Economics of HVDC Projects in Alaska

Alaska Energy Authority
Board of Directors

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Economic Analysis of HVDC in Alaska: Two Approaches

HVDC for the Railbelt

- Examines North Slope power generation delivered to the Railbelt with HVDC
- Analysis based on existing proposal
- Recommendation made for future consideration of this project

HVDC Opportunities in Alaska

- Explores other opportunities to use HVDC to supply power in Alaska
- Economics modeled based on costs provided by proponents of proposed project
- Discussion of AEA's role in developing these opportunities

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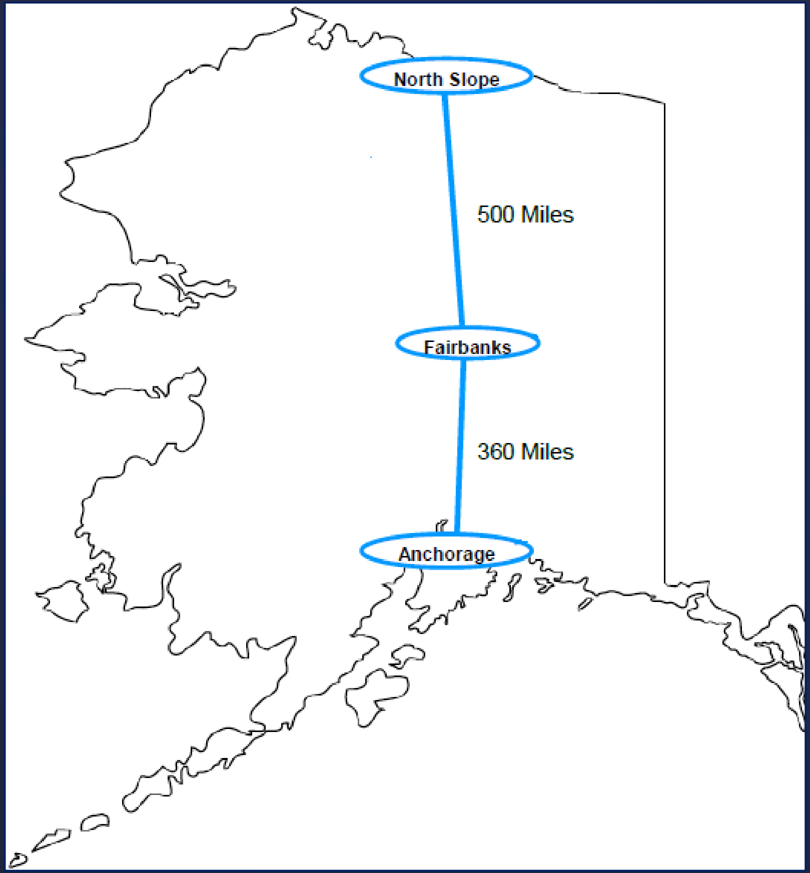
HVDC for the Railbelt



- High level analysis on the economics of a stand-alone project providing the Railbelt with North Slope power using HVDC
- This analysis is intended to provide a clear answer on the economic viability of the project
  - Avoids disputing any assumptions
  - Avoids complex modeling
- Analysis based information from existing project proposal
- Proposed by:
  - Meera Kohler, AVEC
  - Dr. Robert A Jacobsen
  - February 2013 (AK House Energy Committee)

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Economic Analysis for Railbelt HVDC

- This analysis provides a simple test to determine if the Railbelt HVDC proposal warrants further investigation
- The test can be thought of as a "thought experiment"
- The test: *Can a new power plant on the North Slope using HVDC transmission beat a new power plant on the Railbelt?*
  - If no, then it can't beat any realistic Railbelt generation scenario
  - Utilizing existing Railbelt generation capacity will only make the HVDC proposal less economic

- Three step simple test
  - Very conservative approach
  - Doesn't contest any cost assumptions in existing proposal
- Step 1: Isolate annual HVDC transmission costs
- Step 2: Calculate annual gas used by new power plant
- Step 3: Calculate the break even Railbelt natural gas price

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Step 1: Isolate Annual HVDC Costs

- Capital costs include
  - HVDC power lines
  - Converter Stations
- Annual capital costs calculated as debt service on capital
- O&M calculated from proposal
  - O&M cost per MWh multiplied by total MWh to get annual cost
- Total annual savings would need to exceed total annual HVDC costs to achieve a benefit

HVDC Annual Costs ($millions)	
HVDC Power Lines	$1,860
Converter Stations	$575
Total Capital Costs	$2,435
Term (years)	30
Interest Rate	7%
Annual Payment	$196
O&M costs per MWh	$9.81
Reported Annual GWh	6,203
Annual O&M Costs	$61
Total Annual HVDC Cost	**$257**

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Step 2: Annual Gas Used by New Plant

- Adjusted the current total Railbelt electric consumption
  - Used current power demand
  - Netted out current hydro and coal supply
- Heat rate for new power plant was calculated on the proposal's assumptions
  - Measured in Btu per KWh
  - Gas use will be lower with better heat rate

Annual Gas Demand	
Railbelt Demand (GWh)	4,294
Heat Rate	5,687
Annual Gas Use (Bcf)	**24.4**

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Step 3: Calculate Break Even Gas Price

- To break even, annual gas savings must be greater than annual cost of HVDC
- The gas price delta is how much less expensive North Slope gas must be to break even
- Adding the assumed North Slope gas price to the gas price delta gives us the break even Railbelt gas price

Break Even Gas Price	
Annual HVDC Cost ($mill)	$257
Annual Gas Use (Bcf)	24.4
Gas Price Delta ($/Mcf)	$10.53
North Slope Price ($/Mcf)	$3.00
Railbelt Gas Price ($/Mcf)	**$13.53**

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What the Break Even Gas Price Means

- We calculated a break even Railbelt natural gas price of $13.53.
- Under this thought experiment, Railbelt gas would need to cost more than $13.53 to make the Railbelt HVDC proposal economic.
- That means, if our only two choices were building a massive new power plant on the North Slope or the Railbelt, we would build one on the Railbelt (assuming gas will cost less than $13.53).
- In reality, producing power with existing Railbelt power plants is much cheaper than replacing them all with one new plant.
- Therefore, if the Railbelt HVDC proposal is more costly than building a new plant on the Railbelt it must also be more costly than producing power with existing Railbelt power plants.

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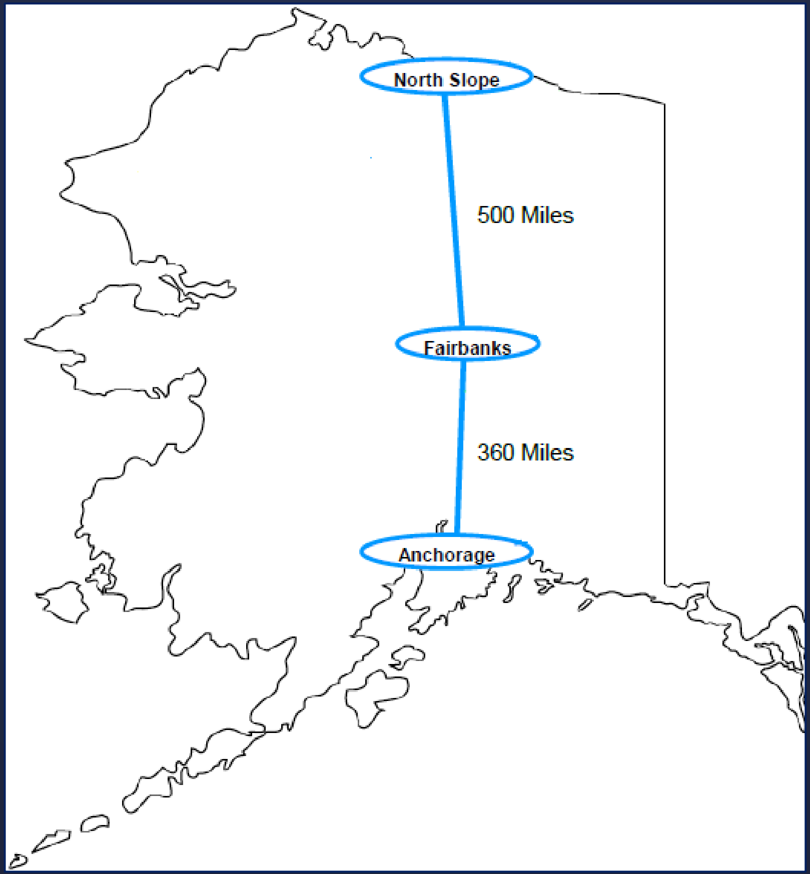
HVDC for the Railbelt



- A more extensive analysis of this proposal may not be necessary
  - The project does not pass this simple and very conservative test
  - The added costs of HVDC outweigh the benefit of low cost North Slope gas
- The break even gas price would actually be much higher than calculated here
  - A whole new power plant would not be needed on the Railbelt
  - Using more complex and realistic assumptions make the project even less economic

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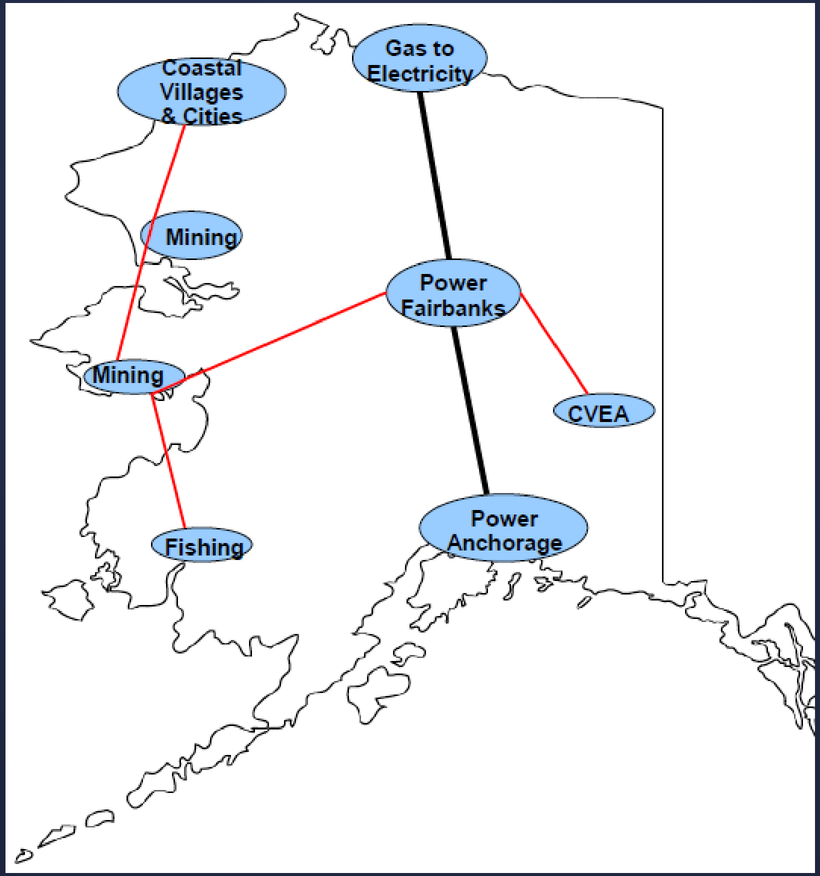
HVDC Opportunities in Alaska



- HVDC projects have been proposed to multiple Alaska markets
  - The Alaska Railbelt
  - Large mines in remote locations
  - Rural Alaska communities
- This analysis identifies potential opportunities to utilize HVDC transmission
- Does not recommend particular projects or project designs

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Economic Analysis of HVDC Opportunities in Alaska

- This economic analysis uses cost data supplied by project proponents to model the economics of different HVDC projects
- The results of the modeling are not exact, but should be accurate enough to identify opportunities in Alaska
- We model each HVDC project as a stand alone project, providing power to only one market
- Increased benefits may occur from combining markets or projects

- The economic benefit of HVDC projects is a function of three variables
  - 1: Quantity of Electricity (GWhs)
  - 2: Price differential between the ends of an HVDC line ($/kWh)
  - 3: Total annual cost of HVDC (HVDC Cost)
- Annual economic benefit = GWhs x $/kWh – HVDC Cost

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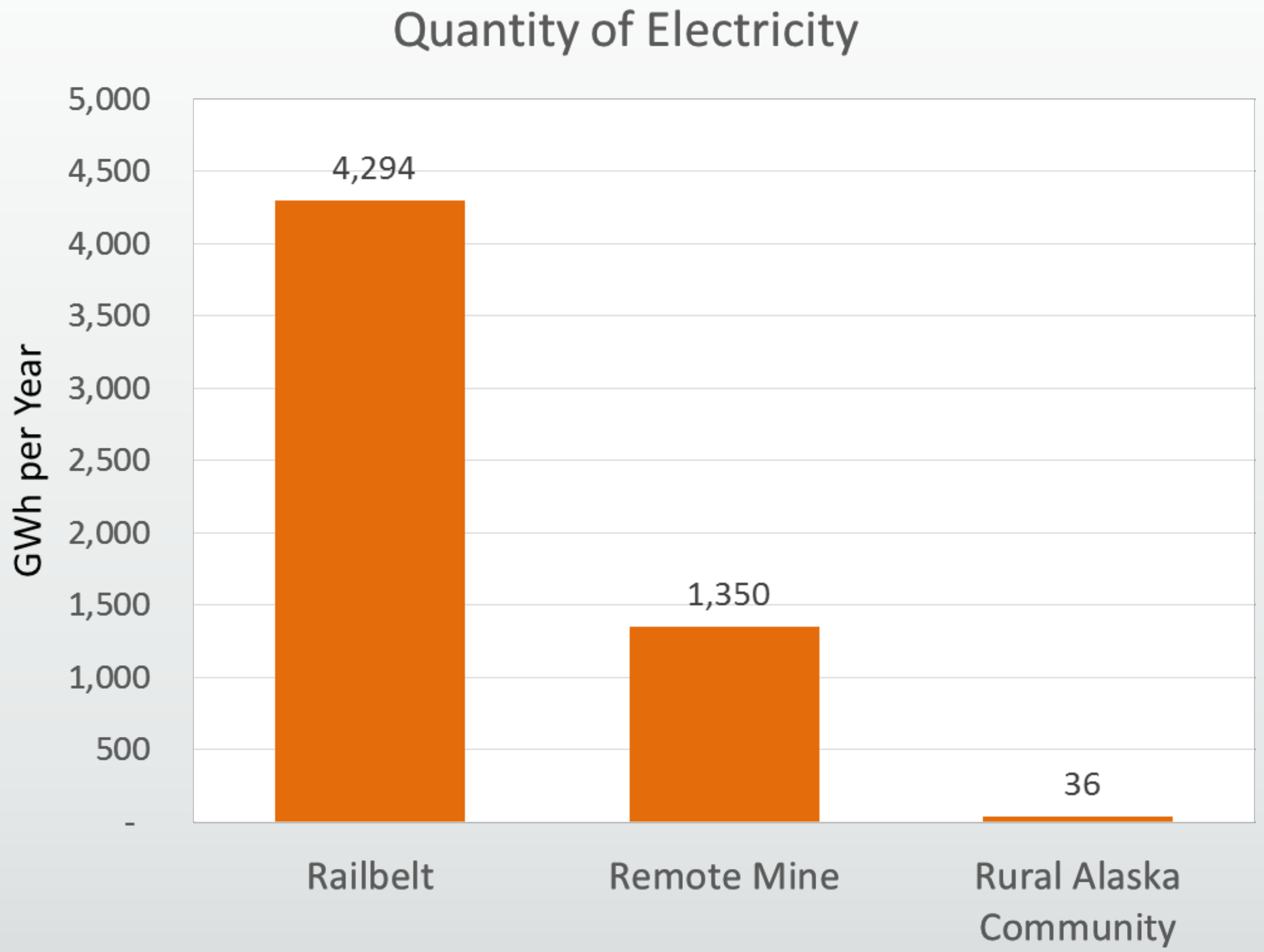
Quantity of Electricity (GWhs)

- Railbelt: includes all current power demand not met by hydro or coal
- Remote Mine: completely hypothetical very large mine
- Rural Alaska: total electricity demand for Northwest Arctic Borough
  - Electricity only, no heat demand
  - Does not include Red Dog Mine demand



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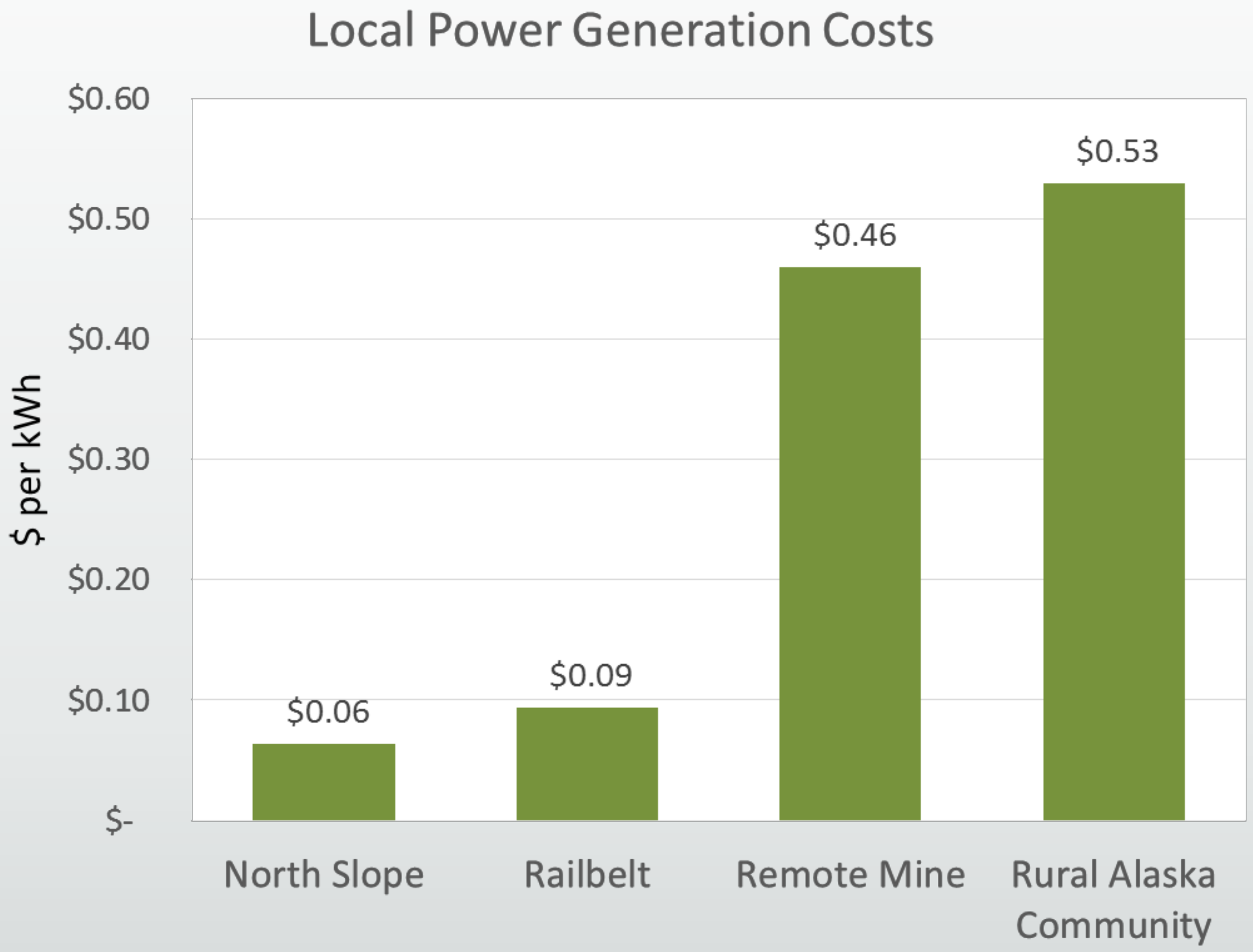
Price Differential ($/kWh)

- This analysis uses very rough estimates of local power costs
- Fuel is the largest driver of price
  - Natural gas for North Slope and Railbelt, diesel for mines and Rural Alaska communities
- Price differential is calculated as:
  - Local power cost minus North Slope power cost
  - Railbelt: $0.03 per kWh
  - Remote mine: $0.40 per kWh
  - Rural Alaska community: $0.47 per kWh



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Factor 3: Total Annual Costs of HVDC

- Capital cost
  - Increases with distance of transmission
  - Increases with amount of power system is designed to carry
- Annual cost
  - Debt service on capital costs
  - Annual O&M
- Data supplied by proponents of existing proposal
  - Does not use their existing system plans

	Capital Cost $mill	Annual Cost $mill
Railbelt	$2,428	$281
Remote Mine	$680	$79
Rural Alaska	$680	$79

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Calculation of Annual Benefits

- Annual economic benefit = GWhs x $/kWh – HVDC Cost
- The potential savings are the GWhs multiplied by the price differential (GWhs x $/kWh)
- Annual savings are the potential savings minus the HVDC costs
- A positive annual savings indicates an economic project

	GWhs	$/kWh	HVDC Costs
Railbelt	4,294	$0.03	$281
Remote Mine	1,350	$0.40	$79
Rural Alaska	36	$0.47	$79

	Potential Savings	HVDC Costs	Annual Savings
Railbelt	$132	$281	($149)
Remote Mine	$535	$79	$457
Rural Alaska	$17	$79	($62)

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What the Annual Savings Mean

- Of the three stand alone HVDC projects analyzed, only the Remote Mine Scenario provided positive economic benefits
- Stand alone HVDC projects to Rural Alaska communities or the Railbelt from the North Slope are not economic
- May be possible to combine a remote mine project to Rural Alaska communities or the Railbelt
  - Potential to provide economic benefits to rural communities or the Railbelt
  - Dependent on a large remote mine pursuing HVDC power first

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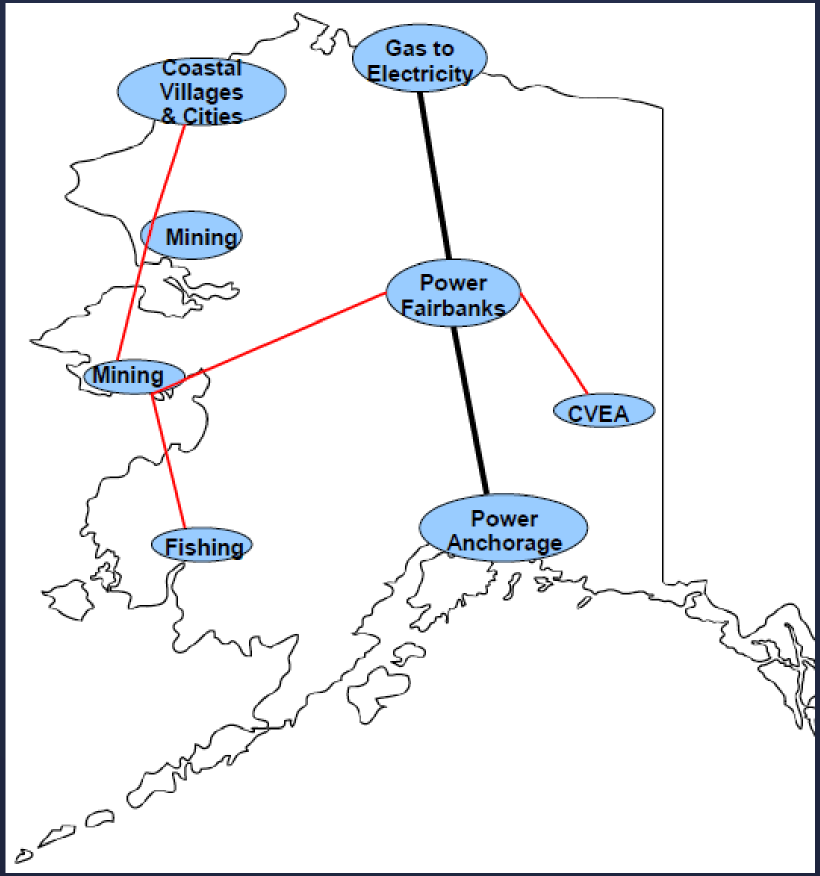
HVDC Opportunities in Alaska



- HVDC has the potential to provide significant economic benefit for remote mines
- Potential remote mining projects should engage AEA to explore an HVDC project
  - AEA can help design and integrate the HVDC system
  - AEA would ensure that the project supplies power nearby Alaska communities

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