02/27/13 Presentations: All Alaska Energy Solution, and Alaska's Energy and Air Quality Crisis

<TARGET><BILL></BILL><SUBJECT>02-27-13 Presentations All Alaska Energy Solution, and Alaska's Energy and Air Quality Crisis</SUBJECT><COMM>HENE28</COMM></TARGET>

Alaska Legislature
House Special Committee on Energy

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Agenda

Wednesday, February 27, 2013
8:00 – 10:00 a.m.
Barnes Committee Room (#124)

1) The All Alaska Energy Solution
Presented by Meera Kohler, CEO, Alaska Village Electric Cooperative

2) Alaska's Energy and Air Quality Crisis
Ward Sattler, President, Alaska Resource Agency and Dr. James Houck

Bills previously heard/scheduled

*	First hearing in first committee of referral
+	Teleconferenced
=	Bill previously heard/scheduled

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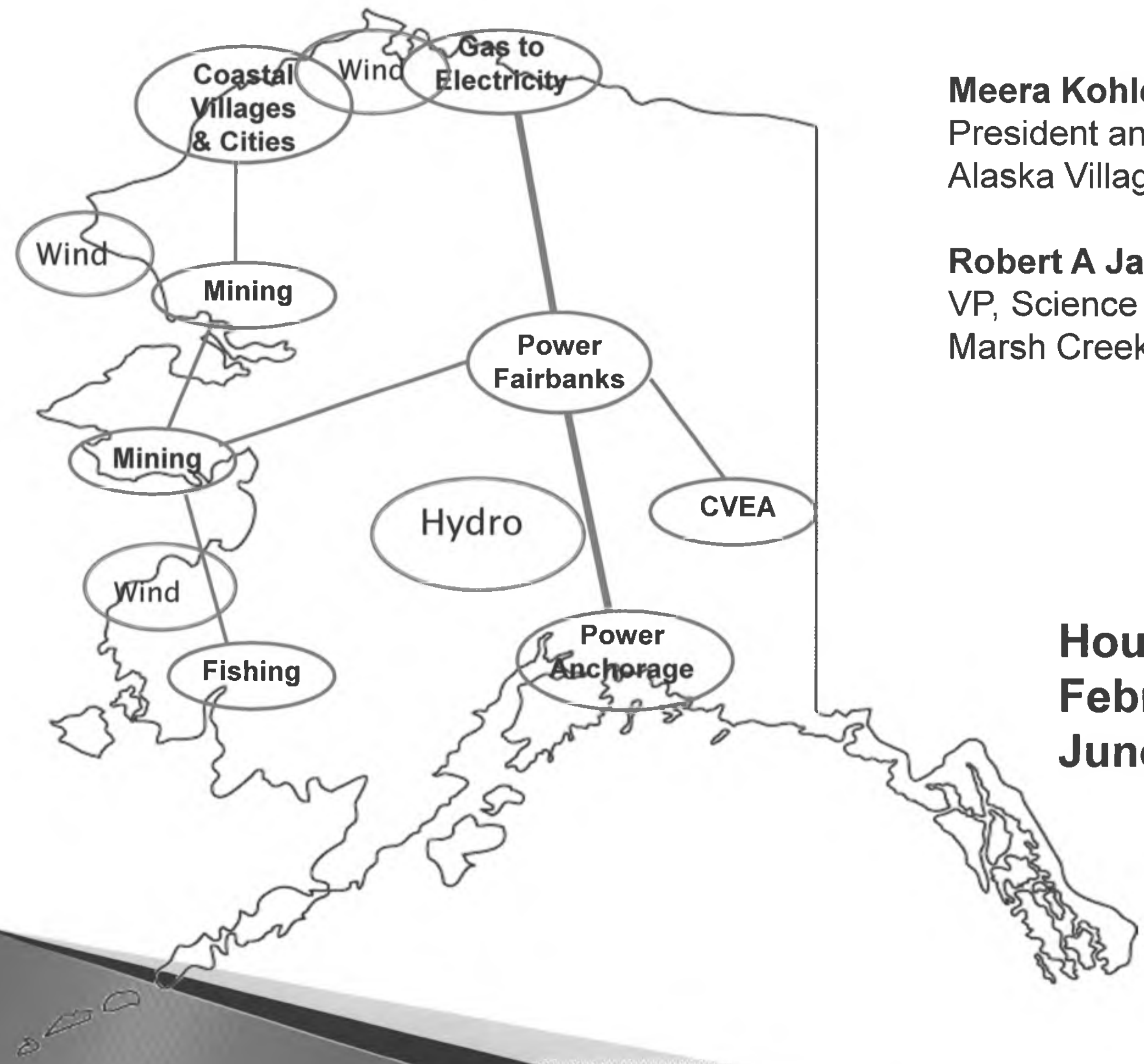
Energy Independence for Alaska - It Really is Possible!



Meera Kohler
President and CEO
Alaska Village Electric Cooperative

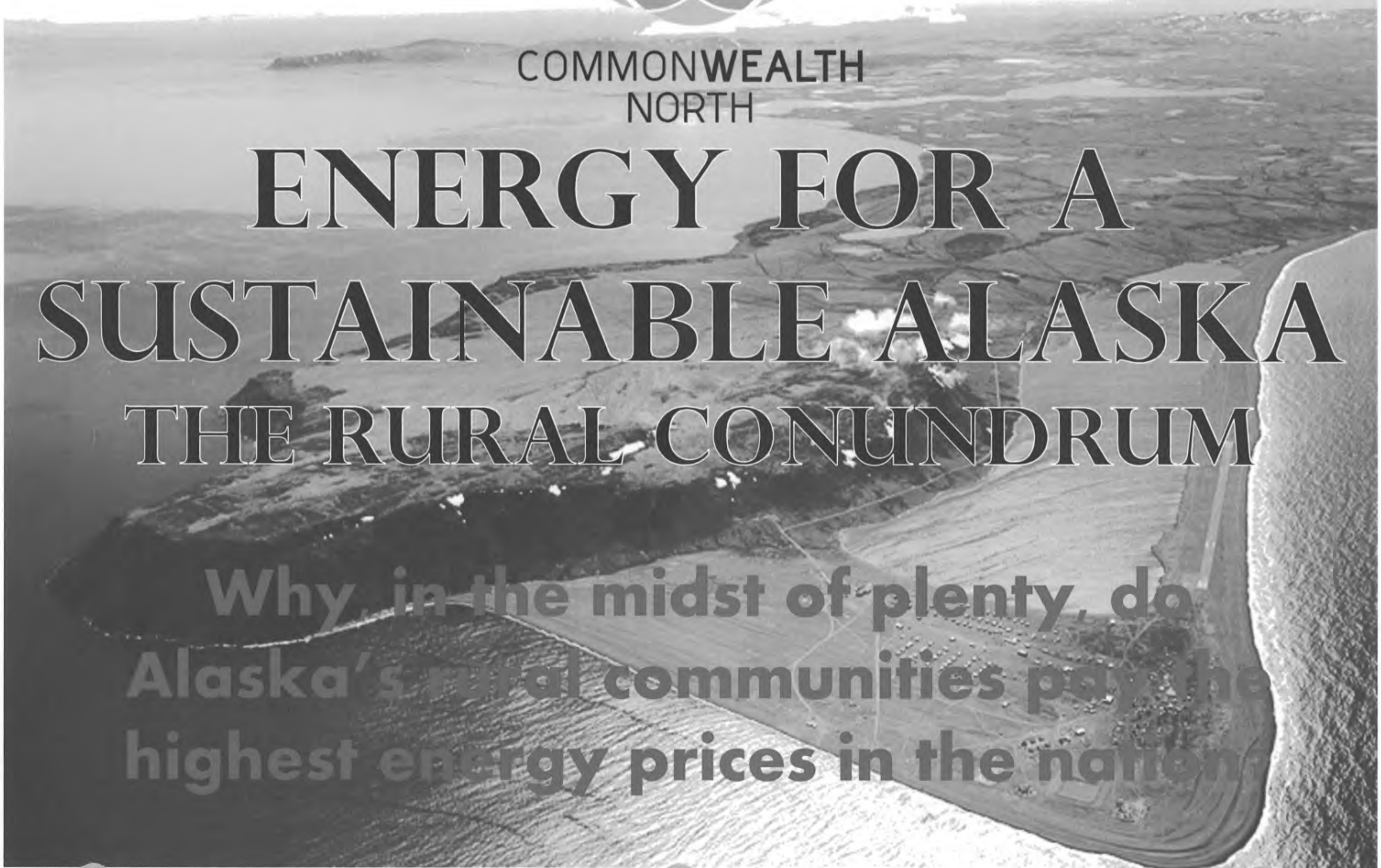
Robert A Jacobsen PhD
VP, Science & Technology
Marsh Creek LLC

House Energy Committee
February 27, 2013
Juneau, Alaska

COMMONWEALTH NORTH

ENERGY FOR A SUSTAINABLE ALASKA

THE RURAL CONUNDRUM

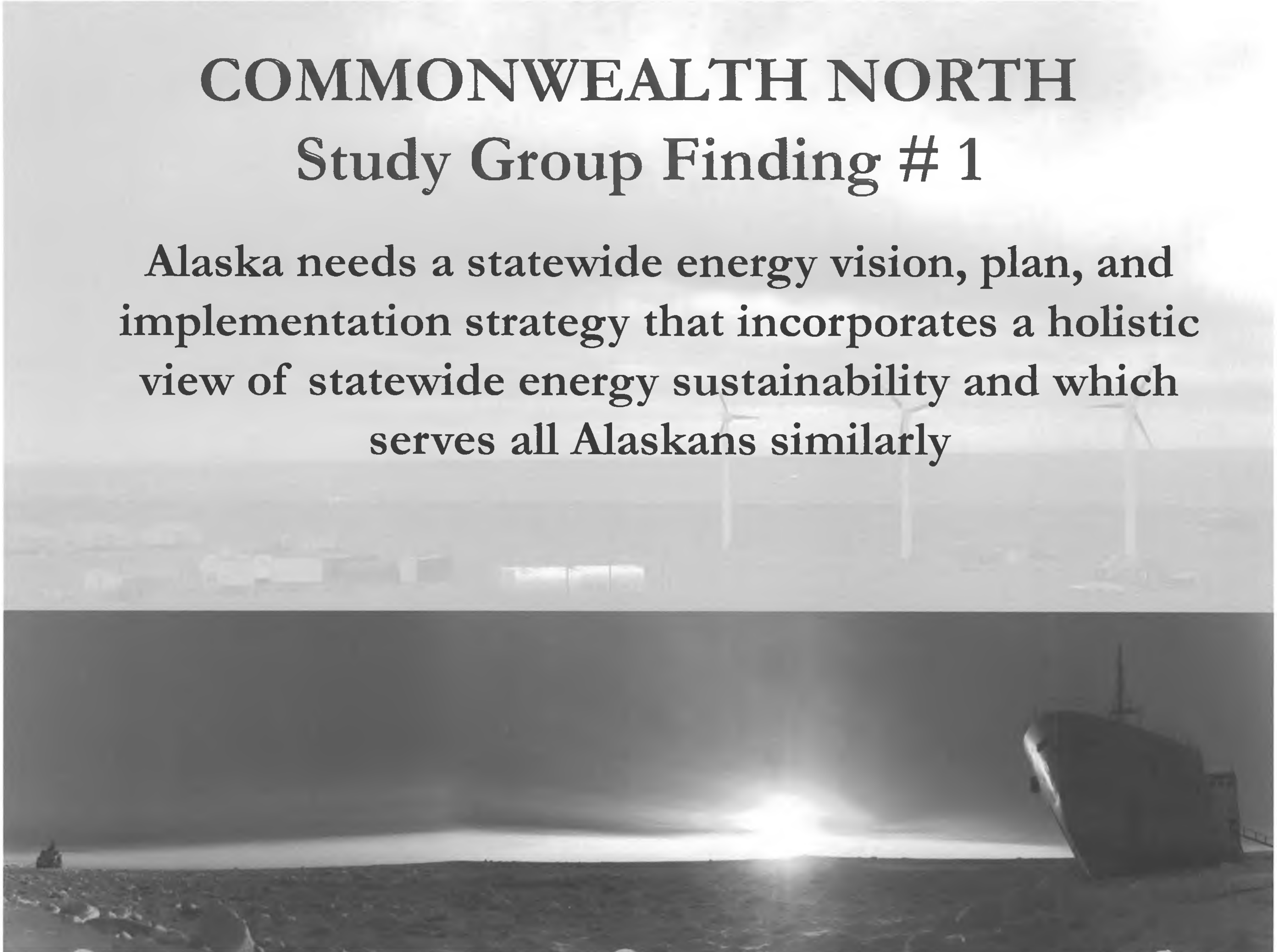


Why, in the midst of plenty, do Alaska's rural communities pay the highest energy prices in the nation?

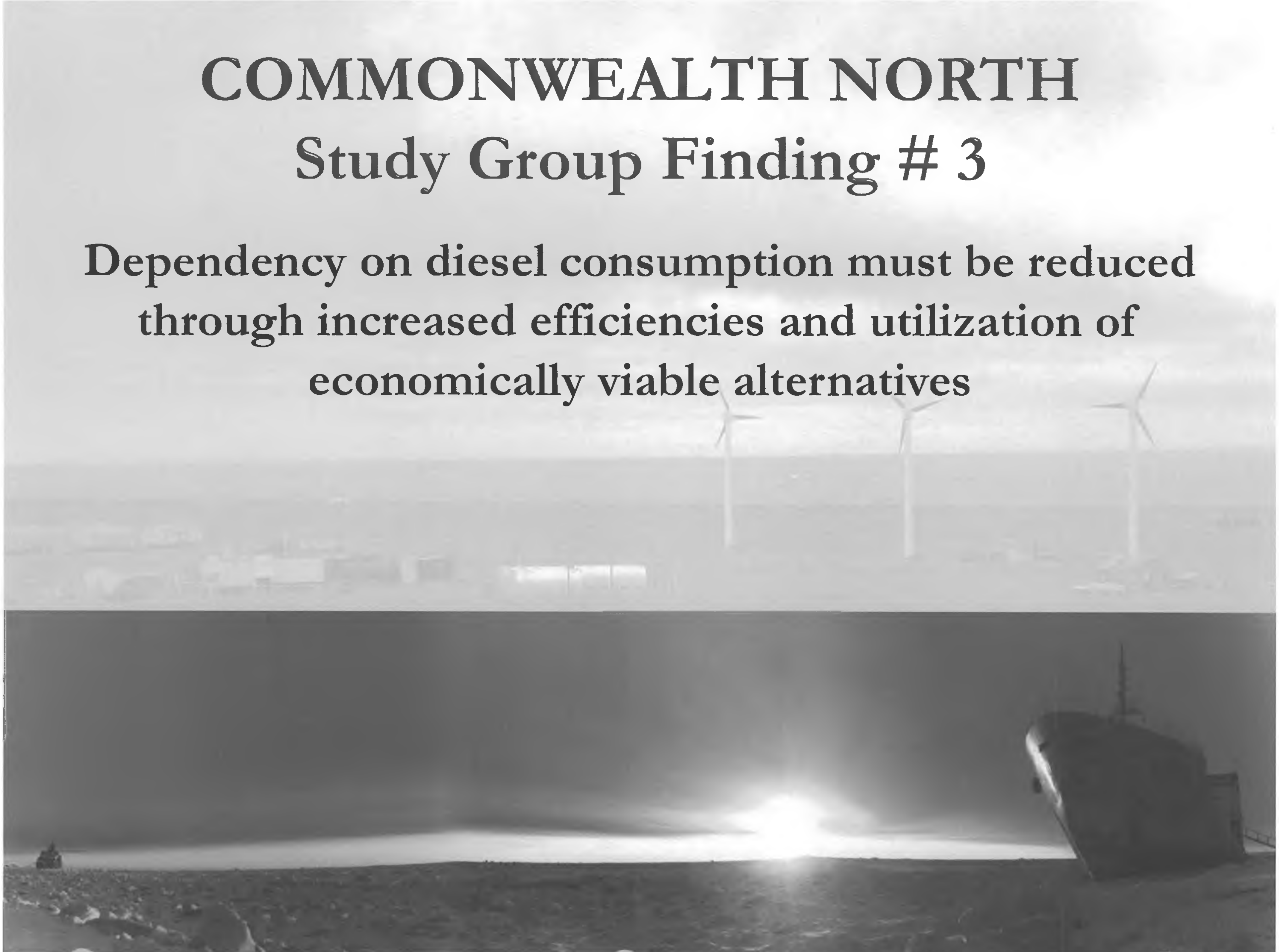
AVEC's Delivered Fuel Cost

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 $2.74 341%


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

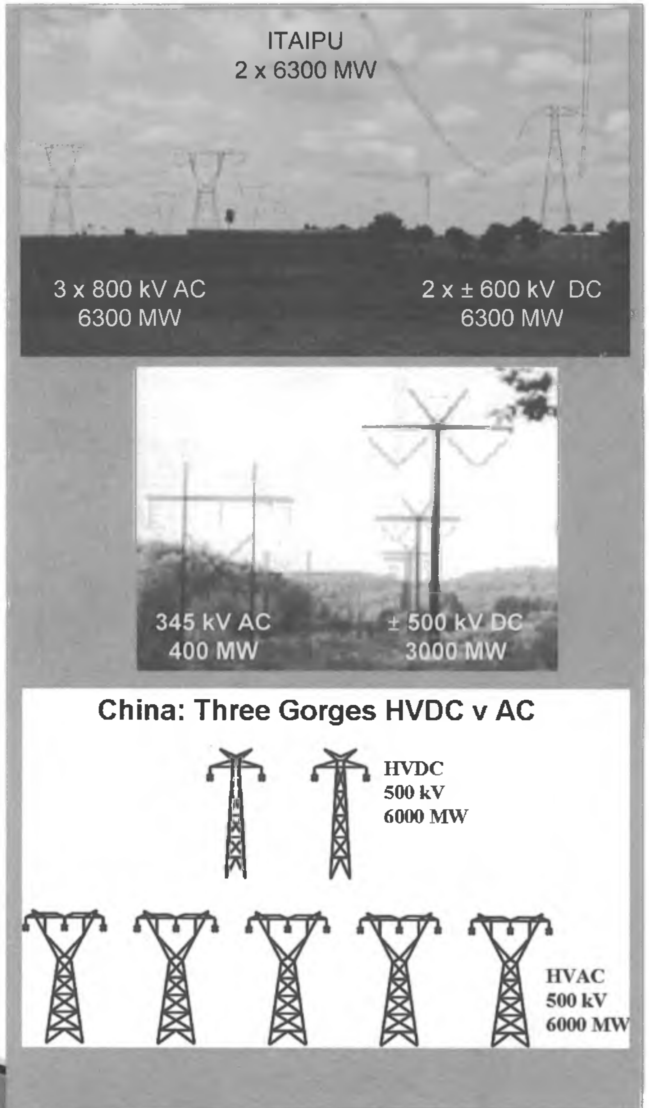
High Voltage Direct Current (HVDC) Transmission
The State of the Art

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

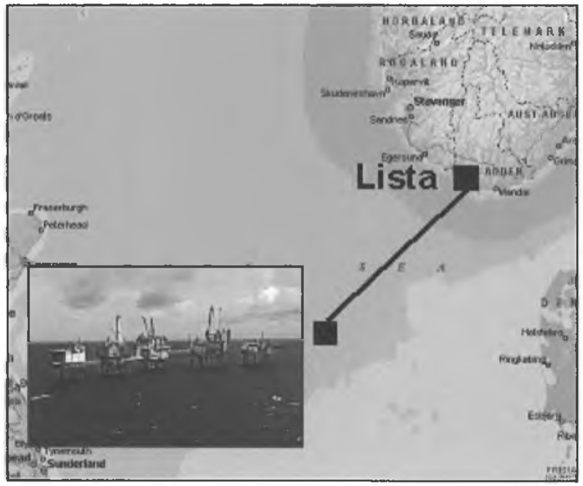


- More power on fewer lines
- Improved stability
- Lower installed cost
- Reduced losses
- Double circuit (bipolar line)
- Reduced Right of Way (ROW)

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

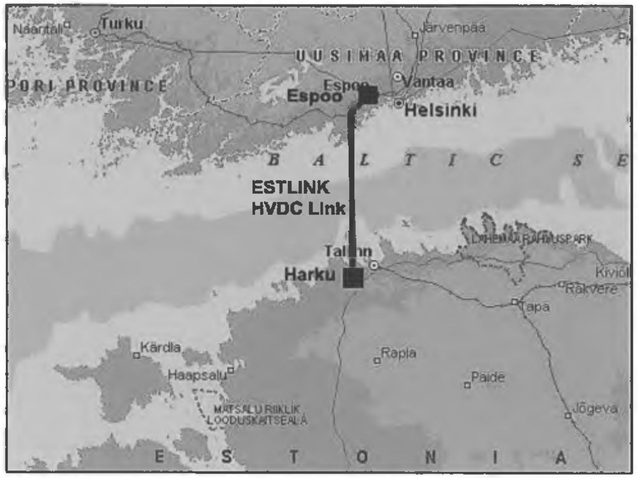


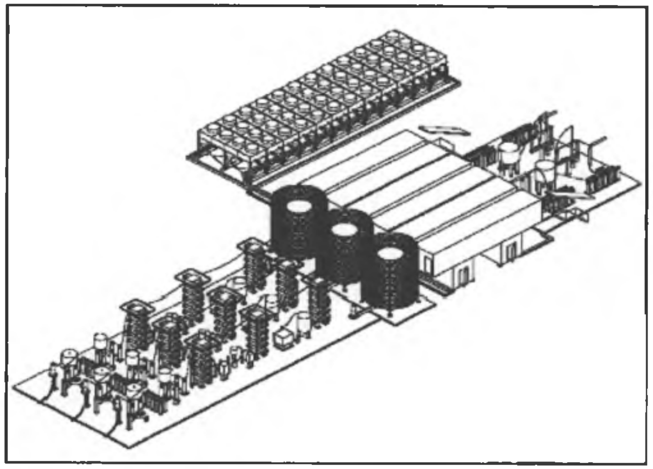
In service:	August, 2009
Power rating:	78 MW
AC Voltage:	300 kV at Lista 11 kV at Valhall
DC Voltage:	150 kV
Length of DC cable:	182 miles

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

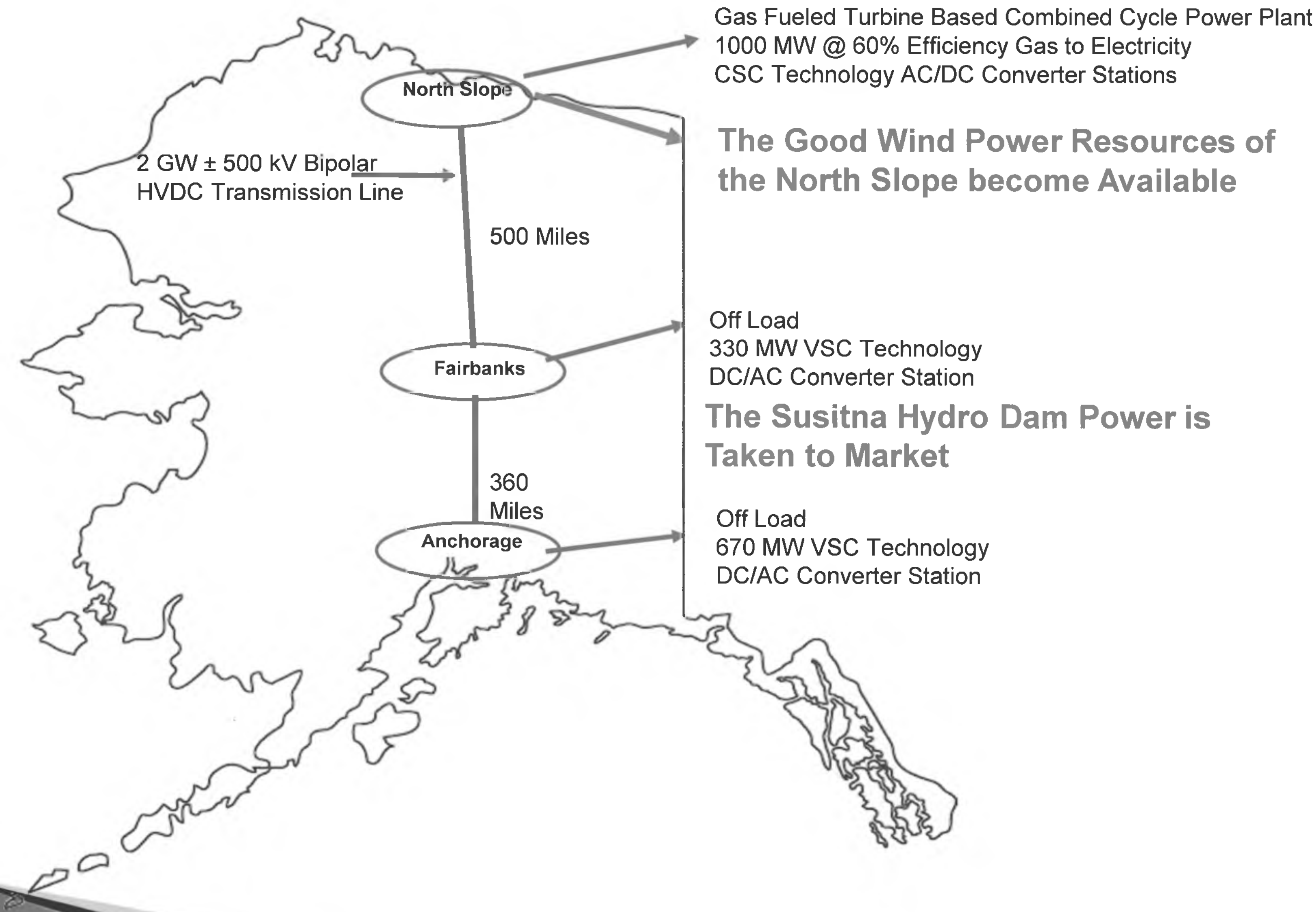
- Asynchronous Tie
- Long cable crossing
- Dynamic voltage support
- Black start

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



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

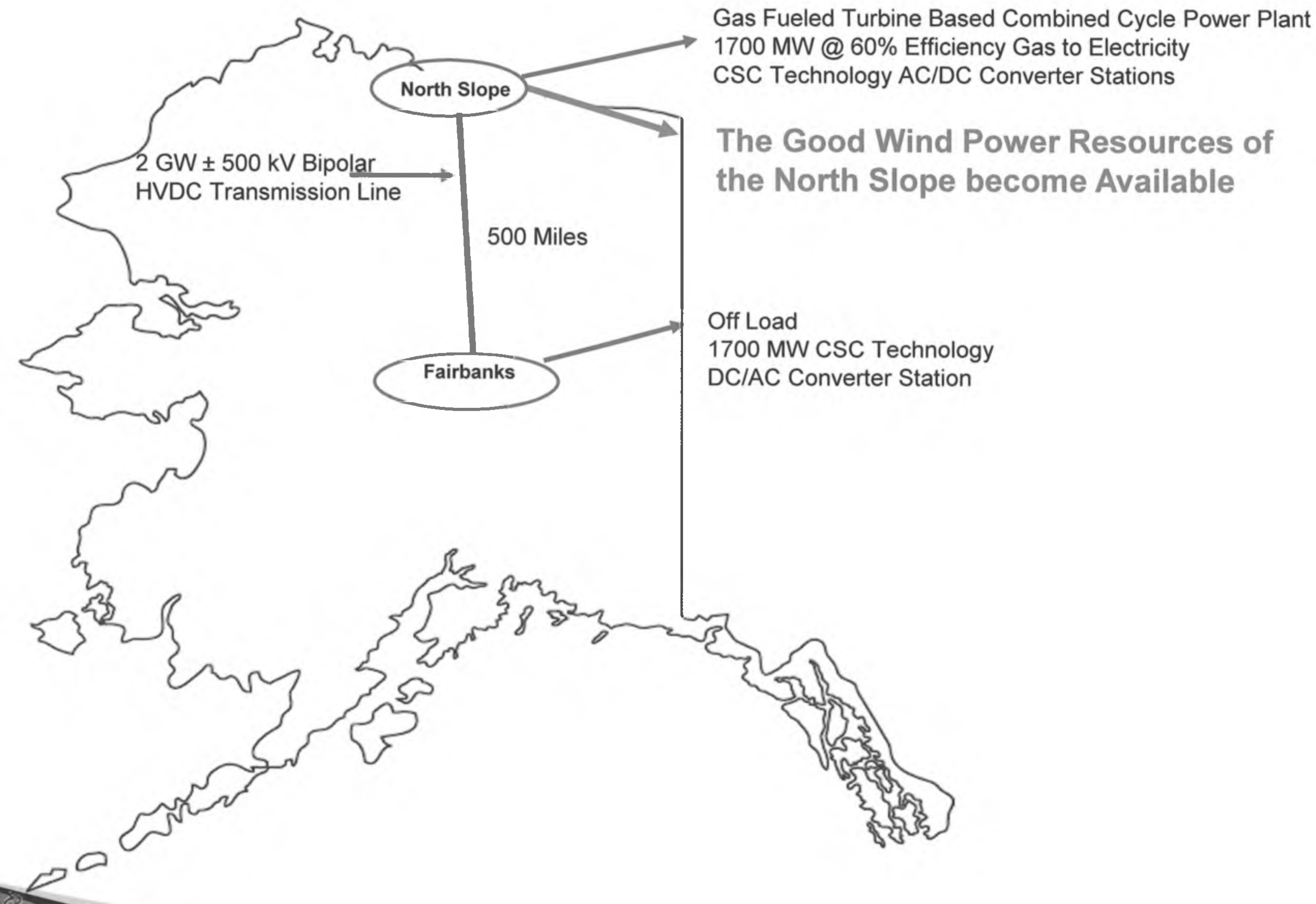
Using Electricity for Heat

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



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

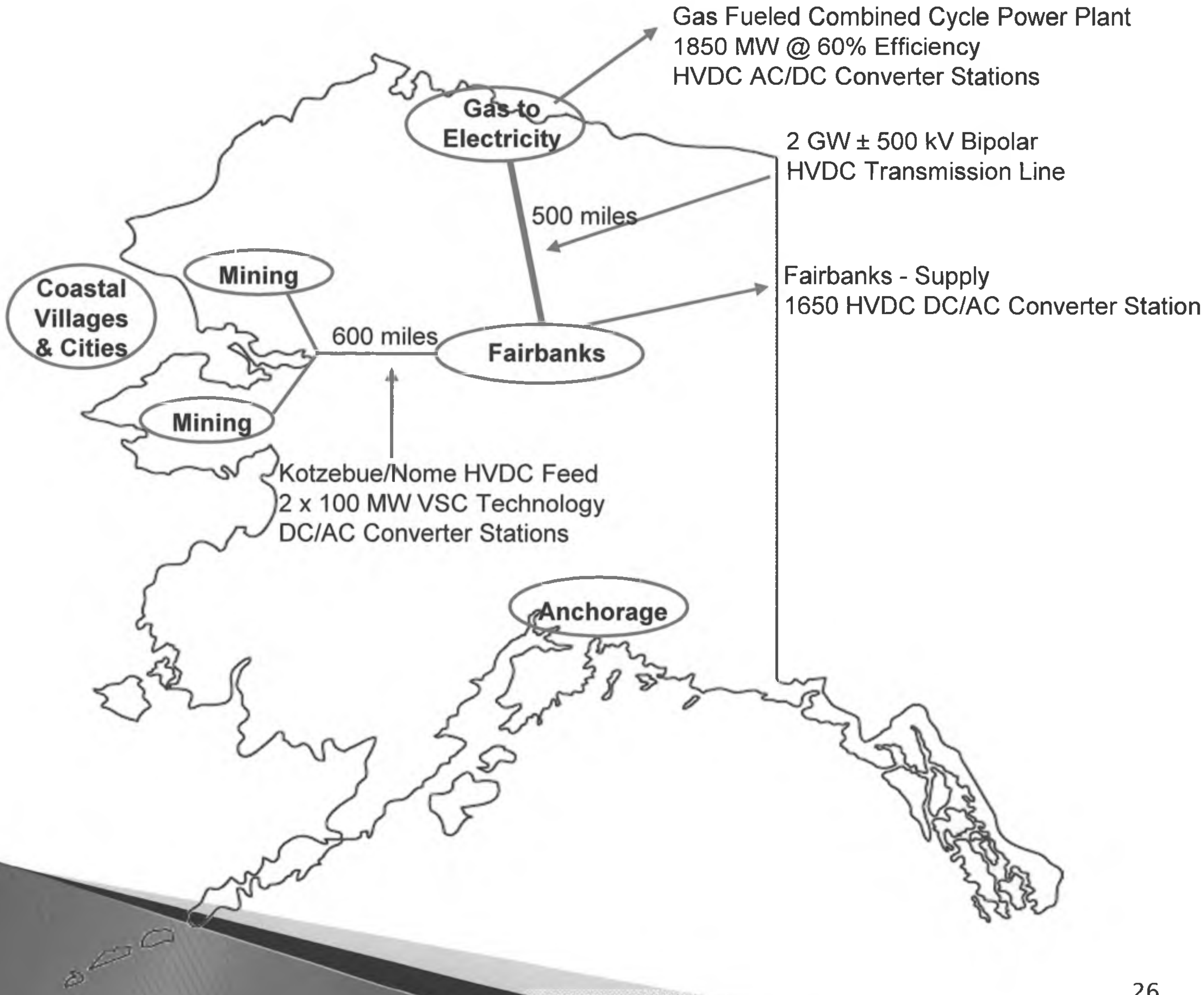
In remote communities, heat with $7 per gallon diesel costs the equivalent of 23.1 ¢/kWh. Electricity costs more than 50 ¢/kWh.

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

Speakers

Ward Sattler
President, Alaska Resource Agency

Dr. James Houck
Professor, Air Quality,
University of Portland

Sustainable Renewable Resource Solutions
for
Interior Alaska's
Energy & Air Quality Crisis

Several large scale energy projects are scheduled or proposed for completion over a decade away.

While these projects are good, what can the Interior do, in the meantime, to offset the high cost of energy and improve quality of life?

Alaska Resource Agency's Mission Statement

Introduce innovative, cost-effective solutions for clean heat & power.

Emphasizing utilization of
Alaska's vast Renewable Biomass Resources.

Why is this effort necessary?

Because the cost of energy is high, people use the most affordable fuels and appliances available to heat their homes and businesses.

The least expensive fuel, combined with antiquated appliances, leads to inefficient/high-cost heating and a serious air pollution problem.

Estimated 2014 Residential Heating Device Counts by Type and Area

Device Type	Entire FNSB	PM2.5 NA Area
1 - All Wood-Burning Devices	13,367	11,934
1a - Fireplace without insert	638	601
1b - Fireplace with insert	707	655
1c - Woodstove	11,490	10,205
Sub-total, Stoves/Inserts (1b+1c)	12,197	10,860
1b/c.u - Uncertified (<1988) Stove/Insert	2,658	2,409
1b/c.c - Certified (>=1988) Stove/Insert	9,539	8,451
1b/c.w - Cord Wood Stove/Insert	11,644	10,364
1b/c.p - Pellet Bags Stove/Insert	553	496
1d - Outdoor Wood Boiler	532	473
2 - Central Oil Furnace	29,392	26,695
3 - Portable Heater	1,892	1,700
4 - Direct Vent Heater	7,067	6,313
5 - Natural Gas Heating	1,336	1,248
6 - Coal Heat	580	502
7 - Municipal Heat	1,004	944
8 - Electric	1,048	920
9 - Other	2,388	2,095
All Devices	58,074	52,351

Detroit Free Press

February 18, 2013

"High pollution creates a thick haze in Beijing last month. At times, the air quality in parts of Alaska has been worse than in **Beijing**." / NG HAN GUAN/ASSOCIATED PRESS

Los Angeles Times

Fairbanks area, trying to stay warm, chokes on wood stove pollution

By Kim Murphy, Los Angeles Times *February 16, 2013, 6:17 p.m.*

"Wood-burning stoves give the Fairbanks, Alaska, area some of the worst winter air pollution in the country."

All the major State and private ventures intended to reduce energy costs and PM2.5 emissions from wood smoke are years away.

Best case scenario for Susitna Dam Project: 2024

(per the AEA report)

Best case for a Fairbanks Gas Distribution Network--expanded to the point **that all** residents switch from wood to natural gas or propane:

2021

What market conditions are favorable for converting to natural gas?

"Switching to natural gas or propane only occurs when the cost of the gas or propane and the estimated conversion cost are **equal to or less than 90 percent** of the price of fuel oil adjusted for average oil-fired appliance efficiency, **or 110 percent** of the cost of wood adjusted for average wood stove efficiency."

"...the model indicates that wood switching will not occur in the high and medium density areas for several years depending on the specific model assumptions that are used. **In most model runs the wood switching does not occur until 2021 or so**, when the volume of gas sales has increased to the point where the fixed costs can be spread across greater gas sales volumes."

"Fairbanks North Star Borough Gas Distribution System Analysis"
June 29, 2012, Executive Summary, pages 9 and 12

With these large energy projects not projecting substantial results in air quality improvement until at least 2021, there are serious economic concerns:

While the Interior waits, what happens with?

The future of Eielson and Wainwright missions;

Federal transportation funds with lack of air quality attainment;

Retailers The Housing Market Service Industry

In terms of Public Health, and Economics, the Interior cannot afford to wait for air quality improvement from a large-scale project.

A cost-effective solution for air quality improvement, and concurrent reduction in energy costs per household, is a **new infrastructure for biomass utilization.**

Alaska Resource Agency addresses the "Interim" Energy and Air Quality problem by
administering field and R&D projects

Launched the **Air Quality Attainment** project (AQA)

The purpose of this project is to:

- **Identify** pollution sources within designated air quality "hotzones" and near sensitive areas, such as schools, and densely populated neighborhoods;
- **Reach out to the homeowner** with information on upgrading or replacing their current appliance;
- **Upgrade equipment** where necessary;
- **Teach** homeowners best burn practices and boiler/stove maintenance procedures;
- **Replace** uncertified, damaged, or old wood stoves with the latest certified equipment.

Recent Field Accomplishments

Since September, 2012

- Inspected and maintained (45) indoor appliances;
- Installed (25) indoor appliances now emitting under 2.6 grams/hour;
- Inspected & repaired/maintained (61) outdoor wood boilers;
- Installed (42) pollution control devices;
- Replaced (5) large outdoor wood boilers with unit emissions well under EPA's pending emission standards;

Progress is being made

Between the Air Quality Attainment Project and FNSB's wood stove Change-out Program, nearly **1,000** units have been upgraded, removed, or replaced in the past two years.

And this figure does not include privately purchased upgrades.

Unique Features of the Program

- Residents, and businesses, can apply online (www.AlaskaResourceAgency.com)
- The program can upgrade, replace, and help maintain any solid fuel burning appliance;
- Equipment costs and potential renovation costs are covered; many applicants are **low income** households;
- Stoves are replaced with only the cleanest, commercially available units with comparable BTU output;
- All installations are followed-up on with personal visits to ensure proper equipment performance and address any operation concerns;
- There is a focus on the **hotzones** within the non-attainment area to address immediate air quality complaints;
- All original furnaces must be removed and rendered inoperative. ARA is the only entity that can guarantee former furnaces are removed.

3 Key R&D activities

- **Pollution Control Device** (PCD) development for
  - Outdoor Hydronic Heaters (Outdoor Wood Boilers)
  - Wood stoves

An example of a Pollution Control Device:

This is a catalyst, with an intelligent controller to regulate heat and air flow.

Visible Emissions can be reduced by **90%** with Catalytic Technology

Similar technology used to reduce vehicle emissions since the 1970s.

Emission Control Technology

- **Improving Furnace Design**
  - Testing for Efficiency and Emissions (at EPA certified laboratories)
    - ❖ Integrating Catalytic Emission Control Technology into a Hydronic Furnace. This increases efficiency by reducing the time it takes for the water jacket to reach temp. and eliminates most emissions throughout the **entire** burn cycle.

Joining me to discuss the economic and health aspects of upgrading equipment through a community-wide change-out effort is **Dr. James Houck**.

Jim Houck received his Ph.D. in Chemical Oceanography from the University of Hawaii, his M.S. in Environmental Chemistry also from the University of Hawaii, and his B.S. in Chemistry from the University of Arizona. He has been involved in the field of air quality since 1980. He currently is an independent consultant, and adjunct professor of air quality.

Wood Heater Change Outs – A Reality Check

James E. Houck, Ph.D.

Benefits of Change Outs

- <u>**Health**</u> – Reduced Air Pollutants
- Contribute to the goal of attainment of federal fine particulate ($PM_{2.5}$) standards (NAAQS)
- Reduced number of home fires – less creosote (fewer chimney fires)
- Safer Units – fewer burns, less indoor carbon monoxide exposure, plus hearth and chimney inspection at time of installation
- New units have higher efficiencies – less fuel consumed – lower fuel cost for home occupants

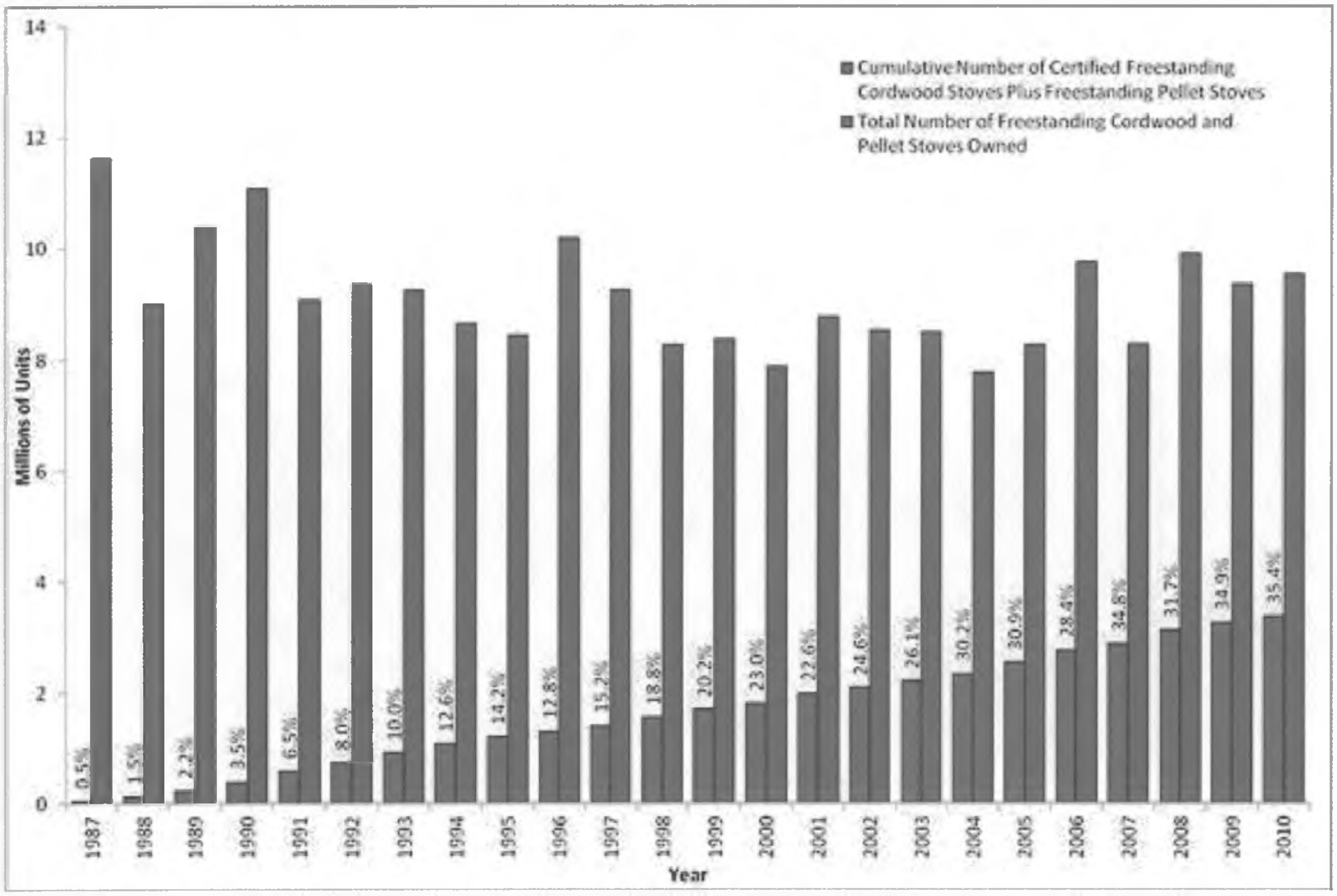
Documented Clean Wood-Burning Candidates for Installation

- Cordwood Stoves (Catalytic and Non-catalytic), new EPA certified units (40 CFR, NSPS)
- Cordwood Inserts – essentially same as stoves but designed to fit into existing fireplace cavity, EPA certified units
- Outdoor Cordwood Boilers, a.k.a. hydronic heaters, EPA qualified units (also indoor and pellet fueled) http://www.epa.gov/burnwise/owhhlist.html

Documented Clean Wood-Burning Candidates for Installation (cont.)

- Pellet Stoves, Inserts, and Furnaces – all clean burning as compared to cordwood stoves, some EPA certified, some boilers qualified
- Fireplaces – EPA qualified units http://www.epa.gov/burnwise/fireplacelist.html
- Masonry Heaters – all clean burning, high cost, upper end homes only
- Fireplace Retrofits – EPA qualified units http://www.epa.gov/burnwise/fireplacelist.html

Opportunity for Change Outs – Nationwide Most Stoves are Still Old, High- Emitting Units



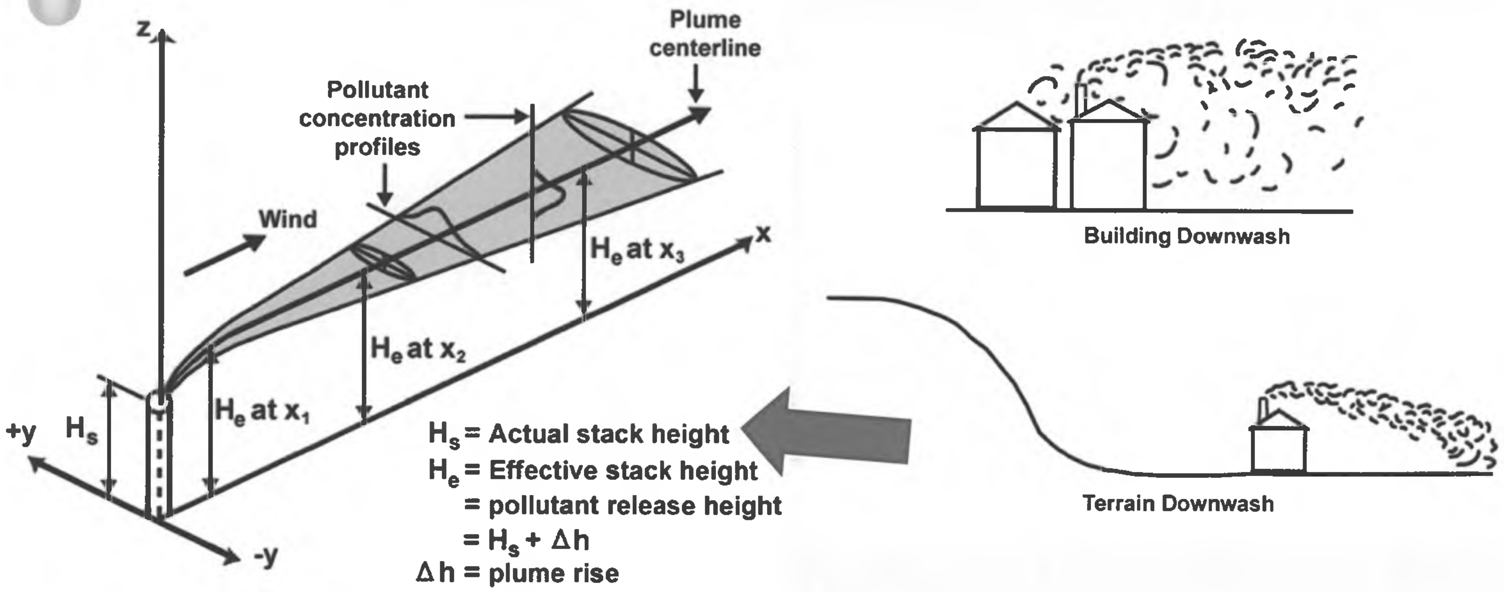
Health Concerns

Majority of wood-burning air emissions are health injurious, incomplete combustion of organic compounds

- Carbon Monoxide
- Respirable Particles, solid or liquid droplets, less than 1 micron in size from combustion sources
- Volatile Organic Compounds (VOC), vapor phase

Exposure

- Discharge at only 10 ft to 30 ft above ground level exacerbates human exposure
- 41 million single-story homes (32%)
- 43 million two-story homes (33%)
- 8.7 million manufactured and mobile homes (7%)

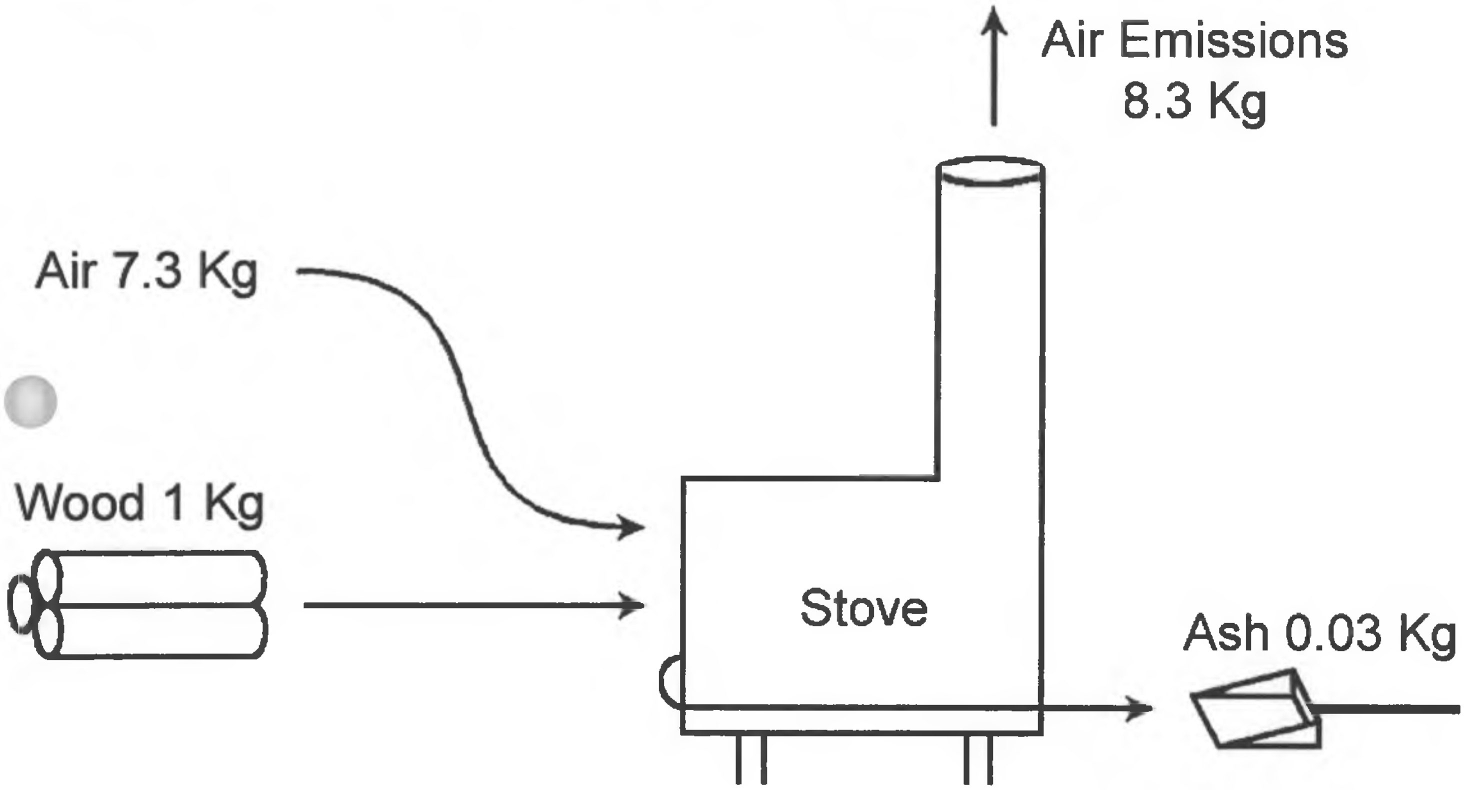


Exposure

Individuals most sensitive to air pollutants (very young, very old, infirm) spend most of their time indoors in residential settings where the home heaters are located

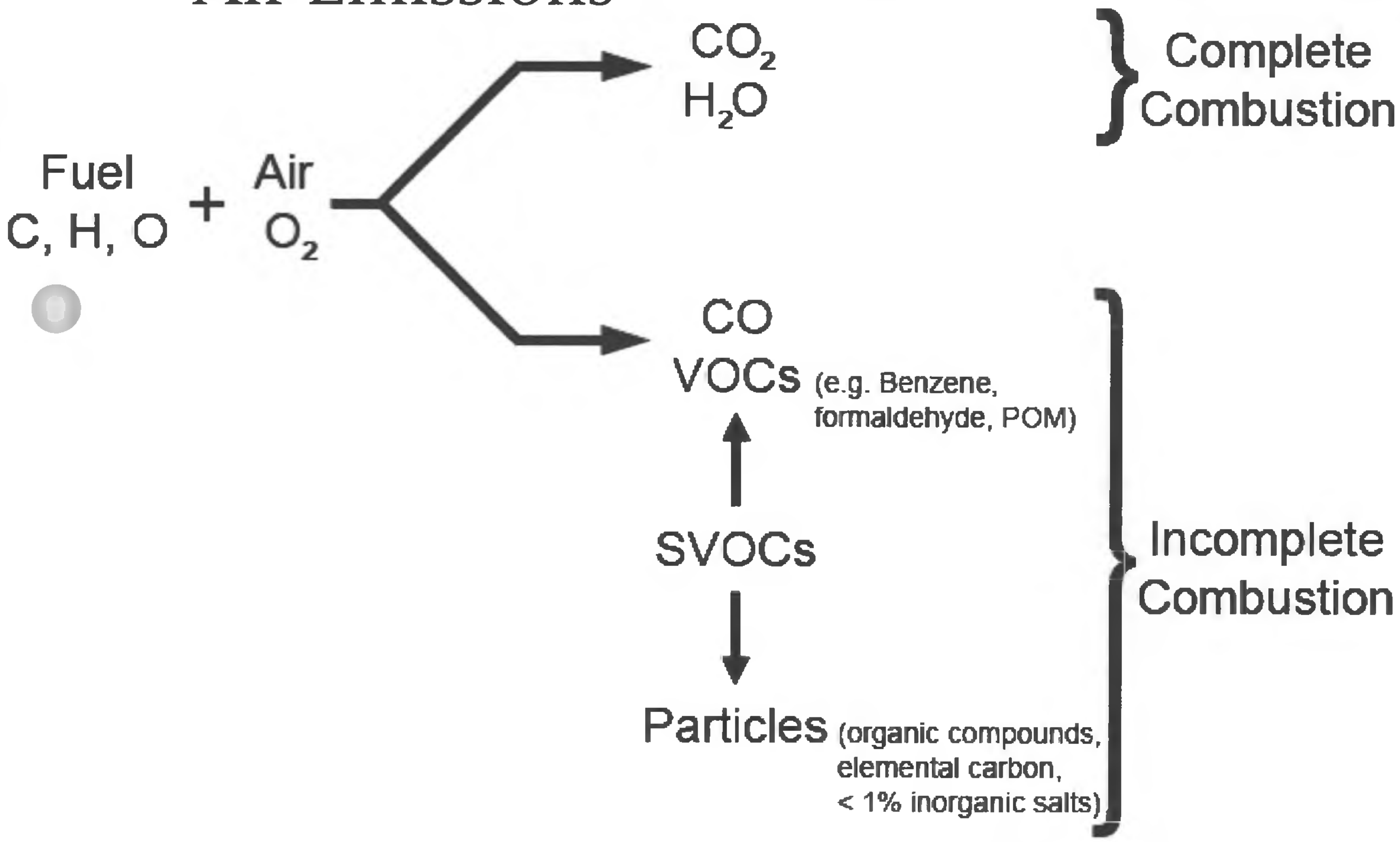
Indoor air originates from outdoor air – Occupied Single-Family Houses – 0.5 to 2.5 air exchanges per hour

Origin of Air Emissions – Mass Balance



20% Moisture Douglas Fir Fuel, Conventional Woodstove, Low Burn Rate

Characteristics of Air Emissions



Health Concerns

- Carbon Monoxide – Even though there are ambient and industrial standards, no level is good, carboxyhemoglobin
- Particles from combustion (< 1 μ) reach the deepest levels of the lungs, chemical exchange with blood, particles from wood-burning emissions are appx. 90% organic compounds, many are toxic, mutagenic, or carcinogenic
- Volatile Organic Compounds (VOC) – many are toxic, mutagenic, or carcinogenic

Conventional Uncertified Wood Heater Title III Hazardous Air Pollutants

Pollutant	Emission Factor (g/Kg)
Acetaldehyde	0.308 g/Kg
Acetophenone	0.010 g/Kg
Acrolein	0.046 g/Kg
Benzene	1.08 g/Kg
Biphenyl	2.43 mg/Kg
1,3-Butadiene	0.197 g/Kg
Catechol	0.331 g/Kg
o, m and p-Creosols	0.080 g/Kg
Dibenzofurans	1.9 mg/Kg
Ethyl benzene	ND
Formaldehyde	0.727 g/Kg
Hexachlorbenzene	13 ng/Kg
Hexane	0.012 g/Kg
Methanol	3.24 g/Kg
Naphthalene	0.091 g/Kg
Phenol	0.147 g/Kg
Polychlorinated biphenyls	0.50 pg/Kg (PCB_{TEQ})
Propionaldehyde	0.096 g/Kg
Styrene	0.117 g/Kg
2,3,7,8-Tetrachlordibenzo-p-dioxin	2.30 ng/Kg ($Dioxin_{TEQ}$)
Toluene	0.320 g/Kg
o, m and p-Xylenes	0.099 g/Kg
Polycyclic Organic Matter	0.315 g/Kg (16-PAH)

Appliance	Particulate Emissions Factor		
	Pounds/Ton	Grams/Kilogram	Reduction (%)
Conventional Stove	37	18.5	--
Non-Catalytic Stove	12	6	68
Catalytic Stove *	13	6.2	65
Pellet Stove	4	2	89
Masonry Heater	6	3	84
Conventional Stove with Densified Fuel	25	14	24

Reduction in Emissions

Conventional = Uncertified

Appliances	Efficiency (%)	Mass Particulate Emissions/Delivered Heat		
		lb/MBtu	g/MJ	Reduction (%)
Conventional	54	3.89	1.68	-
Non-cat. Stove	68	1.14	0.49	71
Catalytic Stove*	72	1.02	0.44	74
Pellet Stove	78	0.31	0.13	92
Masonry Heater	58	0.59	0.25	85
Conv. with Densified Fuel	57	2.79	1.20	27

Certified Woodstoves Continue to Improve

Comparison of Average Certified Emission Rates for Old and New Phase 2 Cordwood Stoves

Time Period	Woodstove Type	Number of Stoves	Average Emission Rate (g/hr, 5H equivalent)	Percent Reduction (%)
First 5 years of certification (1988-1992)	Non-catalytic	115	5.1	-
	Catalytic	110	2.9	-
Currently certified woodstoves (certified or renewed in the last 5 years)	Non-catalytic	137	4.1	19.6
	Catalytic	23	2.7	6.9

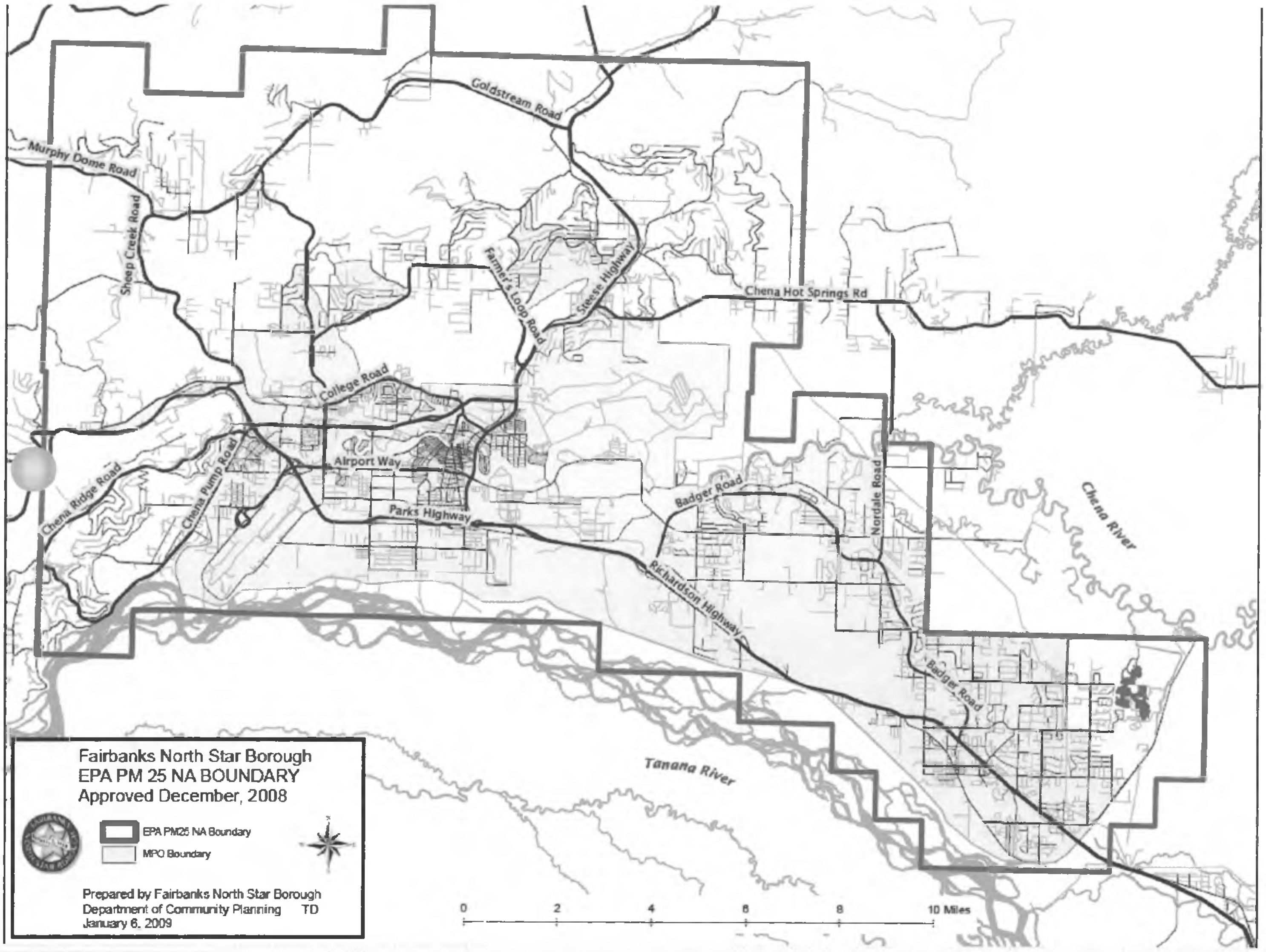
"last 5 years" was 2000 to 2005

Outdoor Wood Boilers Have Improved Dramatically

- Average of 12 models prior to 2005 — 71.6 g/h
- Average of 27 EPA qualified models (annual average values) — 4.7 g/h

Fairbanks is Federally Nonattainment for Fine Particles a.k.a. Respirable Particles or $PM_{2.5}$

- Particles produced by combustion less than 1 micron and as such less than 2.5 microns ($PM_{2.5}$)
- 24 hour standard now 35 $\mu g/m^3$ (prior to Dec. 2006 was 65 $\mu g/m^3$)
- Annual standard now 12 $\mu g/m^3$ (prior to Dec. 2012 was 15 $\mu g/m^3$)



Fairbanks North Star Borough
EPA PM 25 NA BOUNDARY
Approved December, 2008
EPA PM25 NA Boundary
MPO Boundary
Prepared by Fairbanks North Star Borough
Department of Community Planning TD
January 6, 2009
0 2 4 6 8 10 Miles
Goldstream Road
Murphy Dome Road
Sheep Creek Road
Farmer's Loop Road
Steese Highway
Chena Hot Springs Rd
College Road
Airport Way
Chena Pump Road
Chena Ridge Road
Parks Highway
Badger Road
Nordale Road
Richardson Highway
Chena River
Tanana River

More fuel burned (fuel oil, wood, coal, waste oil, motor vehicle fuel) in cold weather plus temperature inversions more common in cold weather

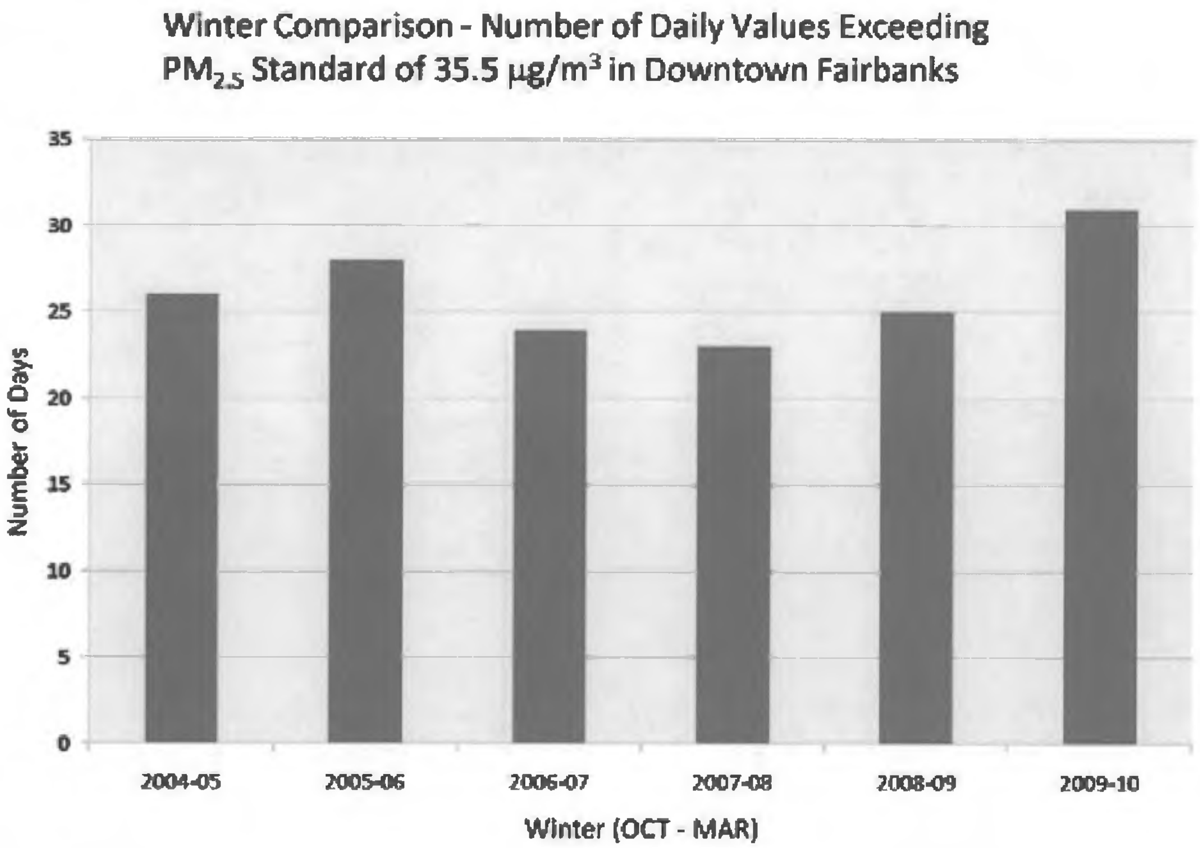


Table 6: Summary statistics for Fairbanks State Office Building site, 2004 to 2009.

	2004	2005	2006	2007	2008	2009
Max 24-hour concentration						
Days above standard						
Annual 98th percentile value	46.2	40.6	**42.2**	33.1	**46.7**	**51.0**
24-hour design value	40					
		40				
			43			
				39		
					41	
						44
Annual design value	10.9					
		10.5				
			11.1			
				11.0		
					11.2	
						11.2

Wood Heater Change Outs and Attainment

- Number of 24-hour wintertime exceedances most likely to be reduced by wood heater change outs
- With the lowering of the federal annual standard from 15 $\mu g/m^3$ to 12 $\mu g/m^3$ in Dec. 2012 and continued future growth, wood heater change outs may be of value for future attainment of annual standard (see annual design values in previous slide)
- Wood heater change outs may contribute slightly to the maintenance of the urban Fairbanks CO attainment – most CO from vehicles

Safety

- Wood heating stoves and fireplace inserts responsible for **11,000 home fires** per year in the U.S. causing **228 civilian deaths** and more than **$366 million dollars** in property damage (NFPA 2003-2006)
- **190 deaths** per year due to carbon monoxide poisoning from space heaters (CPSC 1999-2002)
- Creosote buildup in chimneys and chimney connectors is responsible for another **25% of home heating fires**

Cost Savings Due to Increased Efficiency

- Assume 5 cords/yr in uncertified stove
- Assume $275/cord
- Assume 54% efficiency for uncertified stove and 68% efficiency for certified non-catalytic stove
- Cost per year uncertified stove 5 X $275 = $1375
- Cost per year for certified non-catalytic stove for same heat output 5 X (54/68) X $275 = $1092
- Cost Savings $1375-$1092 = $283 or 21%
- Analogous cost savings by replacing uncertified stove with certified catalytic stove = $344 or 25%

Libby, Montana 2005-2008
Wood Heater Change Out – A Case Study

Libby – Heating Season Attribution of $PM_{2.5}$ Sources (2003/2004)

Local and regional dust (road and wind blown)	1%
Local and regional (15% regional) ammonium nitrate	5%
Local and regional (40% regional) ammonium sulfate	3%
Local wood smoke	66%
Cooking (commercial frying and grilling only considered)	1%+
Regional (background) organic compounds and elemental carbon	6%
Vehicular exhaust	7%
Heating oil	1%
Propane	<1%
Diesel exhaust from trains	3%
	Total 93%

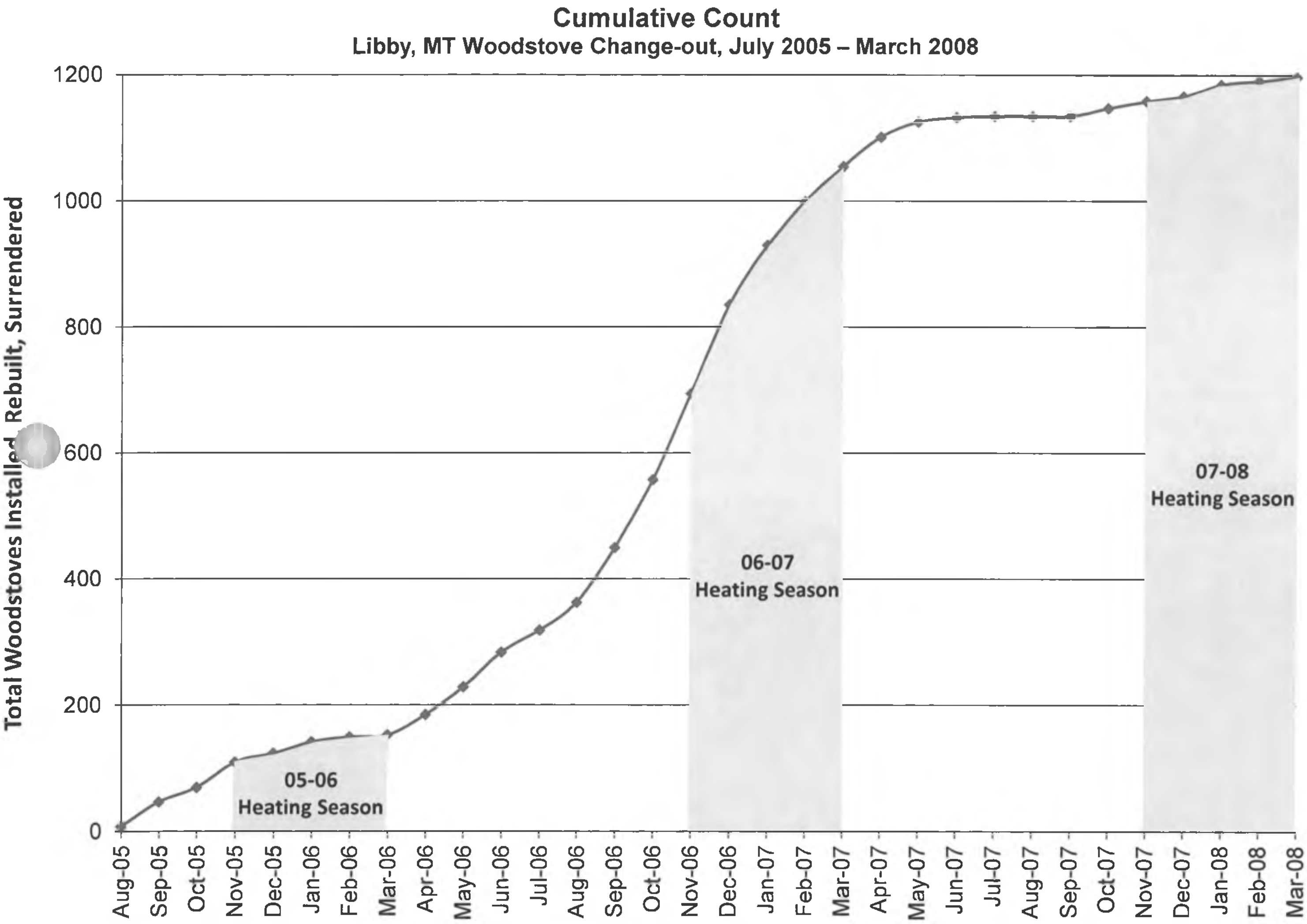
Notes: The local NH_4NO_3 and local $(NH_4)_2SO_4$ which together are about 6% of the average $PM_{2.5}$ concentration in Libby during the heating season are probably primarily from vehicular exhaust and fossil fuels emitting gaseous NO_x and SO_2, some may be from RWC. It is likely that the contribution of heating oil, vehicular exhaust, and diesel exhaust from trains is higher at the courthouse monitoring site due to its proximity to those sources and the estimate provided above for them is from an emission inventory for the airshed as a whole.

Annual and Heating Season Mean and Maximum Particulate Values

Year*	Heating Season	Means (μg/m³)		Max. 24-hr Value (μg/m³)		98th Percentile Value (μg/m³)
		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
2003		25	15.6	91	47	43
	2003-2004	35.9	27.3	76.0 (2/3/04)	42.5 (12/17/03)	
2004		28	14.0	81	40	38
	2004-2005	40.8	27.0	106.0 (2/3/05)	75.3 (1/19/05)	
2005		30	15.8	126	75	51
	2005-2006	32.7	26.0	74.0 (2/10/06)	51.1 (11/3/05)	
2006		28	15.3	100	44	41
	2006-2007	27.1	22.0	96.0 (2/17/07)	41.2 (11/1/06)	
2007		24	11.1	104	35	32
	2007-2008	27.9	22.5	44.0	42.3 (1/4/08)	
Standard		50 μg/m³ (Annual)	**15/12 μg/m³** (Annual)	No Standard	**65/35 μg/m³**	

Note: 98th percentile and not the maximum 24-hour value determines compliance with 24-hour standard, i.e., surveying every three days yields 122 samples per year whereas the top two values "don't count."

*Annual data taken from EPA Monitor Values Reports – Criteria Air Pollutants.



Note: Count is for the beginning of respective month.

Days $PM_{2.5}$ Exceeded 35 µg/m³

Year (winter)	Days Above 35 µg/m³
2004/2005	1/19/2005, (75.3 µg/m³) 1/22/2005 (52.8 µg/m³) 2/3/2005 (45.9 µg/m³) 11/5/2004 (39.7 µg/m³) 11/23/2004 (37.7 µg/m³) 2/27/2005 (35.0 µg/m³)
2005/2006	11/3/2005 (51.1 µg/m³) 12/24/2005 (47.7 µg/m³) 1/14/2006 (43.9 µg/m³) 1/17/2006 (40.5 µg/m³)
2006/2007	11/1/2006 (41.2 µg/m³) 12/22/2006 (40.0 µg/m³) 12/25/2006 (39.6 µg/m³) 11/4/2006 (36.2 µg/m³)
2007/2008	1/4/2008 (42.3 µg/m³)

Down to one!

Summary – Air Quality Reductions from Woodstove Change-out and Potential Application to Other Nonattainment Areas

	2004-2005 Mean (Pre-Change-out)	2007-2008 Mean (Post-Change-out)	Reduction
FRM $PM_{2.5}$ ($\mu g/m^3$)	27.0	22.5	16.7%
$PM_{2.5}$ Normalized* ($\mu g/m^3$)	26.7	21.7	18.7%
PM_{10} ($\mu g/m^3$)	40.8	27.9	31.6%
PAH (ng/m^3)	351.8	104.4	70.3%
Phenolic (ng/m^3)	391.4	151.0	61.4%
Organic Carbon ($\mu g/m^3$)	17.9	12.2	31.8%
Days $PM_{2.5}$ Exceeded 35 $\mu g/m^3$	6	1	—

*Using $PM_{2.5}$ data paired with days with valid HDD data.

Note: The reduction percentages among different parameters are surprisingly different.

Consumer Reasons for Selection of Wood Heating Options

- Energy independence – Non-interruptible fuel supply
- Economic and recreational value of firewood harvesting
  - 58% Minnesota survey 2007-08
  - 66% National 1993 (DOE survey)
- Green Awareness – Climate Change Advantages
  - Carbon Dioxide GHG credit for biomass
  - Methane fugitive emissions from Natural Gas
- Fuel Economy

Economy – Realistic Scenarios

- 3 households, all same heating demand, 115MBtu energy input per heating season, all heaters 80% efficient
- Household #1, Electric Furnace, 22¢/kWh = $7415
- Household #2, Fuel Oil Furnace, $4.00/gal = $3316
- Household #3, Outdoor Wood Boiler, $275/cord = $1375