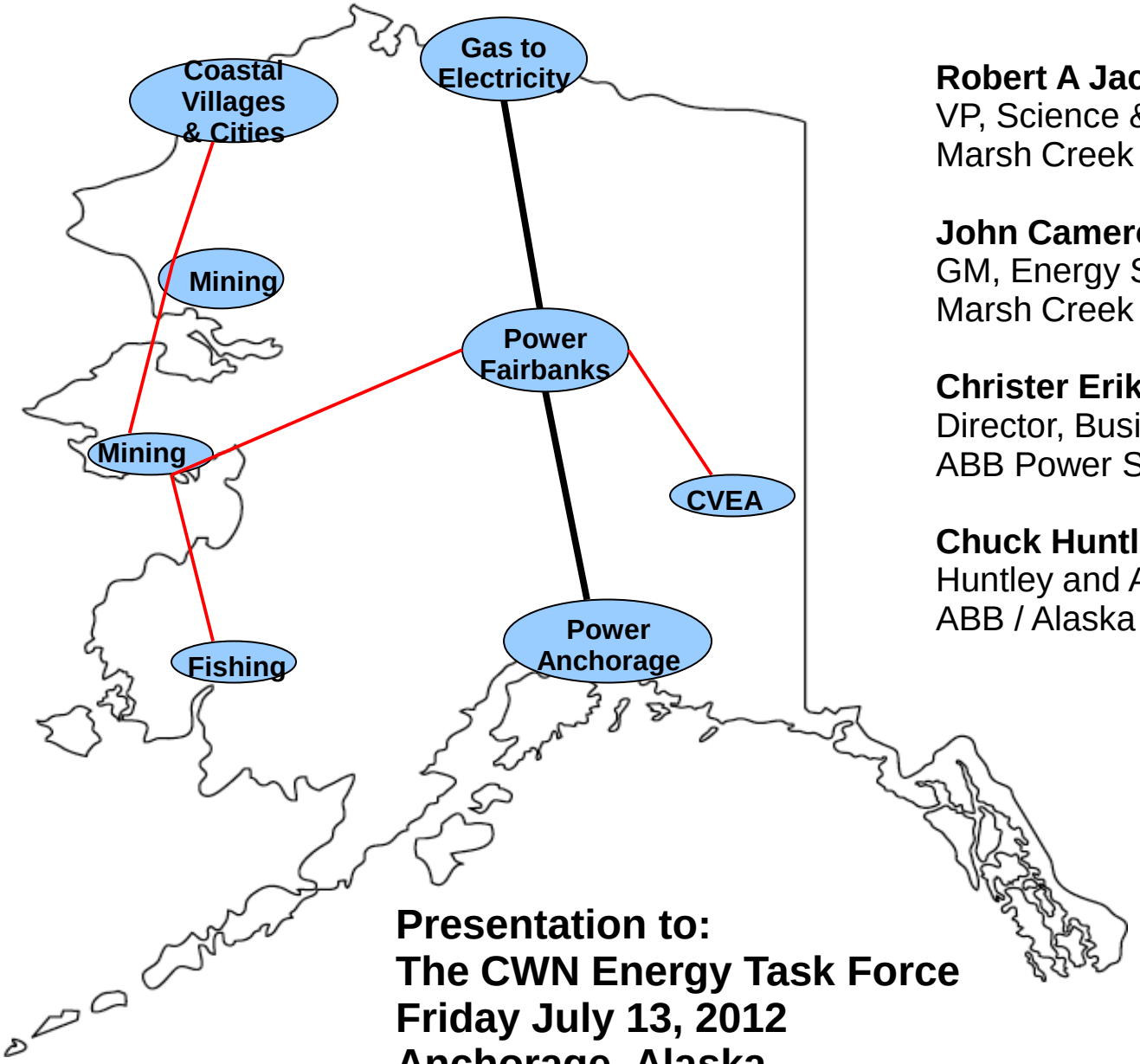
Stranded North Slope Gas to HVDC
Affordable Electrical Power For All Alaska



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Alaska's Energy Problem

At this time Alaskan energy planners are facing a formidable problem: the Cook Inlet gas fields are nearing depletion, gas shortages on timescales of 2014 being predicted. Susitna Hydro Power, given historical precedence, will arrive late and will be woefully inadequate during winter.

LNG imports can solve the problem but will result in sharply increased electrical costs. (Fuel cost goes from 5 ¢/kWh to 17 ¢/kWh. Heating costs will double or triple.)

The villages in rural Alaska are far from the Railbelt grid and need to be energized locally using expensive diesel for almost all of their needs

Alaska has a problem: the affordable energy source is not where the people live, and in the absence of affordable energy the people will never be economically successfully.

A Shortage of Affordable Energy, Really?

The North Slope has 35 trillion cu ft of discovered (technically recoverable) natural gas and an additional estimated 125 trillion cu ft of (technically recoverable) gas awaiting discovery.

Modern natural gas extraction techniques in the lower 48 have driven the Henry Hub prices to record lows (~$2-3/cu ft). These modern techniques are sure to be adopted worldwide guaranteeing that Alaska's North Slope gas assets remain stranded gas.

How does one use this plentiful source of energy for the benefit of all the Alaskan people?

Using Stranded Gas to Heat and Power Alaska

Alaska, by far the largest State, home to 0.23% of the US population, is very different from the Lower-48. Distances are vast, roads are few and for much of the time it endures severe winters. To survive one needs energy, the costs of which can consume on average 20% of the household incomes. For those living in remote rural communities, indeed this number rises to 50% for the poorer members of these communities. The big cost driver is heating oil (diesel), which can cost more than $7/gallon in many villages. Unfortunately, given the realities of the global market and industrial growth in developing countries, oil prices are destined to continue to increase, exacerbating the financial hardships inflicted on these communities by the need to stay warm.

Fortunately, there are vast supplies of cheap stranded gas in Alaska, all that is needed is a simple, cheap and convenient transportation system – HVDC provides it.

Let's bring the gas energy to market for the benefit of all the Alaskan people.

High Voltage Direct Current (HVDC)
The Answer to Alaska's Prayers

Two technologies used:

Current Source Commutation (CSC) – The enabling technology for the efficient transport of bulk electrical power over long distances. Simple, stable and cheap power line offset by expensive AC/DC Converter Stations at each end which feed the power into the local AC grid; as a result it is not economic for lengths much under 300 miles. Low losses – Losses similar to those of a gas pipeline.

Voltage Source Commutation (VSC), introduced in the late 1990's, is becoming economic in power blocks of 10's of MW and lengths of 10's of miles. (VSC) technology allows for reactive power control within local AC distribution grid, providing stability and a black start capability.

Oil Heating versus Gas with HVDC

A gallon of #1 diesel fuel provides 130,500 btu, which when purchased for $7/gallon and used for heating provides heat at the electrical equivalent of 23.1 ¢/kWh, assuming 80% efficiency.

Alaska consumes approximately 380 million gallons of diesel each year, most of it used for heating. This is equivalent to 12.25 million MWh of electrical generation per year, which could be provided by a 2.5 GW gas fired power plant constructed on the North Slope.

Fairbanks alone consumes at least 250 million gallons of diesel each year. A 2.5 GW North Slope power plant together with HVDC transmission lines could energize the entire Rail Belt, energize the Prudhoe Bay oil field activities and provide electrical heating to Fairbanks at approximately 9 ¢/kWh.

HVDC Concepts Relevant to Alaska

Let's explore a few possible applications of HVDC technology, in conjunction with modern high efficiency compound gas turbine generation as it relates to the needs of Alaska, to:

1) Energize the Railbelt Utility Grids

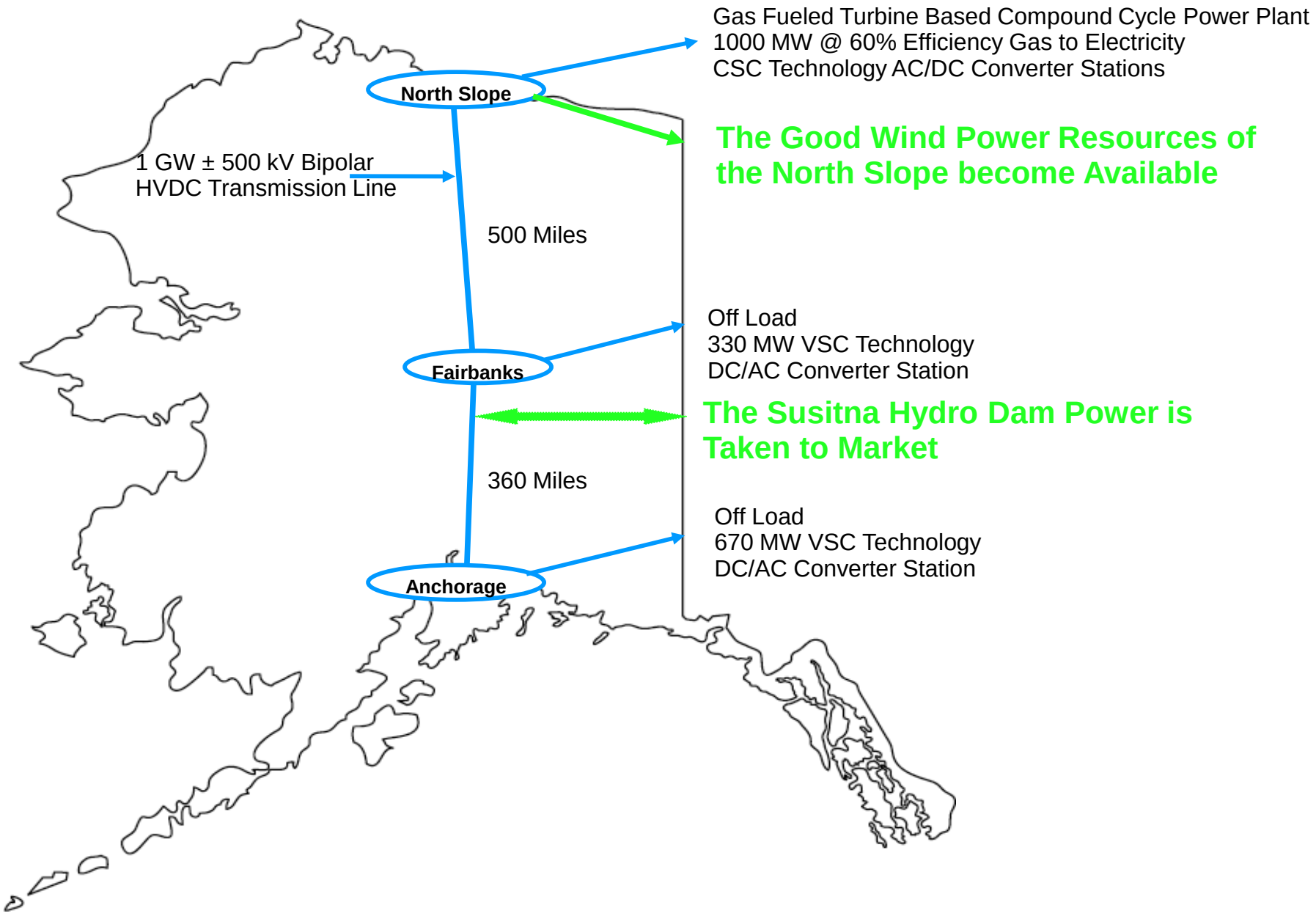
2) Sell Power to the Lower 48

3) Energize Alaska

4) Electrical Heating

5) Heat and Energize Smaller Remote Communities

Energize the Railbelt Utility Grids



Railbelt HVDC/Gas Turbine Power System Costs

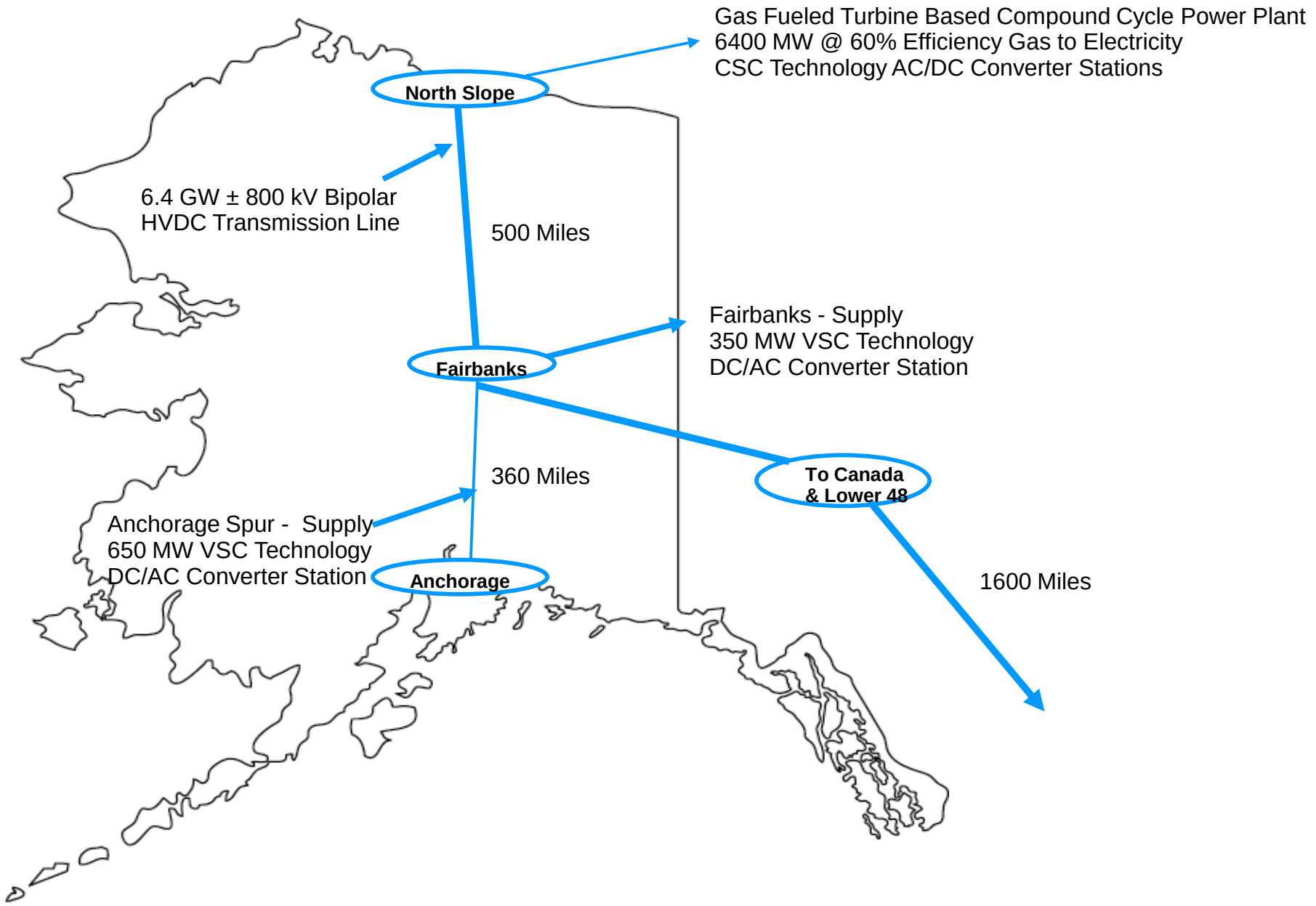
Capital Costs (B$)

Power Plant (833 MW)	1.25
HVDC Power Line	1.86
Converter Stations	0.60
	3.71 (B$)

Operating Costs ($/MWh)

Capital (30 yr @ 7%, 85% Utilization)	48.36
Gas (0.104 bcf/day – Henry Hub $3.00/1000 cu ft)	18.36
O & M Gas Turbine Power Plant	12.50
HVDC Line System Maintenance (1.5%)	5.95
Insurance (0.5%)	3.00
Regulatory Fees	1.00
Property Taxes (0.5%)	3.00
Administrative & OH	1.00
	93.17 ($/MWh)
	9.3 ¢/kWh

Stranded Gas to Market – Power South



Stranded Gas to Market – Power South

Capital Costs (B$)

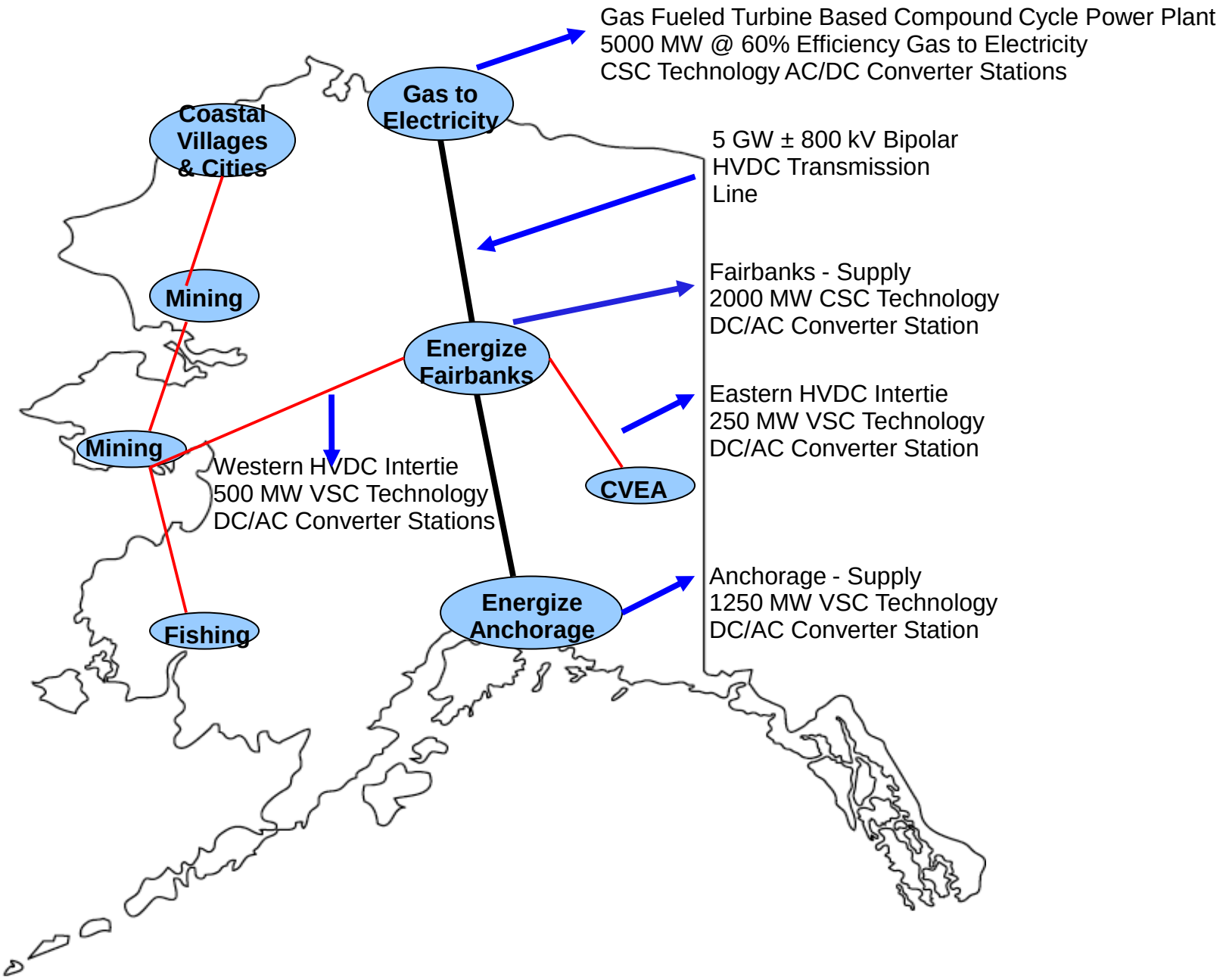
Power Plant (6400 MW)	9.00
HVDC Power Line	9.79
Converter Stations	1.16
	19.95 (B$)

Operating Costs ($/MWh)

Capital (30 yr @ 7%, 85% Utilization)	33.79
Gas (0.8 bcf/day – Henry Hub $3.00/1000 cu ft)	18.36
O & M Gas Turbine Power Plant	12.50
HVDC Line System Maintenance (1.5%)	3.45
Insurance (0.5%)	2.10
Regulatory Fees	1.00
Property Taxes (0.5%)	2.10
Administrative & OH	1.00
	74.3 ($/MWh)

7.4 ¢/kWh

Energize Alaska



Heating and Energizing Remote Communities

With heating oil at $7/gallon (23.1 ¢/kWh) in remote communities HVDC (a rapidly evolving technology) is on the cusp of becoming economic as a means of providing both heat and power to these communities.

Plentiful affordable power is the stepping stone from survival to a viable village economy.

Plentiful affordable power is the key to sustainability of all infrastructure.

Plentiful affordable power is the key to unlocking Alaska's remote resources.

Plentiful affordable power is the engine of a viable State wide manufacturing and industrial base.

Gas Powered Alaskan Energy Infrastructure

A State Infrastructure Project to Benefit All Alaskans.

Gas Provides Electrical Power.

Electrical Power Provides Heat.

Cheap Power Fuels Economic Growth.

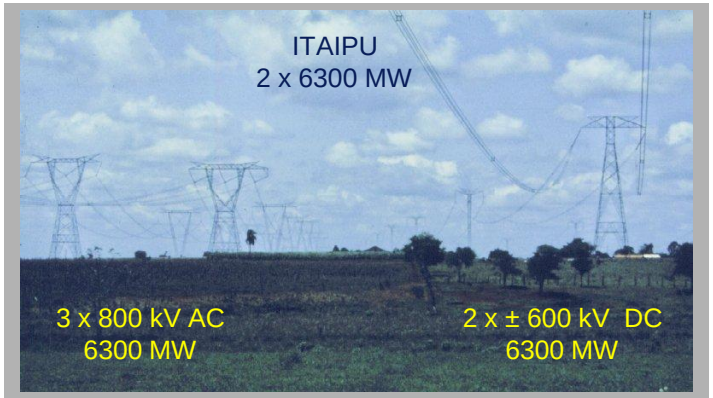
Ship “Made in Alaska” not pieces of Alaska.

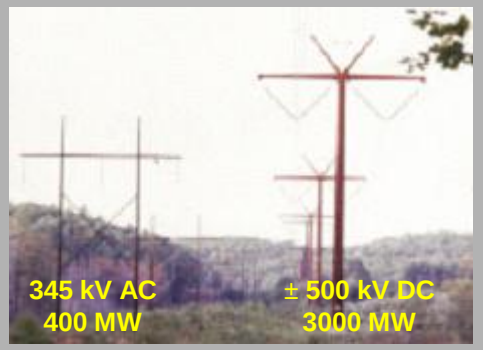
Jobs.

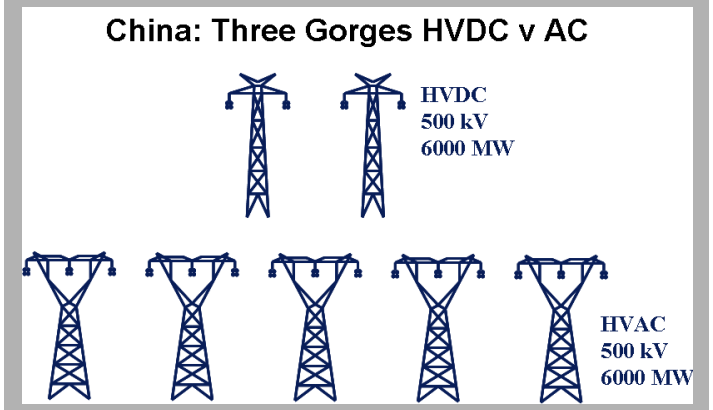
Comparable HVDC Power Lines in Service

HVDC Line	Cohara Bassa	Intermountain (UT to CA)	Quebec-New England	Pacific Intertie (WA to CA)	Three Gorges-Shanghai	Xiangjiaba-Shanghai
Power (MW)	1930	1920	2000	3100	3000	6400
Voltage (kV)	±533	±500	±450	±500	±500	±800
Length (Miles)	887	490	925	850	662	1294
Year Built	1979	1986	1992	1985	2007	2010

Long Distance Bulk Power Transmission







Full Generator Off-Load Transmission

More power on fewer lines
Improved stability
Lower installed cost
Reduced losses
Double circuit (bipolar line)
Reduced Right of Way (ROW)

Valhall 0ffshore HVDC Project

In service: August, 2009

Power rating: 78 MW

AC Voltage: 300 kV at Lista
11 kV at Valhall

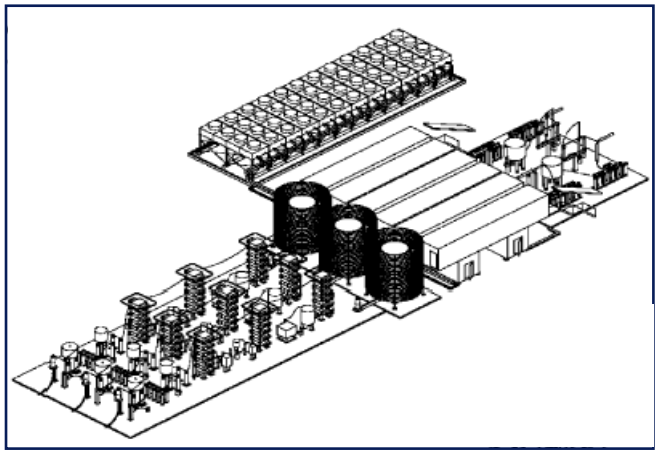
DC Voltage: 150 kV

Length of DC cable: 182 miles

Main reason for choosing HVDC:

Environment, less maintenance and a lighter platform solution.

Estlink – HVDC between Estonia & Finland



Contract signed:	April 2005
In service:	November 2006
Project duration:	19 months
Capacity:	350 MW
AC voltage:	330 kV at Harku, 400 kV at Espoo
DC voltage:	±150 kV
DC cable length:	2 x 66 miles (19 miles land)
Converters:	2 level, OPWM
Special features:	Black start Estonia, no diesel
Rationale:	Electricity trade
	Asynchronous Tie
	Long cable crossing
	Dynamic voltage support
	Black start

In Summary

HVDC Transmission provides a means of moving bulk power long distances more cost effectively at greater efficiency and better stability than conventional AC transmission.

HVDC Light Technology can provide taps to Alaska’s diversified and spatially scattered communities.

HVDC and modern industrial gas turbine technology provides a cost effective means of:

- Powering the Railbelt Utilities with Alaskan gas.
- Taking stranded North Slope gas to market.
- Integrating Alaska's diversified and spatially scattered population centers into a viable economic engine.
- Heating Alaska.