford, dated May 21, 2009.
[2] See, letter from Richard LeFebvre to William Walker/AGPA, dated August 18, 2009.
[3] See, letter from Richard LeFebvre to William Walker/AGPA, dated August 28, 2009.

export license. Now that the application has been filed with the DOE/FE, we return to the Anderson Bay lease application. I relay this to you to make clear that at no time has this project or the Anderson Bay application gone to the wayside. This application is a crucial component to the entire project.

Valdez remains the preferred location as the terminus for an in-state line. The Anchorage Daily News recently reported:

> "Valdez is a deepwater port and the northernmost North American port free of ice year-round....Valdez has hosted oil tankers since 1977, when crude began lowing down the pipeline. Port Valdez waters are relatively docile compared to Cook Inlet, the study says. A fleet of powerful export tugs are stationed there, as well as a U.S. Coast Guard system to monitor vessel traffic. In contrast to Valdez, Cook Inlet is characterized by extreme tides, shoals, strong currents, and less tug and Coast Guard support."[4]

As the Port Authority has noted in the past, the Yukon Pacific Corporation (YPC) undertook substantial research and study in selecting Anderson Bay over all other LNG plant sites. The US Department of Energy Office of Fossil Energy mandated use of the Valdez location over all other sites in issuing an export license to YPC. Consistent with its export license application, the AGPA has identified Anderson Bay as a preferred location for the liquefaction plant.

The Port Authority submits this application for Anderson Bay, in the public interest. As provided in Alaska Statute 38.05.810(i), the Port Authority requests the lease be at a fee less than the fair market value. The Port Authority is a political subdivision of the State under AS 29.35.605(c). As such, a lease of the Anderson Bay property will be consistent with public use and ownership of the land. Alaska Statute 38.04.015 states:

> "The primary public interests in retaining areas of state land surface in public ownership are to make them available on a sustained-yield basis for a variety of beneficial uses including...energy development...."

The public interest will be served through the lease of Anderson Bay to the Port Authority in a number of ways: 1) energy costs will be reduced in parts of the state by up to 80% upon completion of the large-volume instate line; 2) throughout the construction phase of the line up to 20,000 direct jobs will be created in addition to the 50,000-300,000 indirect jobs created;[5] 3) over the life of the line, the state could receive between $220 and $419 billion in revenues.[6]

Pursuant to our previous correspondence, the Port Authority requests assignment of an ADL#, along with the creation of a land lease application file for the Valdez Liquefaction Plant project.

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[4] Anchorage Daily News article "Valdez rated better for LNG line than Cook Inlet", published April 22, 2012.

[5] See, McDowell Group, *Gasline Comparison,* p. 7, January 2012.

[6] See, McDowell Group, *Gasline Comparison*, pg. 6, January 2012, citing Wood MacKenzie, *Alaskan LNG Competitiveness Study,* July 27, 2011.

The Port Authority respectfully requests that its land lease application is granted Phase I preliminary conceptual approval to AGPA's land lease application.

Attached is a copy of our previous correspondence along with the documents requested in your letter dated August 18, 2009:

- Letter correspondence
  - AGPA to Commissioners Irwin and Rutherford, dated 5/21/2009
  - AGPA to Commissioner Irwin, dated 6/1/2009
  - Commissioner LeFebvre, dated 8/18/2009
  - AGPA to Commissioner LeFebvre, dated 8/25/2009
  - Commissioner LeFebvre to AGPA, dated 8/28/2009
- Documents establishing creation of AGPA pursuant to the Alaska port authority enabling statutes
  - Enabling statutes for port authorities (AS 29.35.605)
  - Municipal ordinances and certificates of ratification for establishment of AGPA
  - US IRS letter ruling that AGPA is a political subdivision
  - AGPA amended by-laws
- Documents establishing qualification of AGPA for a less than fair market value lease of State land:
  - Alaska Statute 38.05.810(i)
- DNR standard land leasing form and development plan.
- FERC FIES for YPC's proposed TAGS project, 1995.

As always, if you have any questions, please do not hesitate to contact me any time.

Very truly yours,

William M. Walker
Project Manager/General Counsel

STATE OF ALASKA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND AND WATER

☐ Land Sales and Contract Administration
550 W 7th Ave., Suite 640
Anchorage, AK 99501-3576
(907) 269-8594

☐ Northern Region
3700 Airport Way
Fairbanks, AK 99709
(907) 451-2740

☒ Southcentral Region
550 W 7th Ave., Suite 900C
Anchorage, AK 99501-3577
(907) 269-8552

☐ Southeast Region
400 Willoughby, #400
P.O. Box 111020
Juneau, AK 99811-1021
(907) 465-3400

APPLICATION FOR PURCHASE OR LEASE OF STATE LAND

Date _____ ADL # (assigned by DNR) _____

Applicant's Name Bill Walker Doing business as: Alaska Gasline Port Authority

Mailing Address 731 N Street

City/State/Zip Anchorage, Alaska 99501 E-Mail bill.walker@walkerrichards.com

Message Phone (907) 278-7000 Work Phone (907) 278-7000 Date of Birth _____

Is applicant a corporation qualified to do business in Alaska? ☒ **yes** ☐ **no**. Is the corporation in good standing with the State of Alaska, Dept. of Commerce and Economic Development? ☒ **yes** ☐ **no.**

Is applicant 18 years or older? ☒ **yes** ☐ **no.** Are you applying for a ☒ **lease** or ☐ **sale**?

What kind of lease or sale are you applying for? ☐ **Tideland;** ☒ **Public/Charitable Use;** ☐ **Grazing;** ☐ **Millsite;** ☐ **Negotiated;** ☐ **Competitive;** ☐ **Non-Competitive;** ☐ **Preference Right.**

If a lease, how many years are you applying for? 55 **years**. (55 years Max.)

Legal Description: Lot(s) see map Block/Tract # _____ Survey/Subdivision _____

Other: _____

Meridian Choose from list Township _____, Range _____, Section(s) _____ Acres _____

Municipality City of Valdez LORAN Reading (optional) _____

Geographic Location: Anderson Bay, 3 miles West of Valdez Marine Terminal

What is the proposed use of and activity on the state land? natural gas liquefaction plant and marine terminal for LNG tanker ships

Are there any improvements on the land now? ☐ **yes** ☒ **no**. If yes, who owns the improvements, and what is the estimated value? _____

If yes, describe any existing improvements on the land. _____

Are there any improvements or construction planned? ☒ **yes** ☐ **no**. If yes, describe them and their estimated value.
LNG liquefaction plant, marine terminal for LNG tankers, related facilities

State the proposed construction date: _____; estimated completion date*: _____

Name and address of adjacent land owners and, if you are applying for tidelands, the name and address of the adjacent upland owners: Alyeska Pipeline Service Co., Alaska Dir. Mining, 550 W. 7th, Anchorage, AK 99501

Are you currently in default on, or in violation of, any purchase contract, lease, permit or other authorization issued by the department under 11 AAC? ☐ **yes** ☒ **no**. Within the past three years, has the department foreclosed or terminated any purchase contract, lease, permit or other authorization issued to you? ☐ **yes** ☒ **no**.

Non-refundable filing fee: $100
(Fee may be waived under 11 AAC 05.010(c))

Date Stamp:

Is the land applied for subject to any existing leases or permits? ☐ **yes** ☒ **no**. If yes, ☐ **lease** or ☐ **permit**?
Name lease/permit is issued under: _____ ADL # _____

Do you think you qualify for a non-competitive lease or sale? ☒ **yes** ☐ **no**. If yes, under what provision of **AS 38.05**?

- ☐ **AS 38.05.035(b)(2)** (to correct an error or omission);
- ☐ **AS 38.05.035(b)(3)** (owner of bona fide improvements);
- ☐ **AS 38.05.035(b)(5)** (occupied, or are the heir of someone who occupied the land before statehood);
- ☐ **AS 38.05.035(b)(7)** (adjacent owner of remnant of state land, not adjoining other state land;
- ☐ **AS 38.05.068 and .087** (U.S. Forest Service Permittee);
- ☐ **AS 38.05.075(c)** (upland owner or lessee);
- ☐ **AS 38.05.035(f)** (previous federal and state authorization, erected a building and used the land for business purposes);
- ☐ **AS 38.05.102** (current long-term lessee or current shore fishery lessee);
- ☐ **AS 38.05.255** (millsite lease for mine-related facilities);
- ☐ **AS 38.05.810(a)*** (government agency; tax-exempt, non-profit organization organized to operate a cemetery, solid waste facility, or other public facility; or a subdivision's nonprofit, tax-exempt homeowners' association);
- ☐ **AS 38.05.810(b)-(d)** (non-profit corporation, association, club, or society operated for charitable, religious, scientific, or educational purposes, or for the promotion of social welfare, or a youth encampment);
- ☐ **AS 38.05.810(e)** (licensed public utility or licensed common carrier);
- ☐ **AS 38.05.810(f)** (non-profit cooperative organized under AS 10.25, or licensed public utility);
- ☐ **AS 38.05.810(h)** (Alaska Aerospace Development Corporation);
- ☒ **AS 38.05.810(i)** (port authority);
- ☐ **AS 38.05.825** (municipality applying for eligible tidelands, or tidelands required for private development);
- ☐ other (please explain): _____

If you have checked one of the above statutes, attach a statement detailing your qualifications under each requirement of that statute.

Do you think you qualify to lease the land for less than fair market value? ☒ **yes** ☐ **no**. If yes, under what provision of **AS 38.05**?

- ☐ **AS 38.05.097** (youth encampment or similar recreational purpose);
- ☐ **AS 38.05.098** (senior citizen discount for a residential lease);
- ☒ other (please explain). AS38.05.810(i)

Signature _____ Date 8/23/12

Alaska Gasline Port Authority
If applying on behalf of an agency, municipality, or organization, state which one

General Counsel/Project Manage
Title

NOTICE TO APPLICANT:

*** For applications filed by a municipality under AS 38.05.810, if there is a remaining entitlement of the municipality under AS 29.65, land transferred under AS 38.05.810 shall be credited toward fulfillment of the entitlement.**
*** Construction may not commence until approval is granted by lessor.**
*** This application will not be considered unless it is accompanied by the appropriate filing fee and completed in full. THE FILING FEE WILL NOT BE REFUNDED NOR IS IT TRANSFERABLE. All checks are to be made payable to the Department of Natural Resources.**
*** Include a 1:63,360 USGS map showing location of proposed activities in relation to survey monumentation or fixed geographical features which fully illustrates your intended use, including the location of buildings and improvements and access points, labeled with all dimensions, and a development plan providing a complete list of proposed activities.**
*** The applicant may be required to deposit a sum of money sufficient to cover the estimated cost of survey, appraisal, and advertising. If the land is sold or leased to another party, the deposit will be returned to the applicant.**
*** The filing of this application and payment of the filing fee vests the applicant with no right or priority in the lands applied for. It is merely an expression of the desire to purchase or lease a parcel of land when and if it becomes available. Filing an application serves the purpose of notifying the state that an individual is interested in purchasing or leasing land. It is not a claim, nor does it in any way obligate the state to sell or lease land.**
*** If the application site is in the Coastal Zone, include a Coastal Project Questionnaire (www.gov.state.ak.us/dgc/Projects/projects.html).**
*** If the application is for use in conjunction with a guide/outfitter operation, include proof of a guide/outfitter certification for the use area.**
*** If the application is for a commercial fish camp, include a copy of your limited entry permit or an interim-use salmon set net permit.**
*** If applying for a senior citizen discount, include form 102-1042.**
*** AS 38.05.036(a) authorizes the director to decide what information is needed to process an application for the sale or use of state land and resources. This information is made a part of the state public land records and becomes public information under AS 40.25.110 and 40.25.120 (unless the information qualifies for confidentiality under AS 38.05.036(a)(9) and confidentiality is requested). Public information is open to inspection by you or any member of the public. A person who is the subject of the information may challenge its accuracy or completeness under AS 44.99.310, by giving a written description of the challenged information, the changes needed to correct it, and a name and address where the person can be reached. False statements made in an application for a benefit are punishable under AS 11.56.210.**

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

VALDEZ A-7 QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)

SCALE 1:63 360

Produced by the United States Geological Survey 1960
Revision within and adjacent to National Forest System lands by USDA Forest Service 1996

Topography compiled 1957. Planimetry derived from imagery taken 1984 and other sources. Public Land Survey System and survey control current as of 1996

North American Datum of 1927 (NAD 27). Projection and 20 000-foot ticks: Alaska coordinate system, zone 3 (Transverse Mercator)
Blue 5000-meter Universal Transverse Mercator ticks: zone 6

North American Datum of 1983 (NAD 83) is shown by dashed corner ticks. The values of the shift between NAD 27 and NAD 83 are obtainable from National Geodetic Survey NADCON software

Non-National Forest System lands within the National Forest boundaries may exist in other National or State reservations

Map is not a legal land line or ownership document. Public lands are subject to change and leasing, and may have access restrictions; check with local offices. Obtain permission before entering private lands

Unprotected land lines are predetermined by the Bureau of Land Management Fairbanks Clerks, Copper River Meridian

15TH GRID AND 1999 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
THE MEAN RANGE OF TIDE IS APPROXIMATELY 30 FEET
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

ALASKA
QUADRANGLE LOCATION

1 Valdez B-8
2 Valdez B-7
3 Valdez B-6
4 Valdez A-8
5 Valdez A-7
6 Cordova D-5
7 Cordova D-7
8 Cordova D-6
ADJOINING QUADRANGLES

HIGHWAYS AND ROADS

FOR SALE BY U.S. GEOLOGICAL SURVEY, P.O. BOX 25286, DENVER, COLORADO 80225
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

VALDEZ A-7, AK
1996

STATE OF ALASKA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND AND WATER

☐ Contract Administration
550 W 7th Ave., Suite 640
Anchorage, AK 99501-3576
(907) 269-8594

☐ Northern Region
3700 Airport Way
Fairbanks, AK 99709
(907) 451-2740

☒ Southcentral Region
550 W 7th Ave., Suite 900C
Anchorage, AK 99501-3577
(907) 269-8552

☐ Southeast Region
400 Willoughby,
Suite #400
P.O. Box 111020
Juneau, AK 99801
(907) 465-3400

APPLICANT ENVIRONMENTAL RISK QUESTIONNAIRE

The purpose of this questionnaire is to help clarify the types of activities you propose to undertake. The questions are meant to help identify the level of environmental risk that may be associated with the proposed activity. The Division of Mining, Land and Water's evaluation of environmental risk for the proposed activity does not imply that the parcel or the proposed activity is an environmental risk from the presence or use of hazardous substances.

Through this analysis, you may become aware of environmental risks that you did not know about. If so, you may want to consult with an environmental engineer or an attorney.

Bill Walker	Alaska Gasline Port Authority
Applicant's Name	Doing Business As
731 N Street	Anchorage, Alaska 99501
Address	City State Zip

(907) 278-7000	(907) 278-7000	bill.walker@walkerrich	Bill Walker
Message Phone	Work Phone	E-Mail	Contact Person

Describe the proposed activity:

Construction and operation of a natural gas liquefaction plant and marine terminal for loading LNG tanker ships. The location is Anderson Bay, approximately 3 miles west of the Alyeska Pipeline Service Co., Valdez Marine Terminal at Valdez, Alaska and within the City of Valdez municipal boundary.

In the course of your proposed activity will you generate, use, store, transport, dispose of, or otherwise come in contact with toxic and/or hazardous materials, and/or hydrocarbons? Yes ☒ No ☐

If yes, please list the substances and the associated quantities. Use a separate sheet of paper, if necessary.

1. Natural gas from Alaska North Slope, approximately 2.7 bcf per day
2. Liquefied natural gas (LNG); approximately 19 million tons per annum
3. Various gas fractions (propane, butane, ethynol, etc) used in process for refrigerant
4. See Bechtel narrative

If the proposed activities involve any storage tanks, either above or below ground, address the following questions for each tank. Please use a separate sheet of paper, if necessary, and, where appropriate, include maps or plats:

a. Where will the tank be located? Adjacent to the liquefaction plant

b. What will be stored in the tank? liquefied natural gas (LNG)

c. What will be the tank's size in gallons? 180,000 cubic meters x 2 tanks

d. What will the tank be used for? (Commercial or residential purposes?) Commercial purposes
Holding LNG prior to loading onto tanker ships

e. Will the tank be tested for leaks? Yes

f. Will the tank be equipped with leak detection devices? Yes ☒ No ☐ If yes, describe: _____

Do you know or have any reason to suspect that the site may have been previously contaminated? Yes ☐ No ☒

If yes, please explain: _____

I certify that due diligence has been exercised and proper inquiries made in completing this questionnaire, and that the foregoing is true and correct to the best of my knowledge.

William M Walsh
Applicant

8/23/12
Date

AS 38.05.035(a) authorizes the director to decide what information is needed to process an application for the sale or use of state land and resources. This information is made a part of the state public land records and becomes public information under AS 40.25.110 and 40.25.120 (unless the information qualifies for confidentiality under AS 38.05.035(a)(9) and confidentiality is requested). Public information is open to inspection by you or any member of the public. A person who is the subject of the information may challenge its accuracy or completeness under AS 44.99.310, by giving a written description of the challenged information, the changes needed to correct it, and a name and address where the person can be reached. False statements made in an application for a benefit are punishable under AS 11.56.210.

Alaska Gasline Port Authority

Phone: (907) 474-2011
Fax: (907) 474-2001

www.allalaskagasline.com

Bill.walker@walkerrichards.com

August 23, 2012

Development Plan

The Alaska Gasline Port Authority supplements its Development Plan with a copy of the publicly available Yukon Pacific Corporation (YPC) Final Environmental Impact Statement (FEIS) from the Federal Energy Regulatory Commission (FERC). The Alaska Gasline Port Authority (AGPA) previously acquired an exclusive option on all YPC permits which include this FEIS. While that exclusive option period has since expired, the LNG project APGA proposes is very similar to that previously prepared by YPC for the Anderson Bay Site. Additionally, AGPA submits a narrative of is plan for the LNG facility as prepared for AGPA by Bechtel Corporation.

THE STATE of ALASKA
GOVERNOR SEAN PARNELL

Department of Natural Resources

Division of Mining, Land & Water
Southcentral Region Land Office

550 West 7th Avenue, Suite 900C
Anchorage, Alaska 99501-3577
Main: 907.269.8503
Fax: 907.269.8913

September 14, 2012

Alaska Gasline Port Authority
Attn: Mr. Bill Walker
731 N Street
Anchorage, AK 99501

Subject: Anderson Bay LNG Facility
ADL 231562
Application Received

Dear Mr. Walker:

The Division of Mining, Land, and Water (DMLW) has received the Application for Lease of State Land you submitted on August 23, 2012. The application will be reviewed to determine completeness and any requests for additional information will be sent to you. I will describe the leasing process, which can be quite lengthy, further and attempt to outline any requirements you may need to address so that you may prepare for them.

Project Description/Scope of Project to be Adjudicated

The project to be adjudicated is for a natural gas liquefaction plant and marine terminal in Anderson Bay, near the Port of Valdez. Specific development has not yet been submitted.

The location is within C009S008W (sections 13 and 24) and C009S007W (sections 18 and 19) in Anderson Bay.

Leasing Process

Before I continue, I would like to give you fair warning that the Department of Natural Resources (DNR) Southcentral Region (SCRO) Leasing Unit is currently burdened with a significant backlog of pending applications. Although it is our desire to process your application in a timely manner, our review process is presently delayed and it may be a few years before adjudication.

While waiting for adjudication, your project information will be distributed to agency review participants for a 30-day inter-agency review. Your case will then be assigned to an Adjudicator to examine your application and then prepare a Preliminary Decision (PD).

A PD is a procedural step in which your project is documented and analyzed to determine whether it is in the best interest of the State to issue a lease. If the conclusion is in favor of your project, the Adjudicator then issues a Public Notice.

The Public Notice is mandated in statutes (AS 38.05.945) and will be published in at least one local and one statewide newspaper and sent for posting to local Post Offices. It will also be posted on the DNR public website and sent to all adjacent landowners and permit/lease holders. All other potentially interested parties and applicable organizations may be notified, including, but not limited to: native corporations, tribal and village councils, municipalities and boroughs. The comment period may be open anywhere from 30 – 60 days, depending on the type of authorization being considered.

After the Public Notice phase, the Adjudicator then compiles any and all comments received, researches them, and begins drafting the Final Finding (FF). At this point, the Adjudicator may again request additional information from you to address concerns generated by the comments received. The FF restates the PD, accounts for all comments received from the public and agencies, addresses any alterations made to your project development plan and sets the estimated annual fee, bond amounts and insurance requirements.

The FF may then be circulated for another Public Notice, depending on public interest to the project or if there were significant changes made to your development plan. If the case goes to this second Public Notice and no comments are received or if it is determined a second Public Notice is not required, the FF is then issued and enters a 20-day appeal period. If the project is not appealed, it becomes a Final Decision and the adjudication process is over.

You will now be issued an Early Entry Authorization (EEA) in the form of a Land Use Permit (LUP); this is not a lease and does not give you any rights to the land other than to construct and survey your project. The EEA will outline all the requirements you must meet in a specific timeframe and, when completed, you will be issued your lease. These requirements will include the submittal of bonds, insurance and annual rent outlined in the Final Decision. You will now construct your project.

*You will need to apply for Survey Instructions from the survey section in DMLW which are issued specifically for your project. Survey Instructions may take up to six months to receive from DMLW and are issued directly to your surveyor who may now survey the area. If you do not submit your survey, no fault of DNR, by the date set in the EEA, your survey bond will be forfeited and additional penalties may be assessed.

*Upon the approval of your survey and if there is no annual fee set in your Final Decision, you are now required to apply for appraisal instructions from our appraisal unit which, again may take several months depending on work load. Your appraiser will complete the appraisal and upon approval from our appraisal unit, a minimum annual rent will be determined.

** Completed only if required by your EEA – necessary surveys and appraisals will be discussed more thoroughly during the Adjudication phase*

After you have submitted the bond and insurance, completed construction, and the survey and appraisal* have been approved, we will issue the Lease Agreement for a term of no more than 55 years. During this term, your project will be subject to reappraisal every five years to be adjusted for any increased fair market values which may affect the annual rent.

A lease is a disposal of State interest and, as a result, is time consuming but we hope to not overwhelm and are working to reduce the backlog.

This process is outlined in Statutes (AS 38.05.035 – AS 38.05.075 and AS 38.05.810) and Regulations (11 AAC 58).

Leasing Process Summary Outline

- Application determined to be complete and awaits adjudication
- 30-day agency review
- Adjudicator assigned project
- Preliminary Decision issued
- 30 – 60 day Public Notice period
- Final Finding issued
- 30 – 60 day Public Notice period
    - *May not be required*
- 20-day appeal period
- Final Decision issued
- EEA issued
- Construction of project
- Survey Completed*
- Appraisal Completed*
- Lease Issued

Leasing Costs

A lease is not a cheap authorization by any means and I would like to inform you of any possible, and likely, costs before we approach the point of payment to avoid any surprises.

All costs are estimates and are subject to change.

• Application Fee	$100
• Public Notice	$350
• Public Notice #2	$350
• Survey Instructions*	+/-$275
• Survey*	+/-$5,000
• Appraiser	+/-$2,500
• Annual Fee	≥ $1,000
• Survey Bond*	+/-$5,000
• Appraisal Bond*	+/-$2,500
• Performance Guarantee	+/-$5,000

** Completed only if required by your EEA – necessary surveys and appraisals will be discussed more thoroughly during the Adjudication phase*

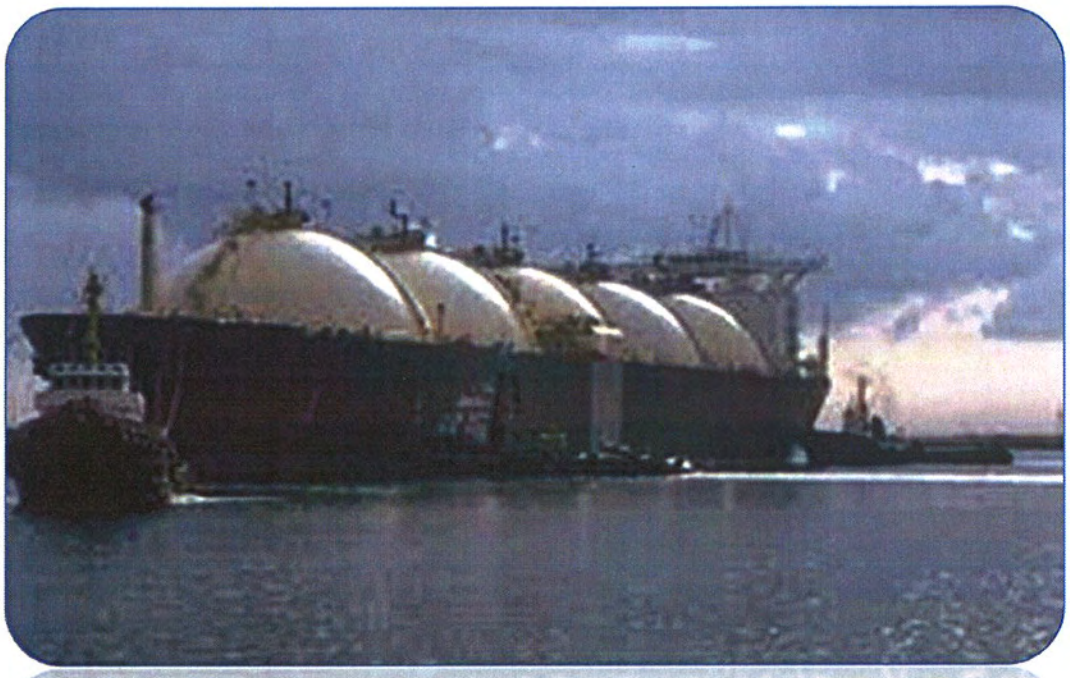
Please use this opportunity to consider whether or not this is the right course of action for you. If you do not feel you can meet the requirements outlined above or have any concerns, please feel free to contact me. If, on the other hand, you are confident that this is the authorization for you, please prepare ahead of time for the financial and contractual tasks involved.

I encourage you to visit the State of Alaska website for more information regarding Alaska statutes and regulations and to follow your project on our Land Administrative System (LAS). The website contains many helpful tools and resources that may be able to assist and answer any questions you might have. Please contact me by phone at 269-5047 or by email at emily.haynes@alaska.gov if you have any questions.

Sincerely,

Emily Haynes
Natural Resource Technician II

** Completed only if required by your EEA – necessary surveys and appraisals will be discussed more thoroughly during the Adjudication phase*



Potential Benefits to Alaskans from a State-Owned Gasline/LNG Project

3 November 2011

PDC Harris Group LLC

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William M. Walker
Alaska Gasline Port Authority
731 N Street
Anchorage, AK 99501

3 November 2011

Subject: Transmittal of LCNG Economic Benefits Study
Transmitted via Email

Dear Mr. Walker:

Attached is the final version of the subject study. If you have any questions or comments, please contact me at (907) 743-3263 or email mikemoora@pdceng.com .

Best Regards,

Michael W. Moora
General Manager
PDC Harris Group LLC

Attachments: 1. "Potential Benefits to Rural Alaskans From AGPA's Gasline & LNG Project" Rev 2, 27 October 2011.

C: W Ward
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AGPA-11.01.01

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1. EXECUTIVE SUMMARY

This preliminary study was conducted to provide an order-of-magnitude assessment of the benefits to Alaska communities of switching their primary fuel for space heating and electric generation from petroleum-derived diesel fuel to natural gas. For the study, natural gas was assumed to be delivered from a future liquefaction plant in Valdez aboard barges as LNG[1].

Bethel was selected as a representative community for developing cost models predicting the future retail cost of LNG-derived gas. This community is currently dependent on barge deliveries of diesel fuel. Bethel has historically experienced relatively high-cost retail fuels, based upon its remote location, and seasonal accessibility.

In addition to the work conducted on Bethel, the city gate wholesale cost of natural gas was estimated for Fairbanks, as an indicator of the approximate savings available when compared with wholesale diesel/fuel FOB[2] refinery loading rack.

Five case studies were conducted for Bethel to test the sensitivity of forecasted LNG and diesel pricing to the following parameters:

- ✓ Wholesale LNG cost, FOB Valdez
- ✓ Method of estimating LNG transport cost & retail markup
- ✓ Future wholesale diesel pricing, moderate vs. high perspective vs. worst case[3] future crude oil price @ $75/barrel

The Bethel costing model forecasts that conversion to an integrated LNG-CNG fuel, hereafter designated LCNG, will save approximately 25% to 65% over diesel for cases where a) LNG wholesale cost is equal to that defined by a recent Wood Mackenzie study[4] and b) the wholesale cost of diesel fuel remains within the 'medium' to 'high' ranges, as predicted by Alaskan economists[5]. The savings range from $229 million to $886 million over the period 2021 through 2051, when assuming 100% displacement of petroleum distillates used for space heating and power generation. The Net Present Value (NPV) of these cost savings range from $102 million to $397 million accrued over the same period.

One of the Bethel modeling scenarios, aimed at identifying sensitivity to crude oil pricing, examined retail diesel fuel costs equivalent to crude priced at $75 per

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[1] For Fairbanks delivery, natural gas will be supplied by a regional off-take.
[2] Freight On Board, indicating buyer is responsible for transport costs.
[3] A worst case from the perspective of the lowest crude price studied by Wood Mackenzie, and therefore resulting in lower-priced diesel.
[4] Wood Mackenzie, "Alaskan LNG Exports Competitiveness Study" 27 July 2011.
[5] Fay, Saylor & Foster, "Alaska Fuel Price Projections 2011-2030" Institute of Social and Economic Research, Univ. of Alaska, 2010.

barrel (in 2021) resulted in a retail cost advantage for LCNG, between 21% to nearly 42% below predicted retail diesel fuel cost.

Another scenario was modeled where LNG wholesale cost in Valdez is determined in a similar manner to Wood Mackenzie's built-up model, but with an additional well-head gas value of $1.00 per million BTU added to the FOB Valdez cost. In this case, the savings remain significant, with a predicted nominal value of approximately $335 million (NPV = $146 million).

A wholesale natural gas cost at a city gate take-off for Fairbanks was estimated @ $5.29 per million BTU, as compared to a predicted diesel fuel cost of $27.23 per million BTU in 2021, representing a savings of approximately 80%. Based on the number of oil-fired furnaces and boilers identified in the city by a 2010 survey, and the average fuel usage per year noted in the same study, and assuming that 100% of these furnaces/boilers are converted to natural gas, the predicted total value of the fuel savings from 2021 through 2051 is estimated at over $2.4 billion (NPV of $1.1 billion).

In addition to cost savings, significant reductions in air emissions will result from converting from diesel/fuel-oil (or wood fuels in the case of Fairbanks) to LNG-derived natural gas. On a per fired BTU basis, natural gas is estimated to reduce emission rates approximately 99% for SO_2[6], 29% for NO_x, 99% for PM_{10}[7], and 24% for CO_2, when comparing EPA published emission factors for natural gas versus fuel oil.

The modeling assumptions for LNG wholesale costs, which duplicate those of the referenced Wood Mackenzie study for the majority of the case studies, result in widening cost advantages for LNG over diesel/fuel oil in later years. The model assumes that the more significant cost components of the built-up LNG cost do not escalate, resulting in a relatively stable LNG cost over the life of the study duration. The diesel fuel cost forecasts assume escalation. Thus the model predicts the difference between forecasted future retail diesel prices and LNG increase from initiation in 2021 to completion in 2051.

2. INTRODUCTION

2.1 Rural Alaska's Energy Challenge

From the lean days of 2002, when a barrel of oil averaged approximately $22, to the maximum of nearly $145 per barrel observed during the summer of 2008, fuel pricing in remote Alaskan communities increased as dramatically, causing fear, anger and frustration. During 2008, the summer's fuel barge deliveries to interior

[6] Based upon a fuel oil sulfur content of 500 ppm.
[7] Defined as particulate matter with aerodynamic diameter less than 10 microns.

Alaskan villages brought unheard of prices, up $3 to $4 per gallon since the last year's delivery, to $7.50 to $8.00 per gallon[8].

The result - astounding increases in home heating and electrical costs to rural villagers – is tied not only to increased wholesale pricing of petroleum-based distillate, but also the fuel-burning transport ships or air tankers that haul it. Single family fuel costs, for space heating and cooking range from $300 to $900 per month, representing an average of 40% of a typical family's income[5]. Low per capita village income, coupled with increased fuel prices of the last several years have reached the tipping point for some; out-migrating residents from their life-time home to urban settings in Anchorage, Fairbanks and other less rural communities, in a struggle to reach economic balance.

2.2 The State Gas Line & LNG Project

The Alaska Gasline Port Authority (AGPA) has encouraged a state-owned project for transporting and liquefying 2.7 BCFD of North Slope (NS) gas to serve Alaskans and the Asian liquefied natural gas (LNG) markets. The project includes a large bore gas transmission system between the North Slope (NS) and Valdez, a liquefaction and export facility in Valdez, upstream gas off-take points to serve multiple Alaska communities, military bases, as well as a lateral pipeline to augment the supply of natural gas to South Central AK.

A recent study conducted by Wood Mackenzie[9] indicates favorable LNG pricing relative to competing projects to supply the Asian market, either planned or underway in Australia, western Canada and the Lower 48. The following summarizes findings that signal an attractive pipeline to Valdez for export of LNG.

- ✓ *"Proposed LNG exports have a substantial cost advantage relative to possible competing LNG supply Projects."*
- ✓ *"Alaskan LNG exports have a delivered cost structure below $10/MMBtu....Alaskan LNG could be priced DES between $18.00 - $46.00/MMBtu through 2050."*
- ✓ *"The Pacific Basin market is short of proximate LNG and a number of projects will compete for long term supply requirements (including Alaska LNG)."*
- ✓ *"Royalties (12.5%) and state taxes (starting at 25% post royalties) could yield $2.4 to $24 billion per year."*

[8] Anchorage Daily News, June 4, 2008.
[9] Wood Mackenzie, "Alaskan LNG Exports Competitiveness Study" 27 July 2011.

2.3 In-State Benefits of the Alaska LNG Project

Besides the attractive Wood Mackenzie forecasts for Alaska, including substantial netbacks to NS producers, the development of a large-scale pipeline/LNG project in Alaska offers another benefit:

- ✓ *A cost competitive supply of Alaska liquefied natural gas, produced at tidewater offers fuel cost savings to rural communities accessible by barge, currently contending with high diesel/fuel oil pricing.*

The referenced fuel savings have heretofore been inferred based on significant differences in the wholesale price of a BTU of LNG relative to diesel or fuel oil[10]. Subsequent sections of this report quantify expected savings. Other benefits to Alaska communities include:

- ✓ *Reduction of diesel/fuel oil tank farm inventories, and therefore a corresponding reduction in spill and contamination risks*
- ✓ *For each displaced volume of diesel/fuel oil, significant reductions in combustion emissions result (SO_2, NOx, unburned hydrocarbons, fine particulate matter, and CO_2)*
- ✓ *For wind and solar electric generation projects, switching the backup generation system to LNG-derived gas yields additional savings relative to diesel fuel firing.*
- ✓ *Conversion of users from fuel oil to gas requires minor capital expense; replacement of boilers and generator drives is generally not required[11].*

The wholesale price difference between diesel/fuel oil lifted from Alaska refineries, and Cook Inlet LNG are attractive[12], but without an LNG supply infrastructure specific to small-volume, remote Alaskan users, the real cost structure remains unknown, and hence these savings have been characterized as potential. This study represents a preliminary step in defining an LNG supply chain to an Alaska community, examining wholesale gas costs for Fairbanks, and quantifying the relative incremental costs for supplying these communities with substitute fuel.

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[10] Petroleum News, "Could LCNG Cut Cost of Rural Energy?" 28 February 2010.

[11] Residential forced air furnaces operating on fuel oil may need complete replacement to handle the conversion, which would not be a minor expense from the perspective of a homeowner. Conversion of higher output boilers and furnaces are likely to involve a simpler change in burner components. Refer to Schwörer & Fay, 'Economic Feasibility of North Slope Propane Productions and Distribution to Select Alaska Communities, UAA, ISER, June 2010.

[12] Refer to Appendix A for a comparison of market pricing for these commodities.

3. STUDY DESCRIPTION

3.1 LNG Implementation in Rural Alaska

The concept for supplying remote communities with LNG-derived gas involves the integration of liquefied and compressed natural gas (LCNG). The liquid form (LNG) of natural gas is approximately 600 times more dense than conventional pipeline gas distributed at low pressure to residences, and is the optimal phase for transport in its most energy-dense form over long distances. In this instance, LNG will be transported from the export docks adjoining the Valdez liquefaction plant, to various hub or larger village locations for off-loading and storage. Barges with double-walled and vacuum insulated LNG tanks will be placed in service for this leg of the supply chain, and hauled with tugs; which is logistically similar to the existing mid-scale line-haul barge system used for moving petroleum distillates to rural Alaska.

A disadvantage of LNG transport is its energy density relative to conventional petroleum distillates. LNG is only 60% the energy density of typical diesel fuel, thus requiring 1.67 volumes of LNG to supply the energy in 1.00 volume of diesel oil. This disadvantage must be offset by LNG's wholesale pricing advantage in order to be a feasible candidate replacing rural Alaska's primary fuel.

Once an LNG barge reaches a destination port, generally a hub community with line-haul barge accessibility, pumping and warming the LNG to the compressed natural gas (CNG) phase can take place. Pumping the cryogenic liquid to high pressure, followed by vaporization with multi-stage heat exchangers is an efficient conversion process, and allows the charging of storage cylinders located on-shore without the need for less efficient gas compressors. The on-shore pressure vessels will receive and store the CNG at pressures up to 3600 PSIG. The stored high pressure natural gas will then be available for:

- ✓ Distribution in small diameter piping distribution systems to nearby fuel users (residences, community buildings or electric generators) through a pressure letdown system. Generally residential distribution systems for communities is now easy to install coiled plastic pipe, and operates in a pressure range of 30 to 60 psig.
- ✓ Charging of smaller gas cylinders for use beyond the immediate hub location, including bulk transport to surrounding villages.
- ✓ Refueling of CNG powered vehicles at a metered fueling station.

While the storage volume for CNG is approximately 400% of that required for the same mass of LNG[13], storage in this form requires minimal maintenance or operator

[13] The density of CNG at 3600 psig is 12.1 lb/ft^3 compared with LNG at 45 to 46 lb/ft^3

attention, and does not require containment in the event of a leak. Storage as LNG may not be the optimum choice for relatively small volumes of gas in a rural setting. It is relatively expensive, and is more operator intensive, and may require vapor recovery refrigeration or compression to capture normal boil-off. Nonetheless, there are advantages of LNG versus CNG storage, and further study is required to determine specific LNG and CNG storage concepts, when a rural project progresses to the design phase.

For the purposes of this study, it is assumed the LNG is converted to CNG on-board the delivery barge as part of the off-loading process. Refer to Appendix B which depicts a line-haul barge delivery and storage facility.

3.2 Objectives

PDC Harris Group has been requested to quantify potential fuel cost savings when substituting LCNG-derived gas (or pipeline gas in the case of Fairbanks) for existing diesel/fuel in representative Alaskan communities. Our experience in this involves developing a pilot program for substituting liquefied and compressed natural gas (LCNG) in the City of Bethel[14].

Specific objectives of this study are as follows,

- ✓ Use Wood Mackenzie cost predictions as the FOB Valdez LNG cost basis.
- ✓ Develop feasibility-level cost models forecasting the retail pricing and cost savings for substitution of LCNG-derived natural gas in Bethel
- ✓ Exercise retail pricing model to assess sensitivity to various input changes such as crude oil price, FOB Valdez LNG cost and other variables.
- ✓ Estimate the wholesale cost of gas provided to Fairbanks for a representative city gate off-take. Compare these costs with those forecasted for wholesale diesel/fuel oil.

3.3 Case Study Communities

Bethel was used to establish the retail LNG pricing forecasts. It is important to note the Bethel case study is developed as a 'shared' capital project, in terms of the LNG loading or transport equipment. Facilities or equipment are assumed to be shared by three (3) additional communities, and therefore the capital and operating costs for same are borne 25% by a single community. This assumption can be considered valid for a pilot or small commercial operation involving a region, but would not adequately represent the real costs of a single community, or a start-up of a pilot

[14] City of Bethel and PDC Harris Group LLC, "Liquefied & Compressed Natural Gas as a Bridge to Reducing Energy Prices in Rural Alaska" 17 March 2011, application for grant funding to Alaska Energy Authority RFP AEA-11-027.

facility. Greater supply chain cost benefits would of course accrue to users as an LCNG supply chain expands.

3.3.1 Bethel

Located in Western Alaska, Bethel's lengthy fuel supply chain is a common denominator for scores of other villages throughout the state; distant from supplies produced in Alaskan refineries, and subject to sea ice restrictions for much of the year. The community is a good example of a remote Western Alaska hub city which is handicapped by winter ice, and distance from fuel sources. Diesel/fuel-oil prices in the city are approximately 80% higher than the wholesale refinery rack rates, attributable to delivery (20% of wholesale), sales tax (flat 6%, or 10% of wholesale), and retail markup (50% of wholesale)[15].

Bethel supports a network of 56 villages in the Yukon-Kuskokwim delta, in terms of the distribution of food, fuel, medical, and other services. Most of the surrounding villages receive barged delivery of liquid fuels at a twice per year frequency using smaller barges that are loaded from larger line-haul barges arriving from Anchorage. Fuel pricing increases with distance for the various Bethel satellite villages, and no simple pricing structure can be used to represent retail pricing in each individual village.

Bethel has approximately 1800 residences, and space heating of residences and community structures is predominately by fuel-oil fired furnaces and boilers. Electricity is provided by a private utility using diesel-fired engine generators. Tank farms for liquid fuels, owned primarily by Yukon Fuel and Crowley Marine, have approximately 15 million gallons of capacity. Significant area exists along Bethel's river wall for additional storage capacity.

3.3.2 Fairbanks

Fairbanks, like rural Alaska communities also suffers from geographic disparities in energy supplies and costs, based upon a dependency on petroleum-derived fuel for space heating and electricity production. "A sustained spike in oil prices this year has aggravated that disparity, increasing the cost of living in Interior and rural Alaska faster than in Southcentral Alaska. Fairbanks mayors have suggested the situation cripples any chance at economic development. Estimates suggest space heating represents two-thirds of the average Fairbanks businesses' or household's total energy costs, and local mayors and assembly members have lobbied for state assistance on a number of fronts"[16].

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[15] Szymoniak et al, "Components of Alaska Fuel Costs: An Analysis of Market Factors and Characteristics that Influence Rural Fuel Prices", Institute of Social and Economic Research (ISER), Univ. of Alaska, February 2010

[16] Fairbanks News-Miner, May 19 2011.

There are approximately 31,200 people, and 12,000 occupied residences in the city[17]. The Fairbanks Northstar Borough population is approximately 92,600. Owing to the proximity of Fairbanks to the Flint Hills Resources and PetroStar refineries in North Pole Township, fuel oil prices are low by comparison to rural, off-road Alaska communities.

4. LCNG CASE STUDY, BASIS & ASSUMPTIONS

For the Bethel LCNG case study, the following sections detail the development of the retail cost models, summarize assumptions, and describe different study cases. Refer to Section 5 for a discussion of the basis and assumptions for the case studies developed for natural gas in the Fairbanks market.

4.1 LNG Source

Description of Assumption	***Case Study Variation***
LNG for Alaska markets is loaded in barges @ the 2.7 BCF/day Valdez LNG export terminal	*Applicable to all cases*

To leverage the cost competitiveness of large-scale NS gas processing, transport and subsequent LNG liquefaction, this study assumes that LNG destined for Alaska users is lifted from a 2.7 BCFD liquefaction plant at the port of Valdez. Small volumes of LNG for Alaskan use will be loaded on barges[18] on an irregular basis, and would have no significant impact on the operations of the continuous multi-train LNG plant; a facility whose revenue will be tied to long term oil-indexed agreements with Asian buyers.

4.2 LNG Cost, FOB Valdez

Description of Assumption	***Case Study Variation***
Wholesale LNG, FOB Valdez from Wood Mackenzie 'Greenfield Alaska LNG Cost Build Up'	*Base Case*
Wholesale LNG, FOB Valdez Wood Mackenzie 'Greenfield Alaska LNG Cost Build Up' with wellhead cost set @ $1.00/million BTU	*Alternate Case*

[17] www.factfinder.census.gov, Source: U.S. Census Bureau, 2005-2009 American Community Survey

[18] Low capacity in comparison to marine LNG tankers, carrying approximately 2-3 million gallons (5600 to 8400 metric ton).

The Base Case model was developed on the assumption that LNG loaded at Valdez is valued pursuant to the Wood Mackenzie cost buildup[19]. An alternative case was developed based on a more conservative assumption that value of LNG FOB Valdez is valued using the Wood Mackenzie cost build-up with the addition of a wellhead value of $1.00/million BTU[20].

4.3 LNG Transport Costs

Description of Assumption	***Case Study Variation***
Cost to transport and unload LNG is factored based on published data of $/gal of diesel fuel, w/ adjustment for lower LNG energy content/volume.	*Base Case*
Cost to transport and unload LNG is developed from order of magnitude capital and operating cost for new barges and Valdez loading facilities.	*Alternate Case*

Transportation costs include marine line-haul transport from the Valdez export terminal, as well as loading, unloading, working capital, administration and insurance costs. The sum of these components equals the landed wholesale price at the destination terminal, which for Bethel's current diesel/fuel oil represents approximately 70% to 75% of the total retail price.

Published data[21] specifically addressing the cost of shipping diesel/fuel oil from refinery loading terminal to the destinations' tank farm were used as the basis for estimating shipping of LNG by barge for the Base Case. In this simplified approach, the published diesel shipping costs are corrected to account for LNG energy density, i.e. the need to transport the same energy content in more gallons of LNG.

As an alternative case study, more rigorous capital and operating costs were developed for a) LNG transfer and loading equipment at Valdez, and b) two(2) line-haul barges. The capital costs were further assumed to apply 25% to the destination, i.e. the assets are shared with three other potential communities as part of a larger line-hauling route. Likewise, the operating costs for the LNG barge berth, pumps and loading arms are 25% allocated to the individual case study community. The following assumptions apply to the Bethel LNG case study:

- ✓ Capital cost two (2) LNG barges: $40 million x 25% = $10 million (2021 $)

[19] Wood Mackenzie, IBID, page 15.
[20] This value was selected based upon current gas sales from Prudhoe Bay gas conditioning facilities to Alyeska' s Pump Station No. 1.
[21] Szymoniak et al, "Components of Alaska Fuel Costs: An Analysis of Market Factors and Characteristics that Influence Rural Fuel Prices", Institute of Social and Economic Research (ISER), Univ. of Alaska, February 2010.

- ✓ Capital cost Valdez loading facility (Alaska barge use only): $30 million x 25% = $7.5 million (2021 $)
- ✓ Capital recovery factor: 10%/year
- ✓ Operating cost, Valdez loading facility: $1.5 million/year x 25% = 0.38 million/year (2021)
- ✓ Operating cost, barge & tug set, $30,000/day[22] (2010)

4.4 Retail Markup

Description of Assumption	***Case Study Variation***
Factored from diesel/fuel oil cost data published by ISER	*Base Case*
Calculated from capital and operating cost estimates for new on-shore storage and distribution system, with contributions from overhead, working capital and profit.	*Alternative Cases.*

In Bethel, the retail markup from wholesale delivered liquid fuels currently comprises 25% to 30% of the total retail cost for these fuels. A simplified approach to estimating the retail markup for LCNG is possible by converting the diesel/fuel-oil markup reported by ISER[23] from units of $/gal to $/million BTU, and assuming the same value for LCNG, as was assumed for the base case transport cost.

A more rigorous approach to estimating retail markup involves estimating the capital and operating costs associated with the LCNG storage and distribution systems which will be installed to store sufficient inventory for the community between deliveries. For Bethel, where winter ice limits the periods when tug and barge sets can operate, a nine month inventory is necessary. In ice-free ports, such as Unalaska, only two to three months of inventory is required.

Capital (Capex) and operating costs (Opex) were developed for the following components of retail mark-up in Bethel.

4.4.1 Storage & Distribution System Capital Amortization

A new CNG storage facility is expected to have higher capital amortization charges, relative to existing diesel systems in Bethel, based on the increased volume and pressure rating required to store the equivalent energy as LCNG. This relative increase may be offset by reduced maintenance requirements associated with LCNG.

[22] Szymoniak et al, IBID.
[23] Szymoniak et al, IBID.

Factors from the open literature for LNG storage tank costs in $/volume were used as the initial basis of generating order of magnitude capital costs storage capacity in Bethel[24].

Resulting capital cost estimates for on-site storage are as follows. A capital recovery factor of 10%/year was used to estimate debt service.

- ✓ Bethel storage Capex: $26.9 million (2021 $)

Distribution system capital for low pressure piping, metering and residential tie-in were estimated as follows:

- ✓ Bethel distribution Capex: $3.9 million (2021 $)

4.4.2 Storage/Distribution System Operation & Maintenance Costs

Operating costs may be expected to be comparable between compressed natural gas storage and distribution versus the current diesel system. Maintenance costs should be considerably reduced, as less rotating equipment is required to deliver CNG-based fuel, and storage vessel maintenance and routine cleaning will be essentially absent for a gas-based system.

The following was assumed for operating and maintenance budgets for Bethel

- ✓ Operating: $1 million/year (2021)
- ✓ Maintenance: 1.5% of capital/year
- ✓ Working Capital: 50% of storage volume, interest @ 7.5%/year

4.4.3 Profit & Overhead

This category includes many of the elements common to the transport sector of the supply chain; overhead labor, regulatory compliance, insurance, and profit are examples.

- ✓ Profit assumed for both locations: 10% of Capex + Opex

4.5 Future Price of Diesel & Fuel-Oil in Rural Alaska

ISER developed estimated fuel cost rural forecasts for ~170 Alaska rural communities, for the period 2011 through 2030[25] for the Alaska Energy Authority (AEA). These forecasts were developed for three scenarios: low, medium and high ranges. This study employed the 'medium' cost data for all cases except two; one each for the two different locations used the 'high' range data.

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[24] Capital cost factor from J Powell, "LNG - Market Challenges & Opportunities for Innovation" Hydrocarbon World, 2007 states $400 per m^3. This study used 300% of this factor, to account for a small scale remote application.

[25] Fay, Saylor & Foster, "Alaska Fuel Price Projections 2011-2030" Institute of Social and Economic Research, Univ. of Alaska, 2010. Post 2030 inflation rate of 2.4%/yr. was assumed.

4.7 Fuel Displacement in Representative Communities

Data published by AEA[26] and PND[27] were used to establish baseline diesel fuel use in Bethel. These data apply to space heating and electric generation, and do not include significant use for marine vessels. The baseline fuel consumption was escalated by 0.5% per year over the duration of the study period of 2021 to 2051.

For this study, it was assumed that 100% of these volumes were replaced by natural gas derived from LCNG. This approach is overly simplistic, since neither 100% of the diesel for heating, nor 100% of the diesel for power generation would realistically be displaced by natural gas during the early years of retrofitting. Therefore the study overstates community-wide fuel cost savings during the initial stages of conversion from diesel to LCNG/natural gas.

Another contribution attributable to displacing existing diesel/fuel oil use with LCNG is worthy of consideration. As conversion to the latter occurs in a community, and the volumes of imported diesel and fuel oil decline, it is likely that their unit costs will be driven disproportionally higher, based on the inefficiencies of transporting and dispensing the reduced volumes. This study does not address this potential cost increase for diesel/fuel-oil users in a community undergoing conversion to LCNG.

5. FAIRBANKS CASE STUDIES, BASIS & ASSUMPTIONS

5.1 Future Cost of Diesel & Fuel-Oil in Fairbanks

Energy Information Administration (EIA) predictions[28] for wholesale distillate fuel oil (diesel) pricing in the lower 48 for the years 2021 -2035 were used as the basis for developing comparable values for Fairbanks. An Alaska market surcharge was added to the forecasted lower 48 costs, based on EIA historical wholesale cost data (approximately $.23/gallon in 2021). Values for future lower 48 diesel costs for the years 2036-2051 were estimated based on an annual inflation rate of 2.4% per year.

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[26] AEA, "Statistical Report of the Power Equalization Program, Fiscal Year 2010", 22nd Edition, March 2011.
[27] PND, "Feasibility Study of Propane Distribution Throughout Coastal Alaska", August 2005.
[28] http://www.eia.gov/oiaf/aeo/tablebrowser/ . 2021 - 2035 EIA Petroleum Products forecast, "Reference Case" and "High Economic case values used for Transportation Fuel, Distillate Fuel Oil (Diesel Oil).

5.2 Future Cost of Natural Gas in Fairbanks

Wholesale natural gas pricing at a city gate take-off on the 2.7 BCF/day Alaska Gas Pipeline was estimated using the built-up cost assumptions developed in the Wood Mackenzie study, with the following adjustments:

- ✓ Liquefaction, LNG losses and liquids credit contributions set to zero
- ✓ Pipeline transport cost prorated based on distance to Fairbanks, adjusted tariff ~$1.15/million BTU

5.3 Quantity of Fuel Oil Displaced by Natural Gas

A study conducted in 2010 for the Alaska Department of Environmental Protection (ADEC) surveyed residential home owners for data on type of heating equipment employed, and the average quantity of fuel used. The purpose of the study, from ADEC's perspective was to trend the level of wood use for residential heating. We used the data gathered on fuel-oil fired furnaces and boilers to estimate the quantity of fuel that potentially could be displaced by natural gas. The following factors were used to estimate future displaced fuel quantities.

- ✓ Central oil furnaces or boilers in Fairbanks, total: 21,134
- ✓ Average oil consumption, gallons/year-residence: 938 gal/yr.

6. MODEL RESULTS

6.1 Bethel Case Designations

The results of the LNG pricing and energy cost savings forecasts are summarized in the following sections. Table 1 summarizes these cases in matrix format. Subsequent sub-sections provide a summary of results.

Table 1
Case Study Matrix

Case Name	LNG $ FOB Valdez	LNG Transport $	Retail Markup $	Future Diesel $/gal.
Bethel Cases				
B1 (Base)	Wood Mac build-up	Factored from diesel $/million BTU	Factored from diesel $/million BTU	AEA/ISER medium forecast
B2	Wood Mac build-up	Estimated: capex $ and opex $	Estimated: capex $ and opex $	AEA/ISER medium forecast
B3	Wood Mac build-up	Estimated: capex $ and opex $	Estimated: capex $ and opex $	AEA/ISER high forecast
B4	Wood Mac build-up	Estimated: capex $ and opex $	Estimated: capex $ and opex $	From crude @ $75/bbl and 1.18 crack ratio[29]
B5	Wood Mac build-up w/ $1/million BTU wellhead cost	Estimated: capex $ and opex $	Estimated: capex $ and opex $	AEA medium forecast

6.2 Bethel Case Studies

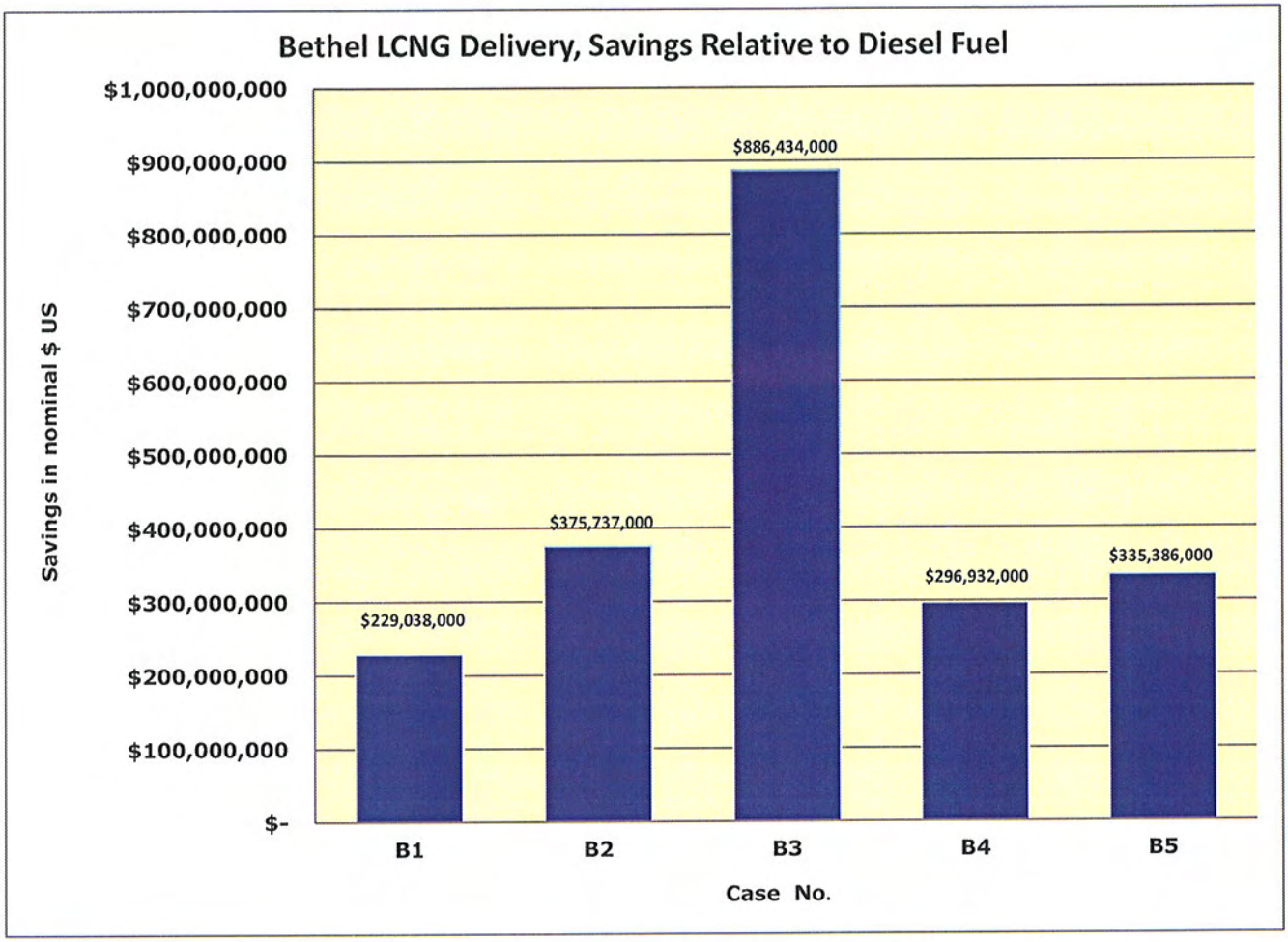
As detailed in Table 1, five (5) cases were developed to assess the impacts of the following variables on the predicted retail cost savings of LCNG versus diesel/fuel-oil.

- ✓ LNG Cost, FOB Valdez
- ✓ Basis for estimating LNG transport cost from Valdez to Bethel
- ✓ Basis for estimating retail mark-up
- ✓ Assumed future retail cost of diesel in Bethel

The summary results for all five cases are presented graphically in , as the total of annual fuel savings over the life of the project (years 2021 to 2051)

[29] Crack ratio: ($ diesel/gallon)/($/barrel crude x 42 gallons/barrel crude), here a historical average value of 1.18 was determined from cost databases supplied by EIA.

Figure 1



All five cases modeled predict significant fuel savings when substituting LCNG for diesel and fuel-oil in Bethel. Additional discussion of the case study results are provided in the following sections.

6.2.1 Case B1

This is considered the Base Case for the Bethel analysis. It is based on a) LNG cost FOB Valdez from the Wood Mackenzie built-up value, b) a transport cost factored from 2009-2010 ISER data for diesel/fuel oil, c) a retail markup factored from the same ISER data for diesel/fuel oil, and d) 'medium range' future diesel/fuel oil retail Bethel pricing predictions by ISER. Case B1 representative model output is provided in Figure 2.

The model predicts annual savings from switching to LCNG of 21% to 28% relative to diesel fuel.

Conversion of the predicted future retail pricing of diesel/fuel oil from a $ per gallon basis to $ per million BTU (gal/E6 BTU), using the higher heating value (HHV) of typical diesel fuel, puts the pricing on a comparable basis to that estimated for the retail price LCNG. As reported for the initial year of operation (2021) the predicted retail price for LCNG is $8.88/million BTU lower than the diesel fuel. With Bethel's forecasted consumption of Btu's for space heating and electrical generation (595,215 million BTU/yr. or approximately 4.6 million gallons diesel/yr.) in 2021, this per million BTU savings equates to annual savings of nearly $5.3 million/year. The total estimated savings over a 30 year period beginning in 2021 is approximately $229 million.

6.2.2 Case B2

Case B2 differs from B1 in the approach to estimating the transport cost from Valdez to Bethel, as well as how the retail markup is estimated.

As noted in Section 4.3, the more detailed transport cost estimate entails an estimate of capital costs (primarily transport barges and loading facilities at the liquefaction facility) and operating costs for representative supply chain elements for transporting LNG[30]. Capital recovery charges and operating costs for LNG transport are then divided by the annual BTU requirements estimated for Bethel in each future year, resulting in an estimated $/million BTU charge for transport.

In a similar manner, the retail mark-up estimate includes capital and operating estimates representing the costs accrued by a Bethel storage and distribution operation, as described in Section 4.4.

The result of the more rigorous treatment of both LCNG transport and retail markup is a) the forecasted transport cost in $/million BTU increases slightly (~7%) relative to the Base Case (B1) while b) the retail markup is reduced by about 29% of the base case[31]. The overall result is an increased savings for Case B2 over Case B1.

6.2.3 Case B3

Case B3 replicates Case B2 with one major exception; the predicted future pricing of diesel fuel has been increased to the AEA/ISER study 'high' price range for Bethel. A portion of the model output for this case is provided in Figure 4.

[30] For the purposes of this study, two barges were assumed to be shared with 3 other communities, i.e. the capital requirements are 25% assigned to Bethel's economic model.
[31] Both comparisons are for the initial operating year only.

The dramatic increase in projected retail fuel savings over the prior cases is attributable to not only the significantly higher diesel pricing, which increases annually, but an LNG price which remains relatively low, with a price that is not tied insignificantly to inflation.

6.2.4 Case B4

This case is based on replicating Case B2 with the following exception:

- ✓ Wholesale diesel fuel pricing (FOB refinery) is set based on a West Texas Intermediate (WTI) crude oil price of $75/bbl, corresponding to Wood Mackenzie's 'worst case' scenario. To develop the corresponding wholesale diesel price from the crude price, an annual average crack ratio of 1.18 was assumed.

Refer to Figure 5 for an excerpt from this case model output. According to the model, with the 2021 retail diesel price in Bethel predicted to be approximately $3.93 per gallon, and inflated annually at 2.4% thereafter, sufficient savings are still available to generate savings of approximately $297 million over the life of the project. This can be attributed to the fact that LNG wholesale cost is not affected appreciably by changes in crude oil pricing.

This same model, using the historical crude crack spread to predict retail diesel fuel pricing in Bethel, can be used to determine an approximate WTI crude price which results in retail diesel pricing which is competitive with LCNG, on a $ per million BTU basis. Using a trail and error approach, this value was found be approximately $36/bbl., for 2021 WTI crude.

6.2.5 Case B5

Case B5 examines the impact of incrementing the Valdez wholesale LNG cost by $1/million BTU, to apply a defensible wellhead gas value based on historical sales to Alyeska Pipeline. Other assumptions remain the same as Case B2. Refer to Figure 6 following, for an excerpt of the model output.

As with the other Bethel cases, B5 predicts a significant savings over the life of the project in line with cases B1, B2 and B4.

Figure 2
Excerpt of B1 (Base Case) Model

		Start-up	1	2	3	4	5		28	29	30
DIESEL		2021	2022	2023	2024	2025	2026		2049	2050	2051
Predicted Diesel Price, Retail Bethel, $/gal	(a)	$4.74	$4.79	$4.85	$4.90	$4.96	$5.00		$8.27	$8.47	$8.67
Predicted $/E6 BTU (HHV), Bethel Diesel Retail		$34.19	$34.57	$34.99	$35.37	$35.79	$36.10		$59.70	$61.13	$62.60
LNG & CNG	(b)										
WH-Processing (invariant)		0.26	0.26	0.26	0.26	0.26	0.26		0.26	0.26	0.26
Processing & Shrinkage (inflation adjusted)		2.88	2.95	3.02	3.09	3.17	3.24		5.60	5.73	5.87
Transport (invariant)		1.70	1.70	1.70	1.70	1.70	1.70		1.70	1.70	1.70
LNG Losses (inflation adjusted)		0.52	0.53	0.54	0.56	0.57	0.58		1.01	1.03	1.06
Liquefaction (invariant)		4.00	4.00	4.00	4.00	4.00	4.00		4.00	4.00	4.00
Liquids Credit (inflation adjusted)		-0.87	-0.89	-0.91	-0.93	-0.96	-0.98		-1.69	-1.73	-1.77
LNG FOB Valdez, $/E6 BTU		**8.49**	**8.55**	**8.61**	**8.68**	**8.74**	**8.81**		**10.88**	**11.00**	**11.12**
LNG & CNG Price Stack											
LNG Price FOB Valdez, $/E6 BTU (HHV)		8.49	8.55	8.61	8.68	8.74	8.81		10.88	11.00	11.12
Delivery & Offload, $/E6 BTU (HHV)	(d)	4.69	4.80	4.91	5.03	5.15	5.28		9.10	9.32	9.55
Sales Tax @ 6% of FOB + Delivery		0.79	0.80	0.81	0.82	0.83	0.85		1.20	1.22	1.24
Retail Markup	(f)	11.34	11.61	11.89	12.18	12.47	12.77		22.03	22.56	23.10
Retail Price LNG/CNG, $/E6 BTU		25.31	25.77	26.23	26.71	27.20	27.70		43.21	44.10	45.01
SAVINGS											
Savings, Diesel - LNG, $/E6 BTU (HHV)		$8.88	$8.80	$8.75	$8.65	$8.59	$8.40		$16.48	$17.03	$17.59
% Savings		25.98%	25.46%	25.02%	24.47%	24.00%	23.27%		27.61%	27.86%	28.10%
Annual Savings, $/yr		$ 5,287,494	$ 5,264,385	$ 5,263,199	$ 5,229,247	$ 5,215,926	$ 5,127,705		$ 11,282,122	$ 11,714,950	$ 12,160,903
Total Savings, Project Life, $		$ 229,038,410									
Present Value of Savings (2021)	(g)	$101,895,709									
ENERGY DEMAND											
Heating + Electrical Use,E6 BTU/yr	(e)	595215	598191	601182	604188	607209	610245		684422	687844	691283

Figure 3
Excerpt of Case B2 Model

		Start-up	1	2	3	4		27	28	29	30
DIESEL		2021	2022	2023	2024	2025		2048	2049	2050	2051
Predicted Diesel Price, Retail Bethel, $/gal	(a)	$4.74	$4.79	$4.85	$4.90	$4.96		$8.07	$8.27	$8.47	$8.67
Predicted $/E6 BTU (HHV), Bethel Diesel Retail		$34.19	$34.57	$34.99	$35.37	$35.79		$58.30	$59.70	$61.13	$62.60
LNG & CNG	(b)										
WH-Processing		0.26	0.26	0.26	0.26	0.26		0.26	0.26	0.26	0.26
Processing & Shrinkage (inflation adjusted)		2.88	2.95	3.02	3.09	3.17		5.47	5.60	5.73	5.87
Transport		1.70	1.70	1.70	1.70	1.70		1.70	1.70	1.70	1.70
LNG Losses (inflation adjusted)		0.52	0.53	0.54	0.56	0.57		0.99	1.01	1.03	1.06
Liquefaction		4.00	4.00	4.00	4.00	4.00		4.00	4.00	4.00	4.00
Liquids Credit (inflation adjusted)		-0.87	-0.89	-0.91	-0.93	-0.96		-1.65	-1.69	-1.73	-1.77
LNG FOB Valdez, $/E6 BTU		**8.49**	**8.55**	**8.61**	**8.68**	**8.74**		**10.76**	**10.88**	**11.00**	**11.12**
LNG & CNG Price Stack											
LNG Price FOB Valdez, $/E6 BTU (HHV)		8.49	8.55	8.61	8.68	8.74		10.76	10.88	11.00	11.12
Delivery & Offload, $/E6 BTU (HHV)	(d)	5.03	5.12	5.22	5.32	5.43		11.33	11.71	12.11	12.53
Sales Tax @ 6% of FOB + Delivery		0.81	0.82	0.83	0.84	0.85		1.33	1.36	1.39	1.42
Retail Markup	(f)	8.08	8.08	8.09	8.10	8.11		8.57	8.60	8.64	8.68
Retail Price LNG/CNG, $/E6 BTU		22.41	22.58	22.75	22.94	23.13		31.99	32.55	33.13	33.74
SAVINGS											
Savings, Diesel - LNG, $/E6 BTU (HHV)		$11.78	$11.99	$12.23	$12.43	$12.66		$26.31	$27.15	$28.00	$28.86
% Savings		34.46%	34.68%	34.97%	35.15%	35.38%		45.13%	45.48%	45.80%	46.11%
Annual Savings, $/yr		$ 7,013,712	$ 7,171,338	$ 7,354,842	$ 7,509,585	$ 7,689,008		$ 17,917,587	$ 18,581,464	$ 19,259,281	$ 19,951,152
Total Savings, Project Life, $		$ 375,737,136									
Present Value of Savings (2011)	(g)	$163,926,539									
ENERGY DEMAND											
Heating + Electrical Use,E6 BTU/yr	(e)	595215	598191	601182	604188	607209		681017	684422	687844	691283

Figure 4
Excerpt of Case B3 Model

		Start-up	1	2	3	4		27	28	29	30
DIESEL		2021	2022	2023	2024	2025		2048	2049	2050	2051
Predicted Diesel Price, Retail Bethel, $/gal	(a)	$7.44	$7.53	$7.63	$7.70	$7.79		$12.57	$12.88	$13.19	$13.50
Predicted $/E6 BTU (HHV), Bethel Diesel Retail		$53.72	$54.38	$55.07	$55.56	$56.22		$90.80	$92.98	$95.21	$97.49
LNG & CNG	(b)										
WH-Processing		0.26	0.26	0.26	0.26	0.26		0.26	0.26	0.26	0.26
Processing & Shrinkage (inflation adjusted)		2.88	2.95	3.02	3.09	3.17		5.47	5.60	5.73	5.87
Transport		1.70	1.70	1.70	1.70	1.70		1.70	1.70	1.70	1.70
LNG Losses (inflation adjusted)		0.52	0.53	0.54	0.56	0.57		0.99	1.01	1.03	1.06
Liquefaction		4.00	4.00	4.00	4.00	4.00		4.00	4.00	4.00	4.00
Liquids Credit (inflation adjusted)		-0.87	-0.89	-0.91	-0.93	-0.96		-1.65	-1.69	-1.73	-1.77
LNG FOB Valdez, $/E6 BTU		**8.49**	**8.55**	**8.61**	**8.68**	**8.74**		**10.76**	**10.88**	**11.00**	**11.12**
LNG & CNG Price Stack											
LNG Price FOB Valdez, $/E6 BTU (HHV)		8.49	8.55	8.61	8.68	8.74		10.76	10.88	11.00	11.12
Delivery & Offload, $/E6 BTU (HHV)	(d)	5.03	5.12	5.22	5.32	5.43		11.33	11.71	12.11	12.53
Sales Tax @ 6% of FOB + Delivery		0.81	0.82	0.83	0.84	0.85		1.33	1.36	1.39	1.42
Retail Markup	(f)	8.08	8.08	8.09	8.10	8.11		8.57	8.60	8.64	8.68
Retail Price LNG/CNG, $/E6 BTU		$ 22.41	$ 22.58	$ 22.75	$ 22.94	$ 23.13		$ 31.99	$ 32.55	$ 33.13	$ 33.74
SAVINGS											
Savings, Diesel - LNG, $/E6 BTU (HHV)		$31.31	$31.80	$32.32	$32.63	$33.09		$58.81	$60.43	$62.08	$63.76
% Savings		58.28%	58.48%	58.69%	58.72%	58.86%		64.77%	64.99%	65.20%	65.40%
Annual Savings, $/yr		$ 18,633,504	$ 19,021,078	$ 19,430,465	$ 19,713,550	$ 20,093,775		$ 40,050,251	$ 41,358,632	$ 42,699,720	$ 44,074,176
Total Savings, Project Life, $		$ 886,433,544									
Present Value of Savings (2011)	(g)	$397,184,212									
ENERGY DEMAND											
Heating + Electrical Use,E6 BTU/yr	(e)	595215	598191	601182	604188	607209		681017	684422	687844	691283

Figure 5
Excerpt of Case B4 Model

		Start-up	1	2	3	4		27	28	29	30
DIESEL		2021	2022	2023	2024	2025		2048	2049	2050	2051
Calculated Price, Retail Bethel, $/gal	(a)	$3.93	$4.03	$4.12	$4.22	$4.33		$7.46	$7.64	$7.83	$8.01
$/E6 BTU (HHV), Bethel Diesel Retail		$28.40	$29.08	$29.78	$30.50	$31.23		$53.88	$55.18	$56.50	$57.86
$/E6 BTU (LHV), Bethel Diesel Retail		$30.38	$31.11	$31.85	$32.62	$33.40		$57.63	$59.01	$60.43	$61.88
LNG & CNG											
Wood Mackenzie Model Duplication (HHV)											
Nominal WTI Oil Price, $/bbl	(b)	$75.00	$76.80	$78.64	$80.53	$82.46		$142.29	$145.70	$149.20	$152.78
Calculated WTI Oil, $/E6 BTU		12.50	12.80	13.11	13.42	13.74		23.71	24.28	24.87	25.46
Asia LNG $/E6 BTU, DES basis	(c)	11.73	11.82	12.10	12.39	12.69		21.90	22.42	22.96	23.51
Less infl. Shipping, $/E6 BTU		0.59	$0.60	$0.62	$0.63	$0.65		$1.12	$1.15	$1.17	$1.20
Less pipe transportation, $/E6 BTU		4.18	4.18	4.18	4.18	4.18		4.18	4.18	4.18	4.18
Less liquefaction, $/E6 BTU		4.00	4.00	4.00	4.00	4.00		4.00	4.00	4.00	4.00
Wellhead netback, $/E6 BTU		2.96	3.04	3.30	3.58	3.86		12.60	13.10	13.61	14.13
LNG & CNG Price Stack											
LNG Price FOB Valdez, $/E6 BTU (HHV)		8.49	8.55	8.61	8.68	8.74		10.76	10.88	11.00	11.12
Delivery & Offload, $/E6 BTU (HHV)	(d)	5.03	5.12	5.22	5.32	5.43		11.33	11.71	12.11	12.53
Sales Tax @ 6% of FOB + Delivery		0.81	0.82	0.83	0.84	0.85		1.33	1.36	1.39	1.42
Retail Markup	(f)	8.08	8.08	8.09	8.10	8.11		8.57	8.60	8.64	8.68
Retail Price LNG/CNG, $/E6 BTU		22.41	22.58	22.75	22.94	23.13		31.99	32.55	33.13	33.74
SAVINGS											
Savings, Diesel - LNG, $/E6 BTU (HHV)		$5.99	$6.51	$7.03	$7.56	$8.10		$21.90	$22.63	$23.37	$24.12
% Savings		21.10%	22.37%	23.60%	24.79%	25.95%		40.64%	41.01%	41.36%	41.69%
Annual Savings, $/yr		$ 3,567,490	$ 3,892,542	$ 4,226,205	$ 4,568,666	$ 4,920,114		$ 14,912,067	$ 15,488,424	$ 16,076,171	$ 16,675,350
Total Savings, Project Life, $		$ 296,931,968									
Present Value of Savings (2011)	(g)	$124,303,820									
ENERGY DEMAND											
Heating + Electrical Use,E6 BTU/yr	(e)	595215	598191	601182	604188	607209		681017	684422	687844	691283

Figure 6
Excerpt of Case B5 Model

		Start-up	1	2	3	4		27	28	29	30
DIESEL		2021	2022	2023	2024	2025		2048	2049	2050	2051
Predicted Diesel Price, Retail Bethel, $/gal	(a)	$4.74	$4.79	$4.85	$4.90	$4.96		$8.07	$8.27	$8.47	$8.67
Predicted $/E6 BTU (HHV), Bethel Diesel Retail		$34.19	$34.57	$34.99	$35.37	$35.79		$58.30	$59.70	$61.13	$62.60
LNG & CNG	(b)										
Wellhead Value (inflation adjusted)		1.30	1.33	1.36	1.39	1.43		2.46	2.52	2.58	2.64
WH-Processing		0.26	0.26	0.26	0.26	0.26		0.26	0.26	0.26	0.26
Processing & Shrinkage (inflation adjusted)		2.88	2.95	3.02	3.09	3.17		5.47	5.60	5.73	5.87
Transport		1.70	1.70	1.70	1.70	1.70		1.70	1.70	1.70	1.70
LNG Losses (inflation adjusted)		0.52	0.53	0.54	0.56	0.57		0.99	1.01	1.03	1.06
Liquefaction		4.00	4.00	4.00	4.00	4.00		4.00	4.00	4.00	4.00
Liquids Credit (inflation adjusted)		-0.87	-0.89	-0.91	-0.93	-0.96		-1.65	-1.69	-1.73	-1.77
LNG FOB Valdez, $/E6 BTU		**9.79**	**9.88**	**9.98**	**10.07**	**10.17**		**13.22**	**13.40**	**13.58**	**13.76**
LNG & CNG Price Stack											
LNG Price FOB Valdez, $/E6 BTU (HHV)		9.79	9.88	9.98	10.07	10.17		13.22	13.40	13.58	13.76
Delivery & Offload, $/E6 BTU (HHV)	(d)	5.03	5.12	5.22	5.32	5.43		11.33	11.71	12.11	12.53
Sales Tax @ 6% of FOB + Delivery		0.89	0.90	0.91	0.92	0.94		1.47	1.51	1.54	1.58
Retail Markup	(f)	8.08	8.08	8.09	8.10	8.11		8.57	8.60	8.64	8.68
Retail Price LNG/CNG, $/E6 BTU		23.79	23.99	24.20	24.41	24.64		34.60	35.22	35.87	36.54
SAVINGS											
Savings, Diesel - LNG, $/E6 BTU (HHV)		$10.41	$10.58	$10.79	$10.95	$11.15		$23.70	$24.48	$25.26	$26.06
% Savings		30.44%	30.61%	30.84%	30.97%	31.15%		40.65%	41.00%	41.33%	41.63%
Annual Savings, $/yr		$ 6,194,721	$ 6,328,497	$ 6,487,458	$ 6,616,942	$ 6,770,372		$ 16,139,872	$ 16,751,983	$ 17,376,525	$ 18,013,570
Total Savings, Project Life, $		$ 335,386,438									
Present Value of Savings (2011)	(g)	$145,746,753									
ENERGY DEMAND											
Heating + Electrical Use,E6 BTU/yr	(e)	595215	598191	601182	604188	607209		681017	684422	687844	691283

6.3 Fairbanks Case Studies

Two case studies were run for the Fairbanks cost model, representing EIA-forecasted data for future wholesale diesel/fuel-oil pricing for a 'reference case' or baseline, and for a 'high economic growth case'. The same procedure for predicting wholesale natural gas pricing was used for both model runs; each for city-gate price corresponding to a take-off point along a large, high pressure pipeline transporting gas to liquefaction facilities at Valdez.

6.3.1 Cost Savings

To provide an approximate quantification of the savings available to the residents of Fairbanks from converting to natural gas, it was assumed that 100% of residences currently using fuel oil for space heating are converted to natural gas. This assumption is overly simplistic, since not all homeowner would be converted en masse. Nonetheless, the assumption was deemed adequate for the purpose of providing an order of magnitude annual savings which might be achieved in later years of a conversion program.

Annual savings based on the above assumption range from approximately $59 million/year to $118 million/year, depending on the assumed fuel oil pricing model, and the year from inception of the switchover to natural gas. The approximate savings in nominal $ US over the course of the project (2021 – 2051) for the two models developed are $2.41 billion, and $2.58 billion, as shown in Figure 7. Refer also to excerpts of the two models in Figure 14 and Figure 15, following.

6.3.2 Emissions Reductions

Conversion to natural gas will reduce the air emissions from home furnaces or boilers significantly for sulfur oxides (SO_2 and SO_3), oxides of nitrogen (NO and NO_2), particulate matter less 10 microns in diameter (PM-10) and carbon dioxide (CO_2). These reductions are presented graphically in the following figures[32].

[32] All emission factors are based on US EPA AP-42 Emission Factors, May 2010.

Figure 7

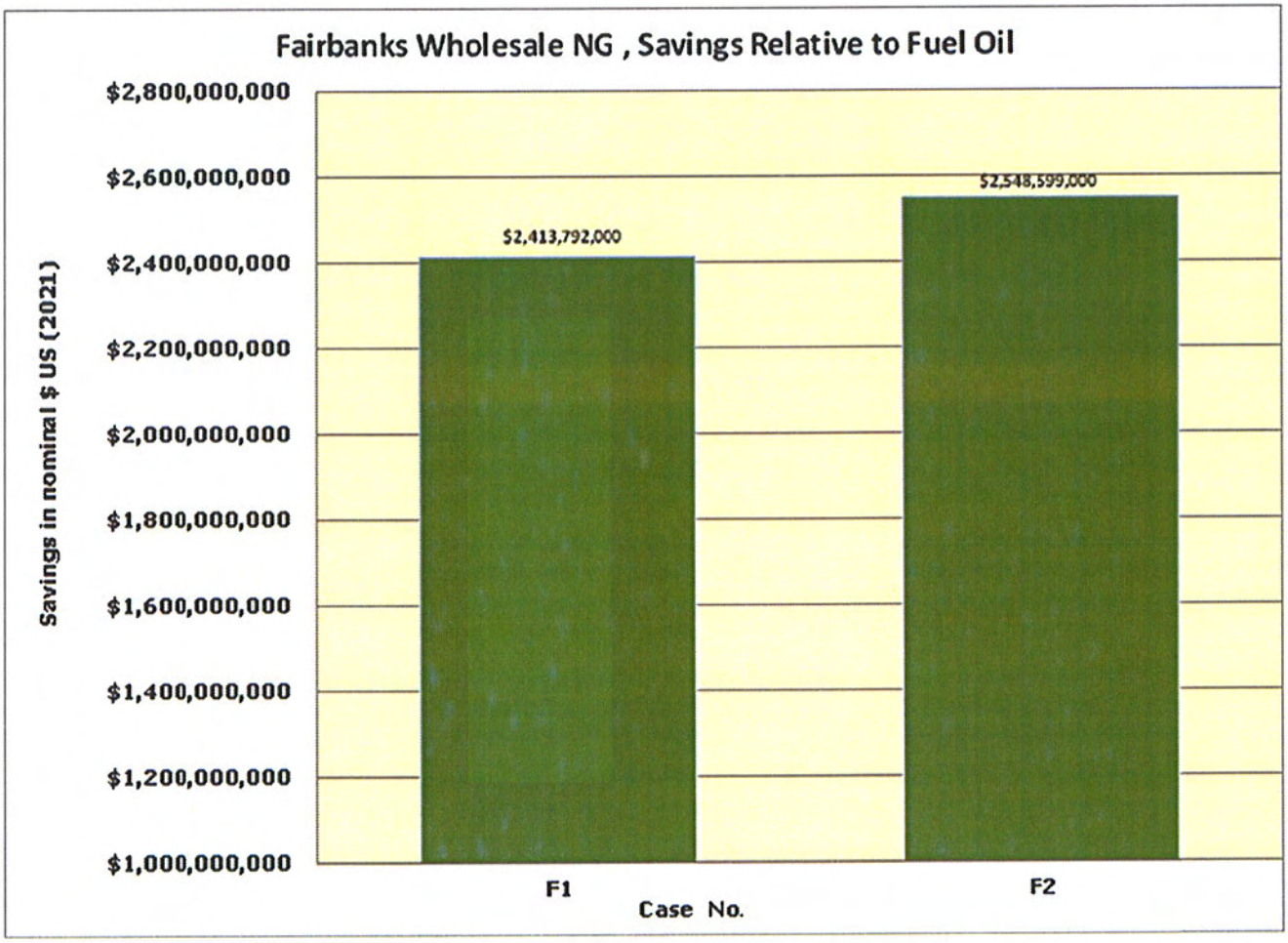

Fairbanks Wholesale NG , Savings Relative to Fuel Oil
Savings in nominal $ US (2021)
$2,800,000,000
$2,600,000,000
$2,400,000,000
$2,200,000,000
$2,000,000,000
$1,800,000,000
$1,600,000,000
$1,400,000,000
$1,200,000,000
$1,000,000,000
$2,413,792,000
$2,548,599,000
F1
F2
Case No.

Figure 8
Comparison of SO_2 Emissions per BTU Fired –
Fuel Oil, Wood, and Natural Gas

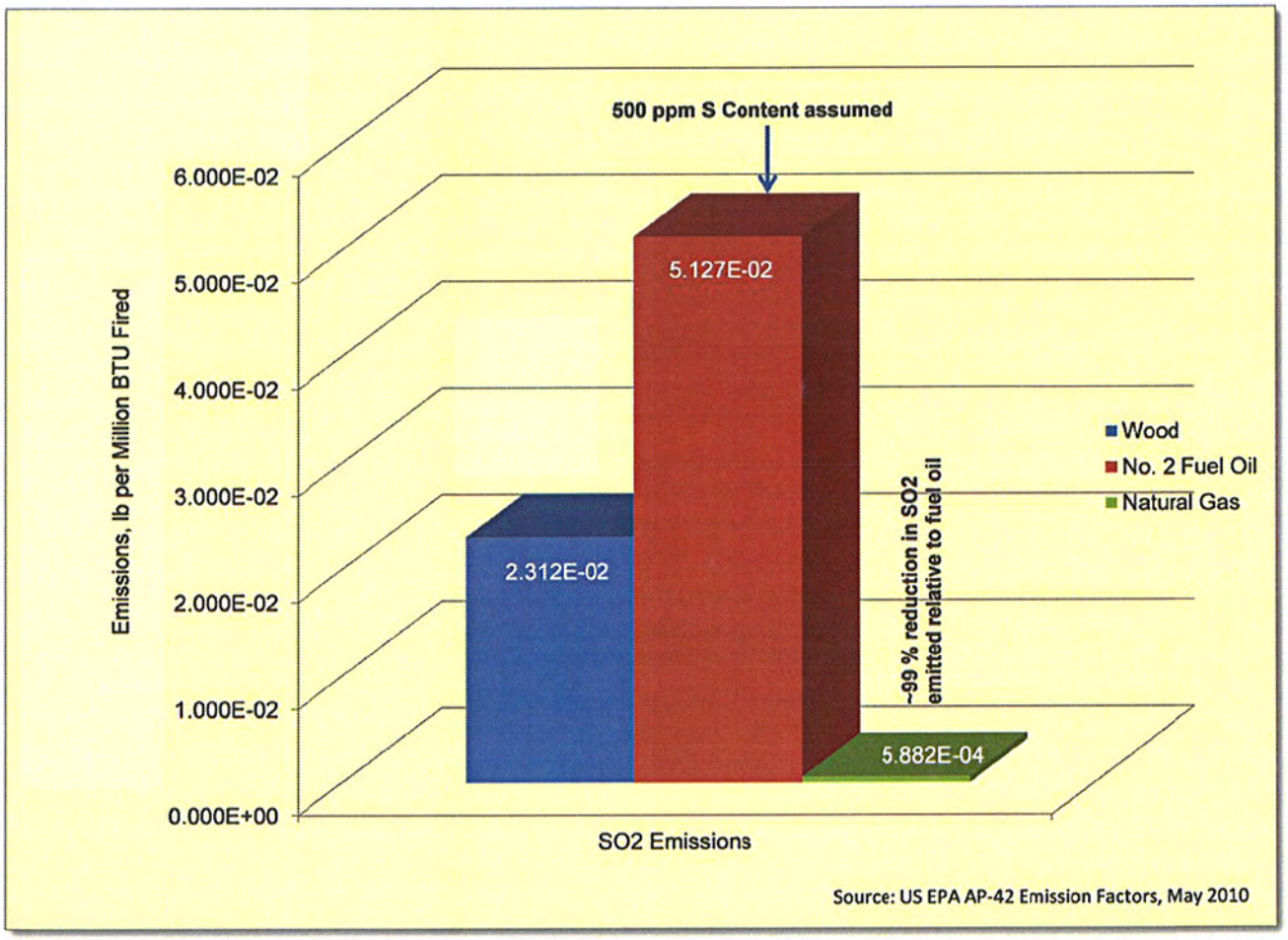


Figure 9
Comparison of NO_X Emissions per BTU Fired - Fuel Oil, Wood, and Natural Gas

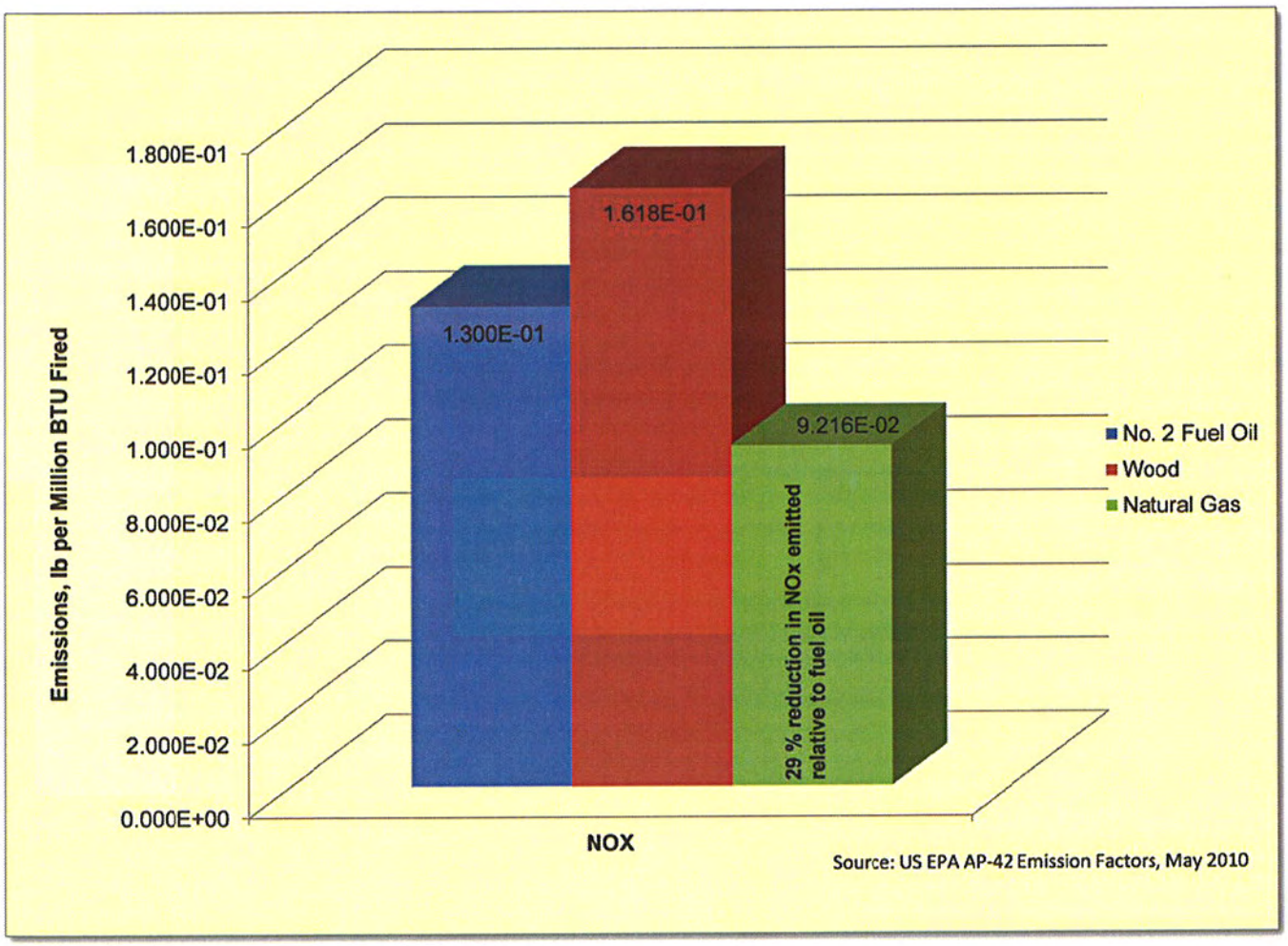


Figure 10
Comparison of Particulate Matter (PM_{10}) Emissions per BTU Fired - Fuel Oil, Wood, and Natural Gas

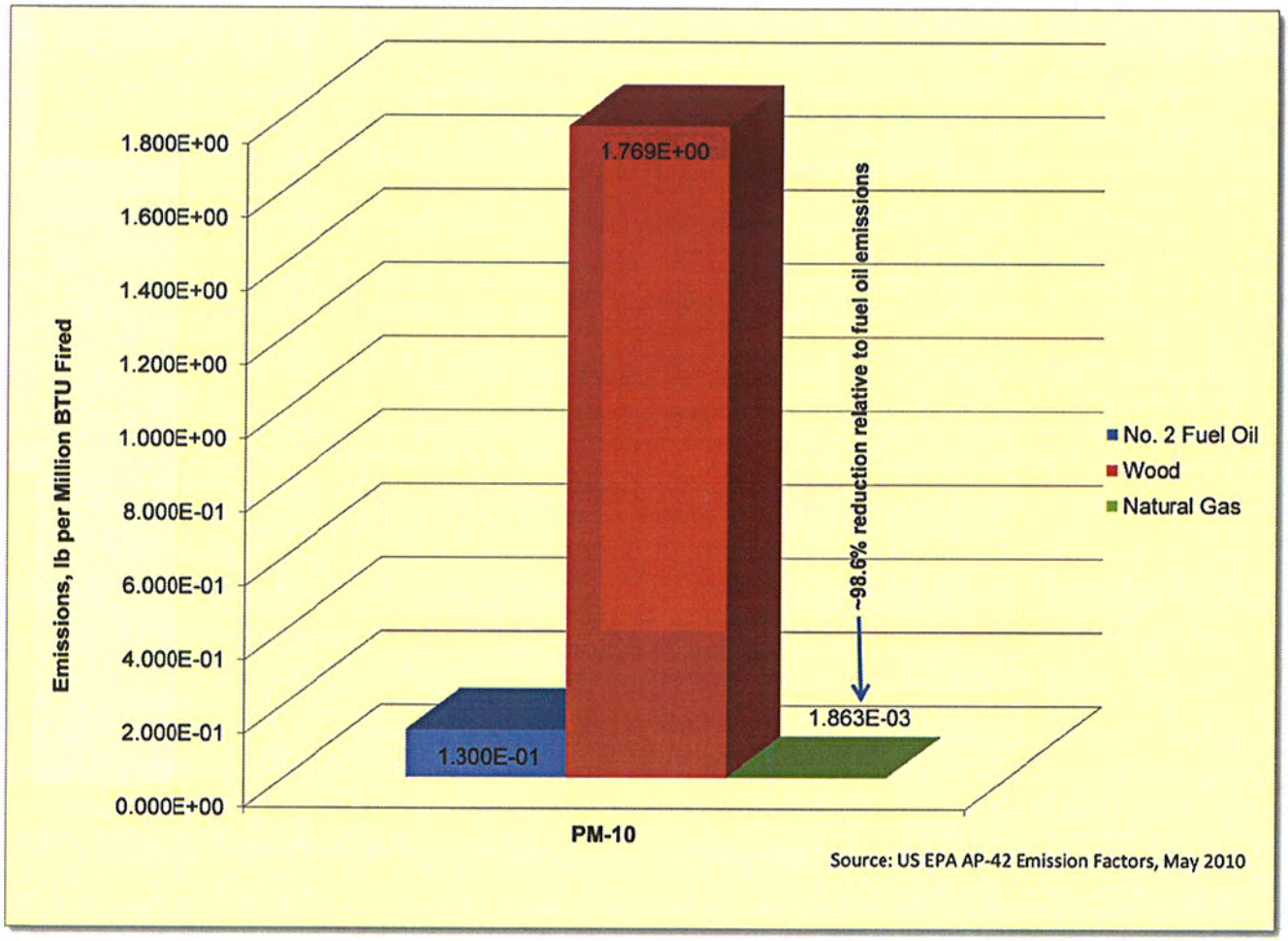
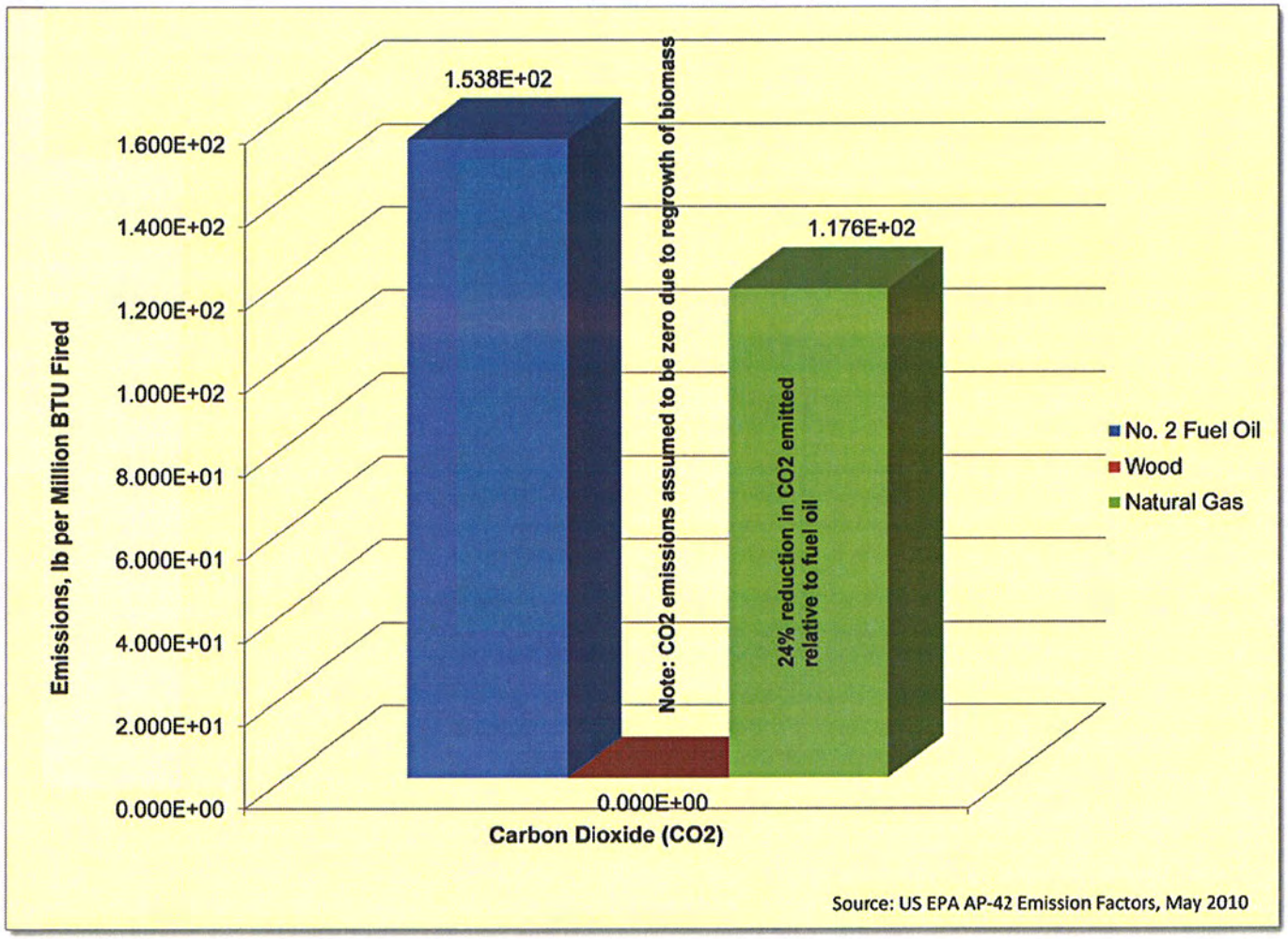


Figure 13
Comparison of Carbon Dioxide (CO_2) Emissions per BTU Fired - Fuel Oil, Wood, and Natural Gas



7. CONCLUSIONS & RECOMMENDATIONS

7.1 Bethel LCNG Substitution

- ✓ Preliminary cost modeling indicates favorable economics for replacement of diesel/fuel-oil for space heating and power generation in Bethel as a standalone project.
- ✓ The extent that capital and operating costs for transport barges and Valdez loading facilities are shared with other communities impacts the retail pricing advantages of LCNG.
- ✓ The inherent stability of LNG wholesale costs used in the model results in increasing fuel savings with time.
- ✓ The primary benefits to residents are annual fuel cost savings of 25% as a minimum, to greater than 65%, subject to the qualifications and assumptions presented.
- ✓ Additional definition of LCNG supply chain and storage/distribution components and costs is necessary to refine the retail pricing of LCNG and confirm these findings.
- ✓ Significant reductions in air emissions can be expected for priority pollutants (SO_2, NOx), hazardous air pollutants (primarily metals, and various organic compounds) and climate change gases (CO_2) relative to current fuels (fuel-oil).

7.2 Fairbanks Natural Gas Substitution

- ✓ The potential of a large capacity natural gas pipeline proximate to Fairbanks offers residents very substantial fuel savings. Wholesale gas priced at approximately $1 per diesel equivalent gallon speaks strongly of the benefits that residents in Railbelt communities potentially could expect from this project.
- ✓ Significant reductions in air emissions can be expected for priority pollutants (SO_2, NOx, CO and PM) and hazardous air pollutants (metals, and poly-aromatic compounds) and climate change gases (CO_2) relative to current fuels (fuel-oil and wood).

8. DISCLAIMER

This study was prepared for AGPA by PDC Harris Group using the referenced sources, and internally developed knowledge and data. Data from external sources has not been verified, and therefore we do not warrant the accuracy of conclusions

drawn based on this information. Any opinions expressed are those of PDC Harris Group.

9. APPENDICES

Appendix A – Cost Comparison of Wholesale Diesel and LNG

Appendix B – Schematic Diagram, Transport & Storage of LCNG for Rural Setting

Appendix C – Model Spreadsheets, Bethel

Appendix E – Model Spreadsheets, Fairbanks