M/V Arctic Voyager

Alaska Energy Authority

Discussion about LNG
Southeast Conference
March 13, 2014

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Annual Generation by Region

AEA Energy Region	Net MWHs per Year	Percent of Total
Aleutians	65,340	1%
Bering Straits	55,362	1%
Bristol Bay	55,145	1%
Copper River/Chugach	116,700	2%
Kodiak	150,503	2%
Lower Yukon-Kuskokwim	96,625	1%
North Slope	82,544	1%
Northwest Arctic	35,549	1%
Railbelt	5,075,507	77%
Southeast	785,190	12%
Yukon-Koyukuk/Upper Tanana	31,175	0%
Total	6,549,640	100%

- Southeast Alaska consumes more energy than any other energy region outside the Railbelt.
- Hydro generation meets ~95% of Southeast electric demand. The remaining is met with diesel. (About 2.7 million gallons annually, 32,000 MWh)
- Heating demand is generally equal to electric demand.

2011 Alaska Energy Statistics

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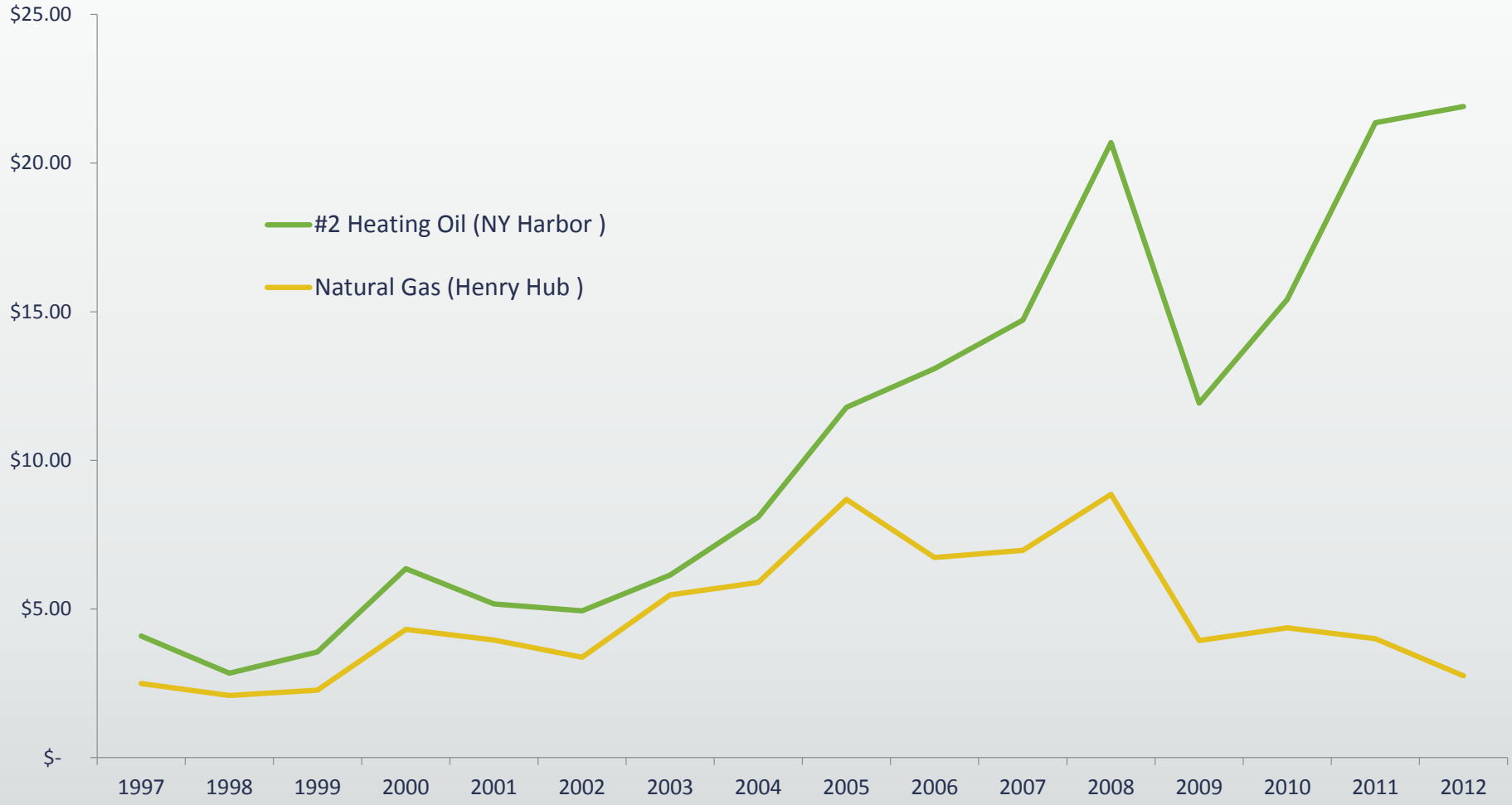
Why LNG Now?

Comparative Commodity Costs, $/MMBtu



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Can LNG Work for Coastal Communities?

- AEA-commissioned a screening level analysis with goal to assess opportunity and identify potential constraints of the ISO container delivery model
- Study Framework:
  - Assumes WesPac model
  - Screening level
  - Includes electric utility loads only
  - Coastal communities
  - ISO containers
- Not included
  - “Fatal flaw” assessment- Issues may have solutions outside of analysis framework
  - Independent assessment of “true” project economics
    - Many potential optimization (cost reduction) and complications (cost increases)

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Can LNG Work for Coastal Communities?

- Assumptions:
  - Fortis British Columbia Tilbury liquefaction $4.50/MMBtu
  - WesPac container and shipping cost assumptions:
    - 10,000 MMBtu/day (72,500 gallons/DEG)
    - 168 containers on site to meet demand
    - $125,000 per container
  - Note that assumptions are a moving target

- General Outcomes:
  - Benefits depend on significant non-utility loads
  - Benefits depend on what is aggregated
    - Each addition/subtraction effects economics
  - Benefits might be substantial

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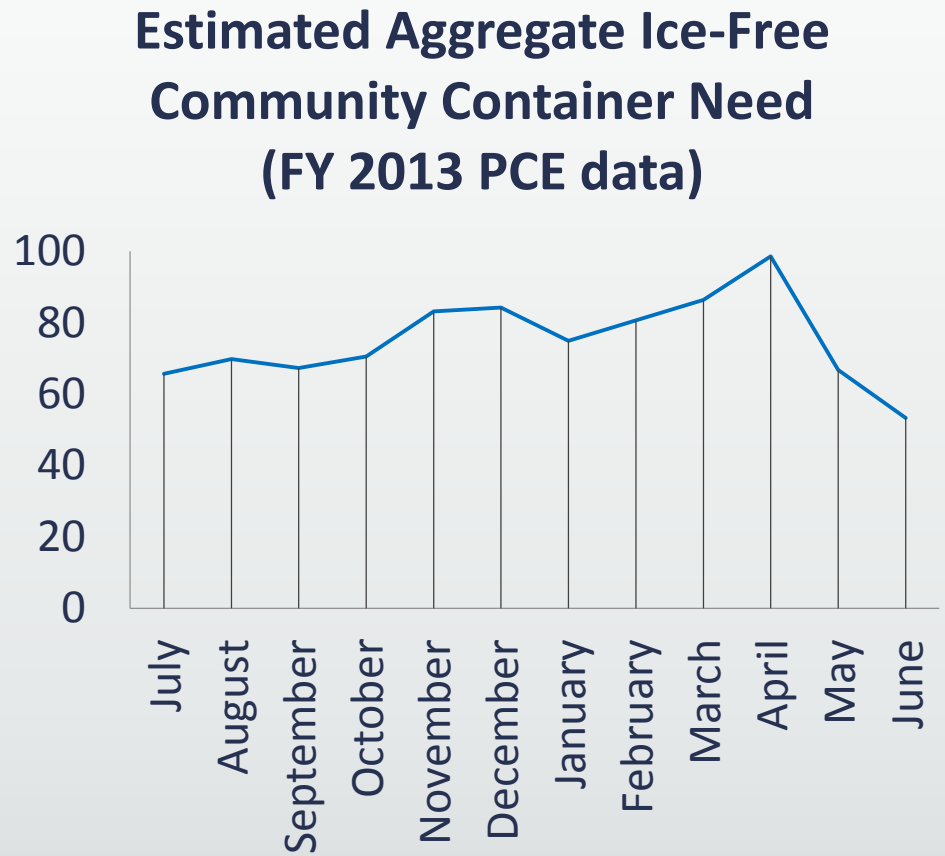
Utility Demand and Industrial Customers

Can Southeast and Southwest Alaska utility demand satisfy WesPac LNG Model?

- Annual diesel demand for 46 PCE-eligible communities in Southeast and Southwest is ~4,000 MMBtu/day
  - 50% of this annual demand met by three communities:
    - Unalaska/Dutch Harbor
    - Naknek, South Naknek and King Salmon
    - Dillingham
  - Large Southeast electric loads are met by hydro
- If 10,000 MMBtu/day is required, then industrial demand is necessary.

Container pricing

- Coastal Utility ISO Demand is not Flat
  - Seasonality in year-round access communities
  - Iced-in communities have no winter delivery
  - Efficient ISO container requires smoothing demand
  - Inefficient use increases cost
- Ice-Free Communities:
  - 99 total containers driven by high demand in April
  - Average price $3.19
  - Coincident peak pricing range $1.90 to $6.47
- Ice-Bound Communities
  - Between 5 and 90 containers
  - Pricing ranges from $12.99 to $23.80
  - Removing Dillingham and Naknek/S. Naknek/King Salmon tightens range to 50 to 28 containers
    - For Naknek and Dillingham costs reduced by ~50% by using 6,000 m^3 storage containers and bulk transport ships



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Power Plant and Facilities Upgrades

- Power Plant Conversion Costs:
  - Average $0.75/MMBtu – cost of conversion ranges $0.41 to $2.32
    - Assumes private financing 11% ROI and 10 year term
    - Public financing 0% ROI and 10 year term results in $50/MMBtu
- Port Facilities and Barge Landings:
  - Most Southeast communities have adequate landing facilities
  - Five Southwest communities have known need for upgrade, many unknowns
- Thermal Build Out:
  - Distribution pipe capital cost highly variable
  - ENSTAR (Southcentral) ~$120,000/mile Fairbanks North Star Borough estimated ~$200,000/mile
  - Does not include connection cost or building conversion cost

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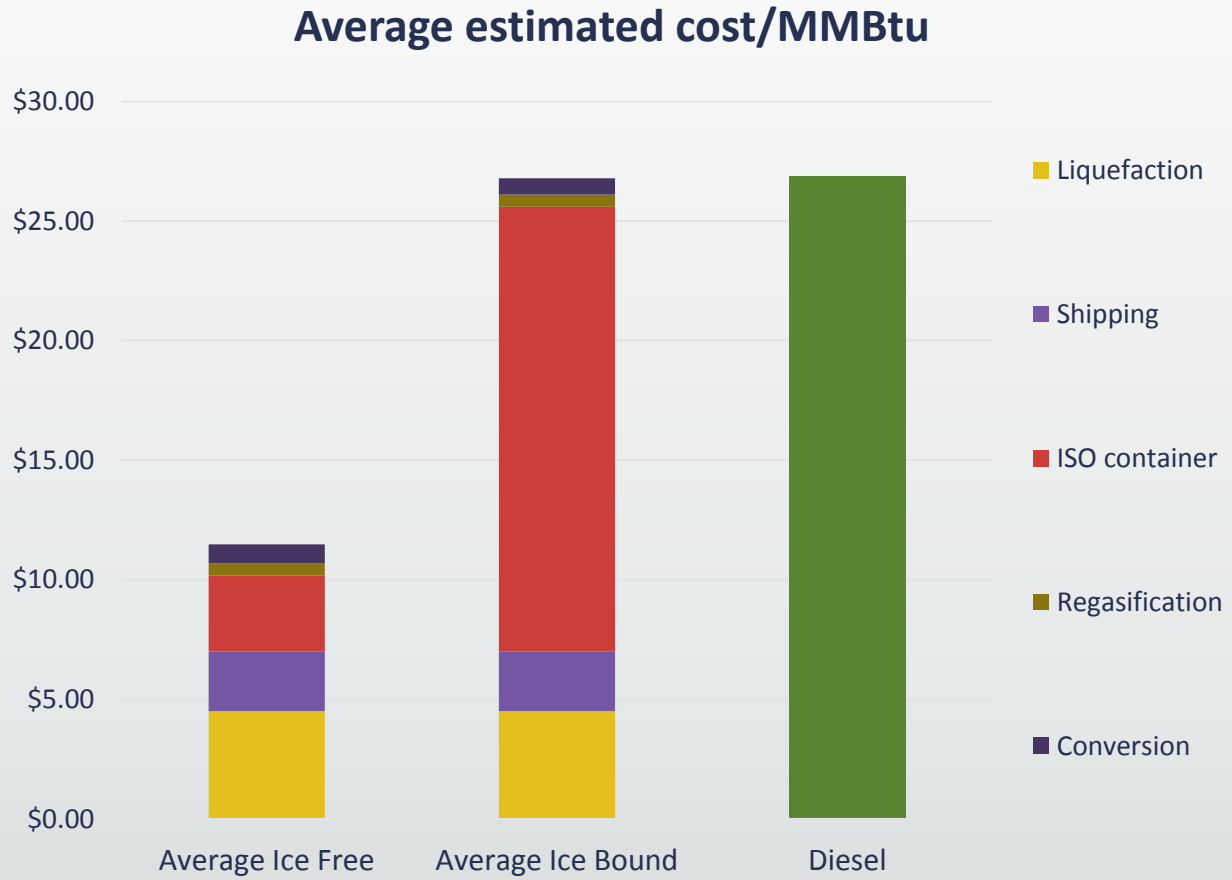
LNG vs Diesel

- Compare to 2010 and 2012 diesel cost
- Assume:
  - $4.50 for liquefaction
  - $2.50 for shipping
  - $0.50 for regasification
  - Calculated ISO container cost
  - Calculated power house retrofit
  - $125,000/container CapEx



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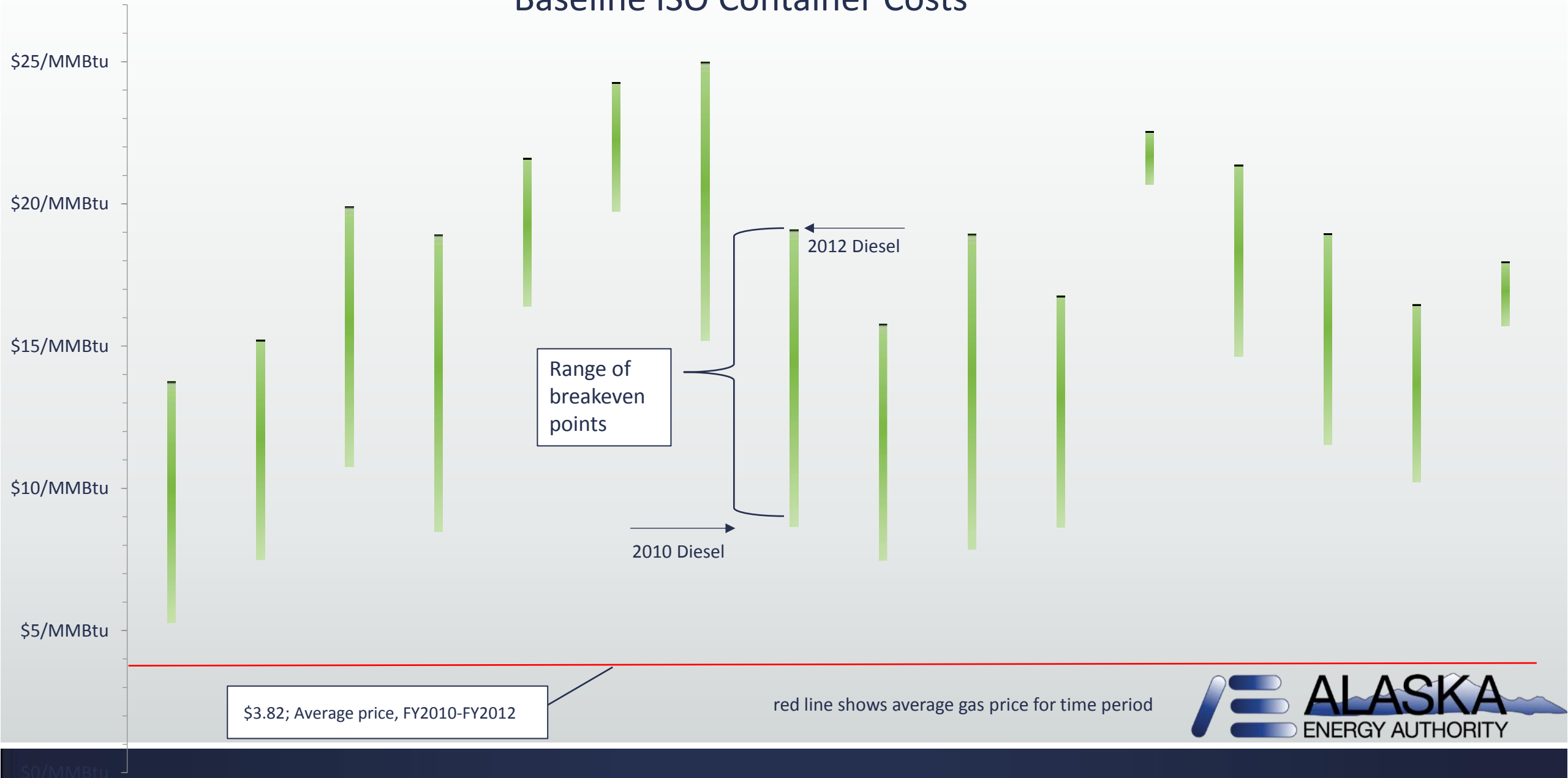
Break-Even Natural Gas Prices for Select Coastal **Ice-Free** Communities
Baseline ISO Container Costs



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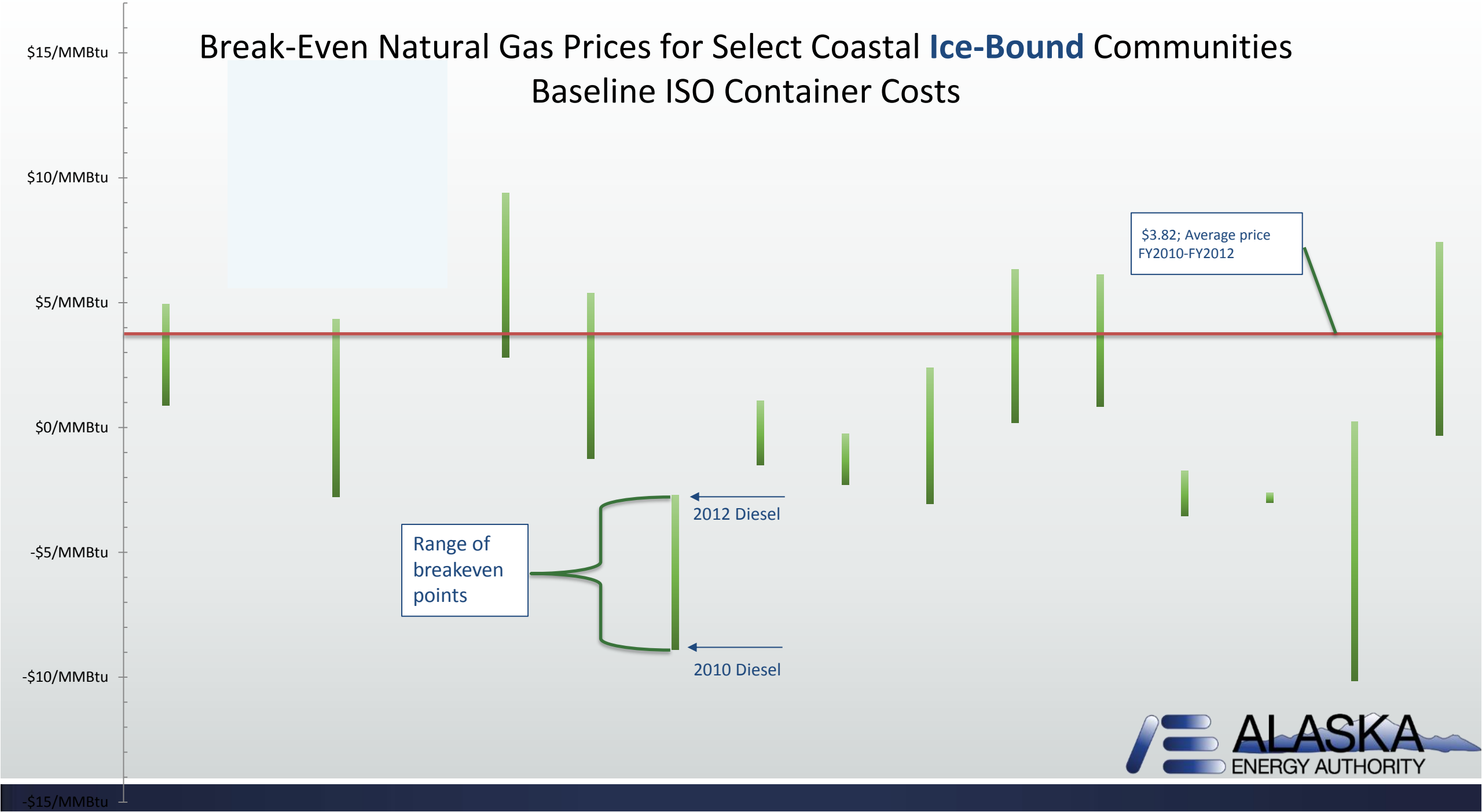
Break-Even Natural Gas Prices for Select Coastal **Ice-Bound** Communities
Baseline ISO Container Costs



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How Is LNG Different From Diesel?

LNG:

- Cannot be stored at room temperature
- Needs low-temperature and pressurized storage
  - -260 degrees F and ≤ 4 psi
- Has a limited storage life
- Has energy density 60% of that of diesel
  - 83,000 versus 138,000 Btu/gallon
- Vaporizes if leaks or spills
- Ignites at 1,004 degrees F
- Weighs 3.5 pounds per gallon

Diesel:

- Can be stored at room temperature
- Has an established infrastructure in rural Alaska for production, distribution and storage
- Contaminates soil if leaks or spills
- Ignites at 437 degrees F
- Weighs 7.1 pounds per gallon

How Is LNG Different From Propane?

LNG:

- Cannot be stored at room temperature
- Tank pressure ≤ 4psig
- Classified as a greenhouse gas
- Lighter than air
- Boils at -260 degrees F
- Has an energy density of 83,000 Btu/gallon

Propane:

- Can be stored at room temperature
- Tank pressure 10-200 psig
- Not a greenhouse gas
- Heavier than air and will pool in low spots
- Boils at -44 degrees F
- Has an energy density of 92,000 Btu/gallon

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Small-Community Considerations

- If demand can be aggregated there are savings opportunities for rural ice-free communities.
- Amount of savings depends on the price of diesel.
- There is future price uncertainty for both diesel and LNG.
- Specialized infrastructure and high energy input are needed for liquefaction and gasification.
- Does your community have the infrastructure needed to receive and store LNG?
- How will LNG integrate with any existing or planned renewables?
- Does your community have the human/technical capacity to run an LNG powerhouse?
- Are there any industrial users in or near your community that might benefit from natural gas-generated power?

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Some Takeaways

- Economies of scale matter.
  - Project will aggregate larger loads to start
  - Economics for smaller loads may work, but larger-project optimization must occur first
  - Challenges face ice-bound communities unless loads are comparatively large
- Reasonable to expect:
  - Unalaska/Dutch – Dillingham – Naknek bulk (non-ISO) project
    - ISOs for proximal communities may follow
  - SE ISO project with PCE utility needs met by ISOs, but anchored by industrial tenant(s)
    - ISOs for proximal communities may follow

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