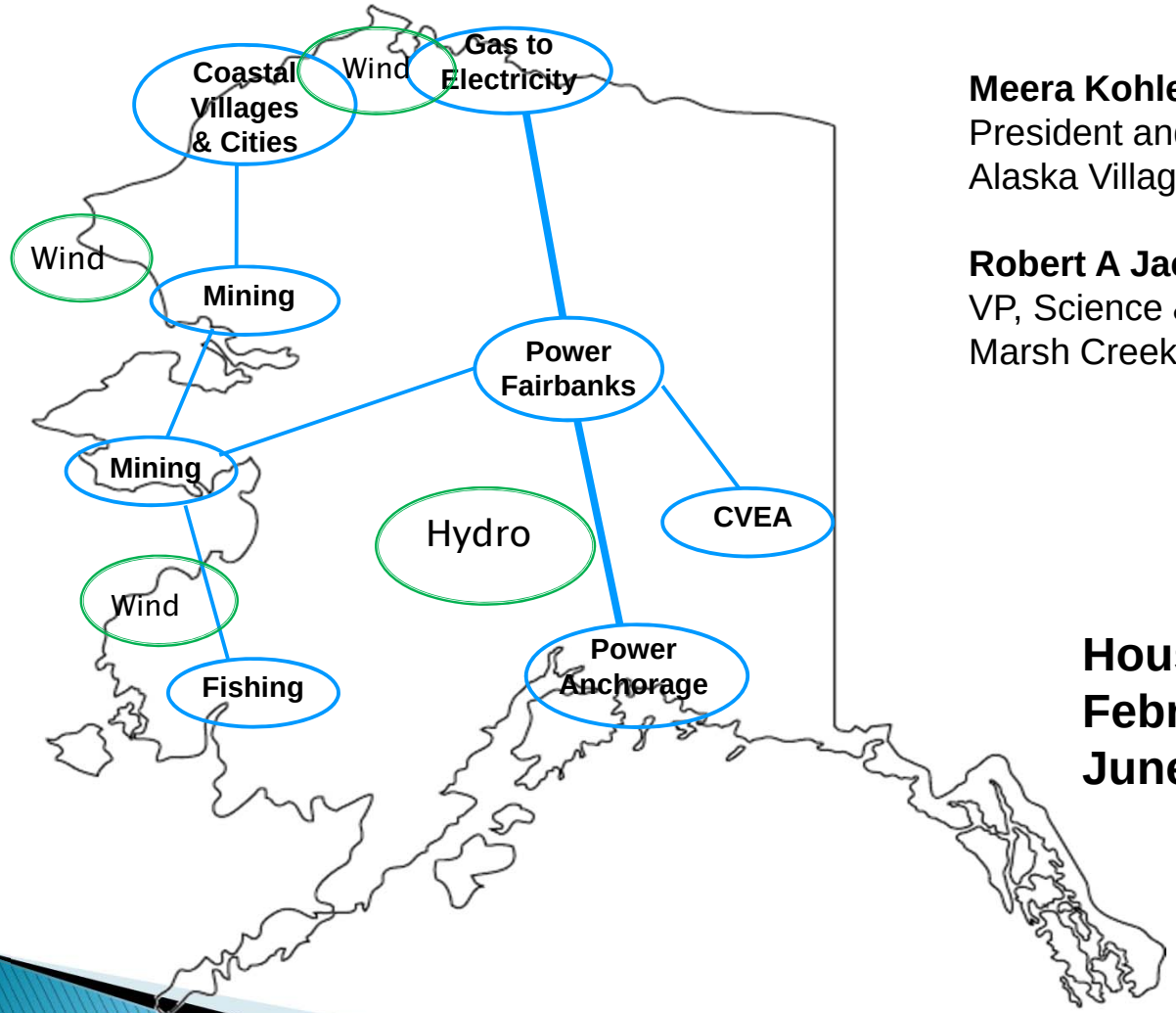
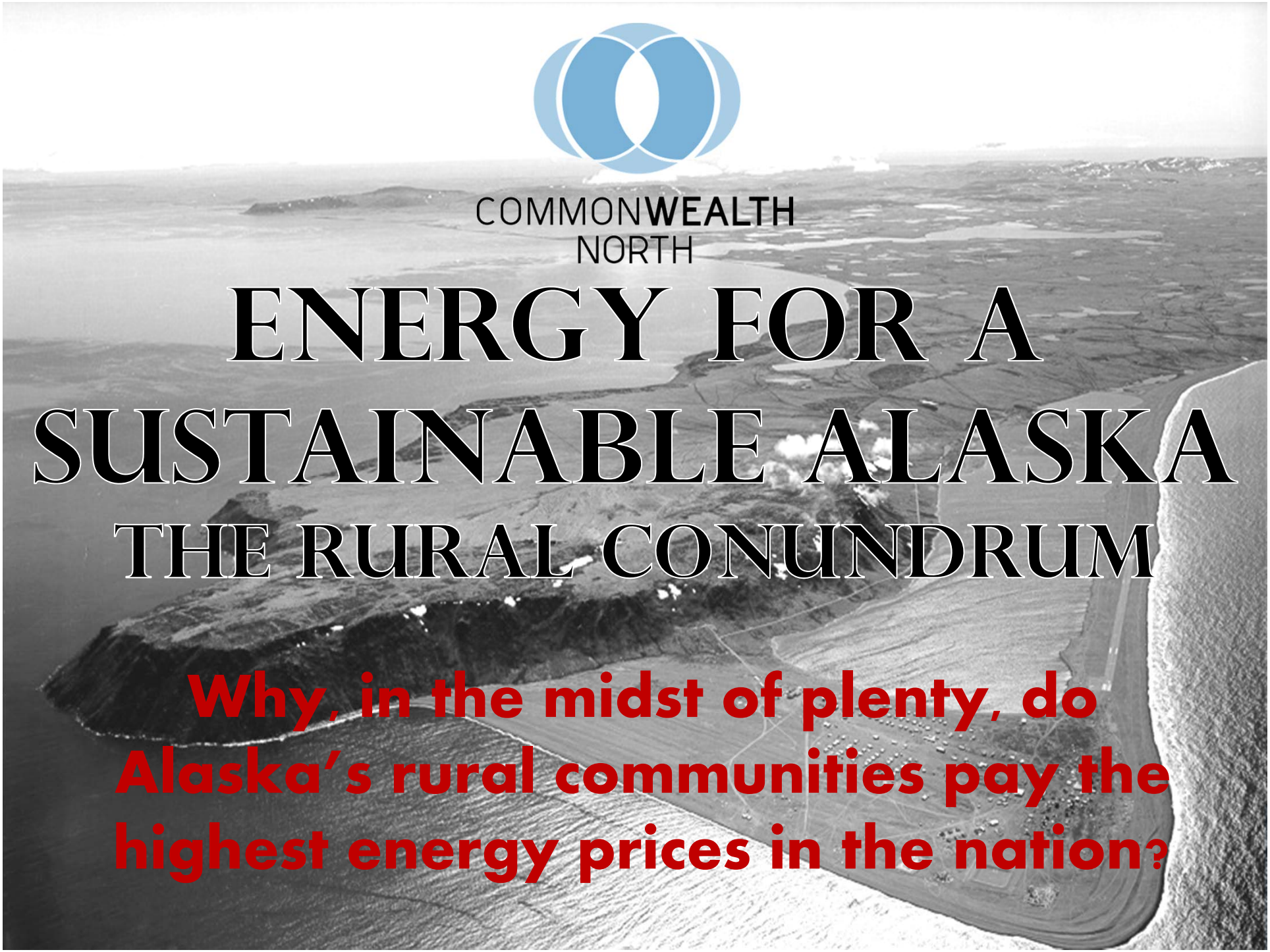
Energy Independence for Alaska - It Really is Possible!



Meera Kohler
President and CEO
Alaska Village Electric Cooperative

Robert A Jacobsen PhD
VP, Science & Technology
Marsh Creek LLC

House Energy Committee
February 27, 2013
Juneau, Alaska



COMMONWEALTH NORTH

ENERGY FOR A SUSTAINABLE ALASKA

THE RURAL CONUNDRUM

Why, in the midst of plenty, do Alaska's rural communities pay the highest energy prices in the nation?

AVEC's Delivered Fuel Cost

• Average 2002	1.29	
• Average 2003	1.47	+.18
• Average 2004	1.98	+.51
• Average 2005	2.26	+.28
• Average 2006	2.26	
• Average 2007	2.93	+.67
• Average 2008	4.55	+1.62
• Average 2009	3.02	-1.53
• Average 2010	3.30	+.28
• Average 2011	4.27	+.97
• Average 2012	4.03	-.24

Increase 2002 - 2012 $2.74 311%

COMMONWEALTH NORTH

Study Group Finding # 1

Alaska needs a statewide energy vision, plan, and implementation strategy that incorporates a holistic view of statewide energy sustainability and which serves all Alaskans similarly

COMMONWEALTH NORTH
Study Group Finding # 2

Developing regional electrical grids yields

- **Economies of scale**
- **Generation and technical efficiencies**
- **Reduced redundant infrastructure**
- **Viable alternative energy projects**

COMMONWEALTH NORTH
Study Group Finding # 3

Dependency on diesel consumption must be reduced through increased efficiencies and utilization of economically viable alternatives

COMMONWEALTH NORTH

Study Group Finding # 4

A single statewide entity could coordinate energy generation and transmission project selection and advocate for all regions of the State in a balanced fashion

COMMONWEALTH NORTH

Study Group Finding # 5

We must ensure high-value and effective investments in energy projects, and provide a "one stop shop" to deal with permitting and federal regulators

COMMONWEALTH NORTH
Study Group Finding # 6

Alaska should strive to eliminate the need for the Power Cost Equalization Program by reducing the cost of power across the state

What We Spend on Heat and Power

From 2010 Alaska Power Statistics:

Electricity revenue	$924 mm

Gas revenue – Southcentral	$536 mm
Diesel – Fairbanks area	250 mm gallons
Diesel – Kodiak, Copper Valley, SE	68 mm gallons
Diesel – Rest of state	63 mm gallons
TOTAL	381 mm gallons
Diesel value at $4.00/gallon	$1,524 mm
Annual cost of electricity/heat	$2,984 mm

Expenditure in 20 years $59.7 billion

Alaska's Energy Problem

Rural communities use diesel for almost all of their energy needs. No other technology is as reliable or well tested.

Fairbanks uses diesel for half their electric generation and much of their space heating needs. Home energy expenditures now rival the mortgage – especially in winter. The use of wood and coal lends to significant air quality issues.

Southcentral Alaska is running out of gas and must import LNG or CNG by 2015 to supplement Cook Inlet production.

Industry is languishing due to unavailable and unaffordable energy

Energy is scarce and expensive and is on track to become even more so

A Shortage of Affordable Energy in Alaska Really?

According to state reports, the North Slope has 235 trillion cubic feet (tcf) of technically recoverable gas.

New gas extraction techniques (fracking) have driven the price of natural gas to record lows (~ $3/mcf). As fracking becomes widespread across the world, Alaska's North Slope gas assets are virtually assured to remain stranded.

How does one use this plentiful source of cheap energy for the benefit of all Alaskans?

We Propose a Solution

- Very large scale generation on the North Slope using Alaska's stranded natural gas
- High Voltage Direct Current (HVDC) lines to move large amounts of power across Alaska
- Abundant power for
  - North Slope operations
  - Fairbanks and other Railbelt communities
  - Remote mines, military and processors
  - Heat and electricity for rural communities

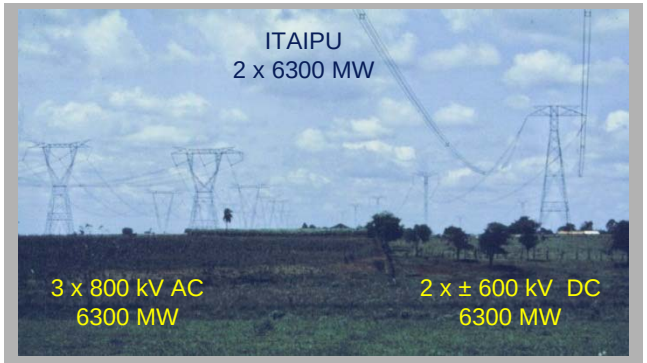
High Voltage Direct Current (HVDC) Transmission
The State of the Art

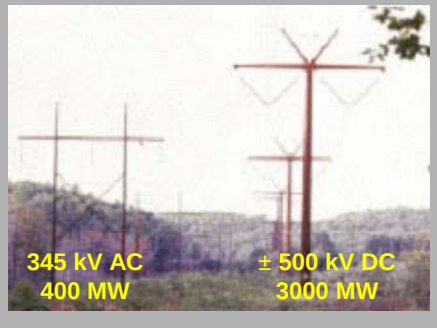
Highly efficient transport of bulk electrical power over long distances - used in the US and internationally to connect remote sources of generation (hydro, renewables, fossil fuel generation) to distant users. Line losses are similar to those of a gas pipeline.

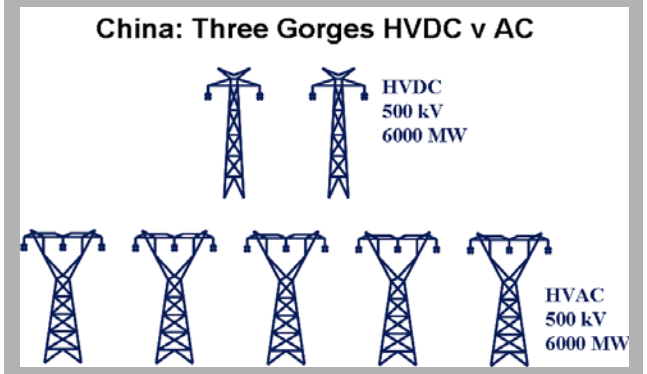
Conventional HVDC, in use since the 1950s, utilizes a simple cheap power line offset by expensive AC/DC Converter Stations at each end; as a result it is not economic for lengths much under 300 miles.

HVDC Light, introduced in the 1990s, is now economic for much smaller power loads and distances. It can tap off conventional HVDC lines and does not experience issues that plague AC transmission, such as reactive power. It can provide black start capability within local AC grids.

Long Distance Bulk Power Transmission







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

HVDC Transmission has been in use since the 1950s

	Cahora Bassa	Utah-California	Quebec-N. England	Pac. 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

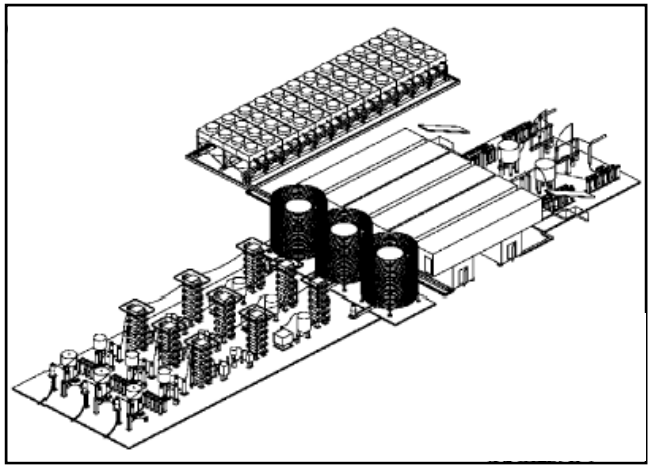
Norway Offshore HVDC Light Project

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 reasons for choosing HVDC:

Environmentally benign, less maintenance and a lighter platform solution.

Estlink – HVDC Link 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

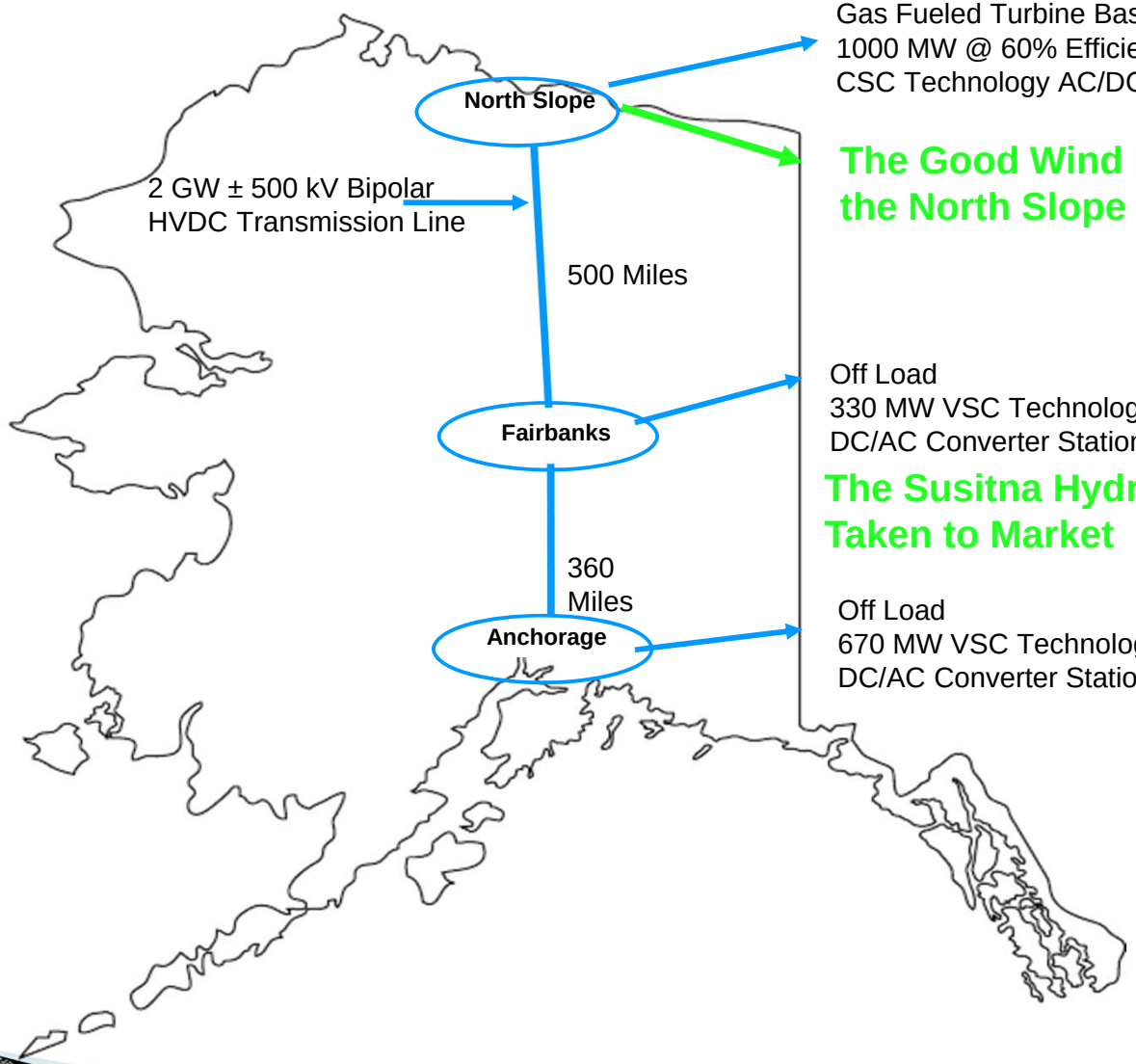
- Asynchronous Tie
- Long cable crossing
- Dynamic voltage support
- Black start

Natural Gas and HVDC for Alaska

Aggregating Alaska's loads creates enough demand to install large (300-450 MW) combined cycle gas turbines, delivering ~60% efficiency. Transmitted by HVDC, it can:

- Energize the Railbelt Grids
- Heat and power Fairbanks
- Heat and power Rural Communities
- Energize industry
- Harness distant renewables (e.g. North Slope, west coast wind, tidal power, Susitna)
- Reduce greenhouse gases from less efficient gas, coal and diesel generation
- Improve air quality by reducing particulate matter emissions

Energize the Railbelt Utility Grids



Gas Fueled Turbine Based Combined Cycle Power Plant
1000 MW @ 60% Efficiency Gas to Electricity
CSC Technology AC/DC Converter Stations

The Good Wind Power Resources of the North Slope become Available

Off Load
330 MW VSC Technology
DC/AC Converter Station

The Susitna Hydro Dam Power is Taken to Market

Off Load
670 MW VSC Technology
DC/AC Converter Station

Railbelt HVDC/Gas Turbine Power System Costs

Capital Costs (Billion $)

Power Plant (833 MW)	1.25
HVDC Power Line	1.86
Converter Stations	0.60
Total	**3.71**

Operating Costs ($/MWh)

Capital (30 years @ 7%)	48.36
Gas (0.104 bcf/day – Henry Hub $3.00/mcf)	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
	9.3 ¢/kWh

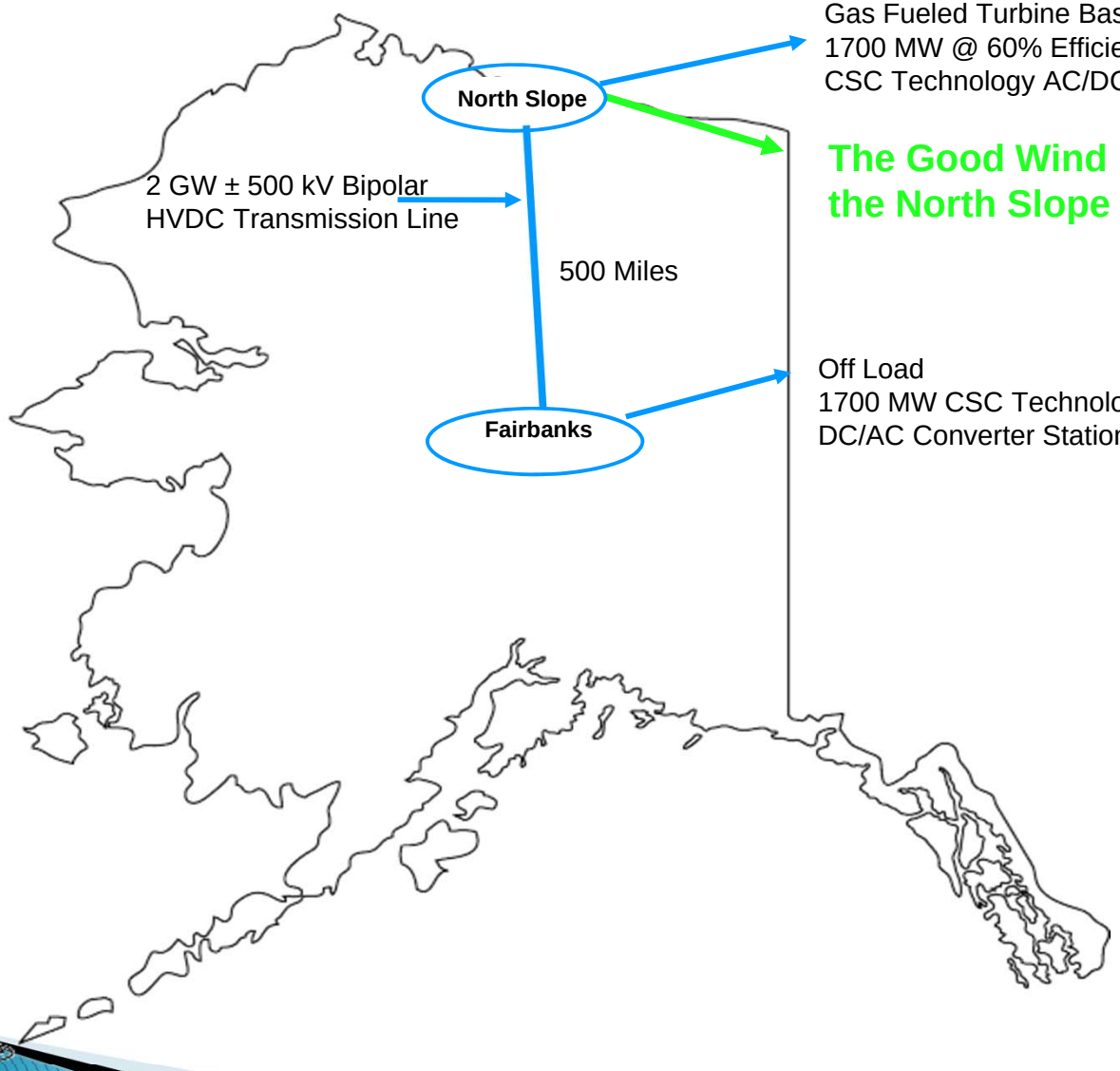
Using Electricity for Heat

At $5 per gallon, diesel used in an 80% efficient furnace costs the equivalent of 16.3 ¢/kWh.

A 2.5 GW gas fired power plant on the North Slope, together with HVDC transmission lines, could energize the entire Railbelt, power Prudhoe Bay oil field activities and provide electric heat to Fairbanks for about 6.5 ¢/kWh.

It would generate 4.5 times the retail electricity sold in 2010.

Heat and Power Fairbanks



Gas Fueled Turbine Based Combined Cycle Power Plant
1700 MW @ 60% Efficiency Gas to Electricity
CSC Technology AC/DC Converter Stations

The Good Wind Power Resources of the North Slope become Available

Off Load
1700 MW CSC Technology
DC/AC Converter Station

Heat and Power Fairbanks

Capital Costs (Billion $)

Power Plant (1700 MW)	2.44
HVDC Power Line	1.05
Converter Stations	0.60
Total	**4.09**

Operating Costs ($/MWh)

Capital (30 years @ 7%)	26.57
Gas (0.208 bcf/day – Henry Hub $3.00/mcf)	18.36
O & M Gas Turbine Power Plant	12.50
HVDC Line System Maintenance (1.5%)	2.00
Insurance (0.5%)	1.65
Regulatory Fees	1.00
Property Taxes (0.5%)	1.65
Administrative & OH	1.00
	64.73($/MWh)

6.5 ¢/kWh

Heating and Powering Remote Communities

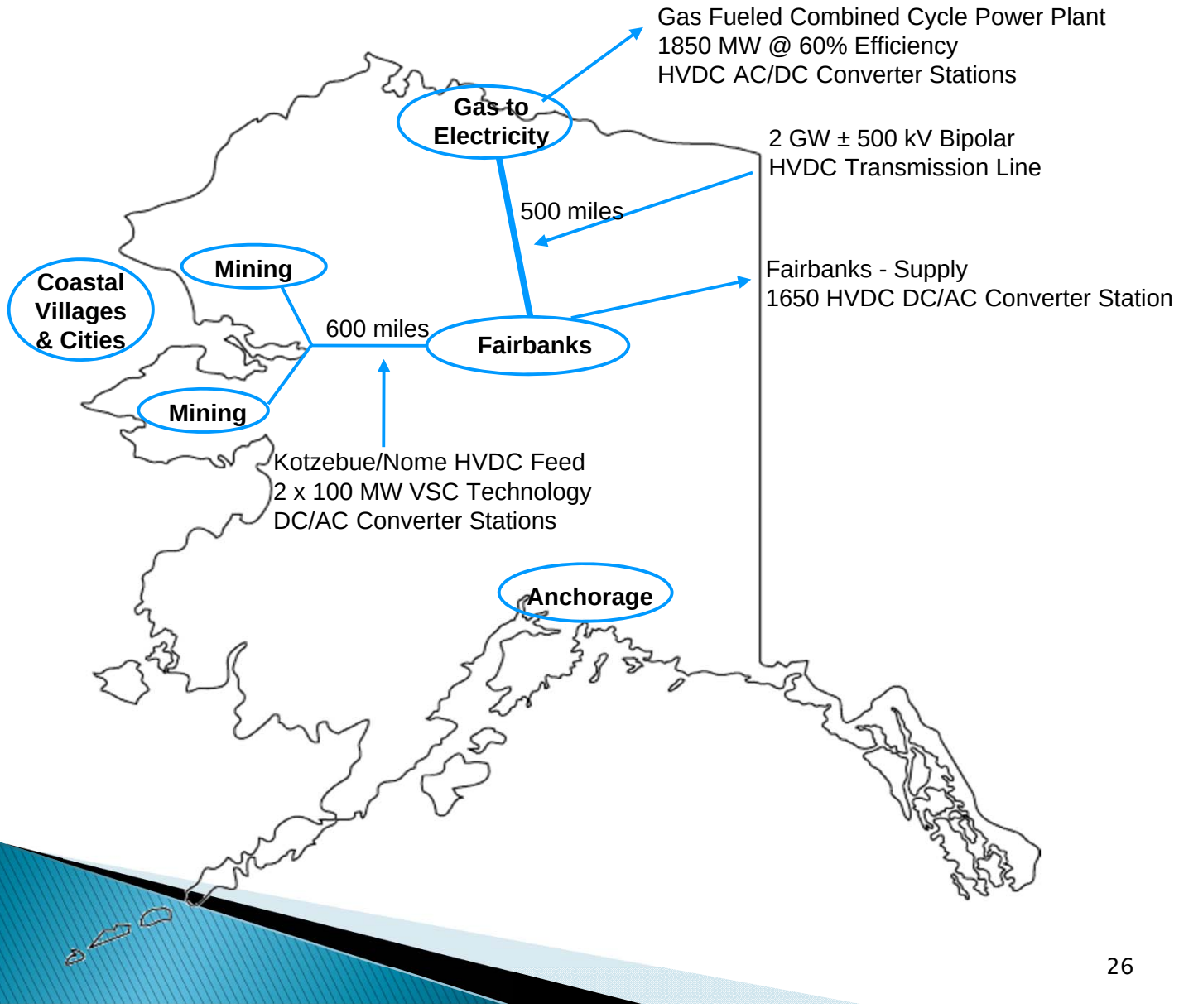
In remote communities, heat with $7 per gallon diesel costs the equivalent of 23.1 ¢/kWh. Electricity costs more than 50 ¢/kWh.

Economic development is impossible. Resource development is constrained.

Plentiful, affordable energy is

- the catalyst to transform villages from survival to viable
- the key to unlocking Alaska's remote resources
- the engine for statewide manufacturing and industrial activity

Heat and Power for NW Alaska



Heat and Power Kotzebue/Nome Area

Capital Costs (Billion $)

Power Plant (Purchase Power at Fairbanks)	0.00
HVDC Power Line (600 miles)	0.78
Converter Stations (2 x 100 MW VSC Units	0.12
Total	**0.90**

Operating Costs ($/MWh)

Capital (30 years @ 7%)	48.68
Gas (0.0 bcf/day – Henry Hub $3.00/mcf)	0.00
O & M Gas Turbine Power Plant	0.00
HVDC Line System Maintenance (1.5%)	9.06
Insurance (0.5%)	3.02
Regulatory Fees	1.00
Property Taxes (0.5%)	3.02
Administrative & OH	1.00
	65.78($/MWh)

Cost of Power at Kotzebue/Nome = (6.5 + 6.6) ¢/kWh **13.1 ¢/kWh**

Reliability/Availability of HVDC Transmission Systems

ABB (manufacturer of 2/3 of worldwide HVDC) guarantees:

Availability due to forced outages	99.0%
Availability including scheduled outages	98.0%
Single pole forced outages	1 event / 5 years
Bipolar forced outages	1 event / 25 years

Ultimately, and as is required in any electrical system, some level of local spinning reserve and stand by power generation is needed as backup.

Green House Gas/Emission Issues

CO_2 production from diesel generation reduced by ~ 60%

Heating oil replaced by electrical heating is CO_2 neutral

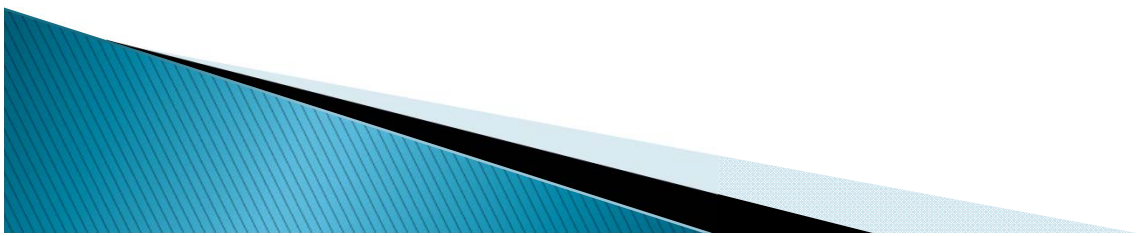
CO_2 Emissions from North Slope Operations reduced by 50% (to the extent that project production is used by Producers)

HVDC transmission grid provides the means to bring remote wind and other renewable resources to market, further reducing CO_2 production

Do We Compete with a Gas Pipeline?

Known North Slope gas reserves are **235** tcf

- 833 MW project uses 38 bcf/year, **1.14** tcf - 0.5% in 30 years
- 1.7 GW project uses 76 bcf/year, **2.28** tcf – 1.0% in 30 years
- 2.5 GW project uses 113 bcf/year, **3.4** tcf – 1.5% in 30 years



In Summary

HVDC Transmission can move power long distances at greater efficiency and better stability than conventional AC transmission.

HVDC can provide power to Alaska's remote communities as well as mining operations, military installations and fish processors.

HVDC and high-efficient gas turbine technology can:

- Energize the Railbelt
- Replace diesel oil, wood and coal used to heat Fairbanks and the rural communities.
- Energize distant mining, military and processing operations.
- Revitalize rural Alaska and create thousands of jobs.

We can ship "Made in Alaska" - not pieces of Alaska