MORE THAN A PIPE DREAM

THE ALASKA GRID

ALASKA MUNICIPAL LEAGUE
NOVEMBER 21, 2013
ANCHORAGE, ALASKA

Meera Kohler, President/CEO
Alaska Village Electric Cooperative
About Alaska Village Electric Cooperative

A non-profit member-owned electric cooperative
Electric service to 55 villages – soon to be 56 with Bethel
Population of 22,800 – 4th largest community in Alaska
44% of Alaska’s village population

Shageluk – 69
Hooper Bay – 1,114
Average 415

Anchorage – 298,610
System Information

- 73 Anchorage-based employees
- 8,000 services
- 48 power plants
- 165+ diesel generators
- 95 village technicians
- 500+ fuel tanks
- 5.5 million gallons of diesel
- 34 wind turbines serving 14 villages
- Two tug and barge sets
AVEC’s kWh Sales in 2012

KWh sales in all 55 villages

<table>
<thead>
<tr>
<th>Category</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>31.1 million</td>
</tr>
<tr>
<td>Commercial</td>
<td>13.8 million</td>
</tr>
<tr>
<td>Street Lights</td>
<td>0.6 million</td>
</tr>
<tr>
<td>Public Buildings</td>
<td>28.5 million</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>74.0 million</strong></td>
</tr>
</tbody>
</table>

Average per village   1,345,000
<table>
<thead>
<tr>
<th>Revenue Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>$19.3 million</td>
</tr>
<tr>
<td>Commercial</td>
<td>$7.4 million</td>
</tr>
<tr>
<td>Street Lights</td>
<td>$0.5 million</td>
</tr>
<tr>
<td>Public Bldgs</td>
<td>$15.5 million</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$42.7 million</strong></td>
</tr>
<tr>
<td><strong>PCE</strong></td>
<td><strong>$13.5 million (32%)</strong></td>
</tr>
</tbody>
</table>

**Average per village**: $776,000
What Does Our Electricity Cost?

Anchorage $0.14 (AVEC = x 4.5)
Fairbanks $0.185 (AVEC = x 2.5)
## What Alaska Spends on Heat and Power

### From 2011 Alaska Power Statistics:
- **Electricity revenue**: $1,024 million
- **2011 Gas revenue**:
  - Southcentral: $564 million
- **Diesel**:
  - Fairbanks area: 150 mm gallons
  - Kodiak, Copper Valley, SE: 68 mm gallons
  - Rest of state: 163 mm gallons
  - **TOTAL**: 381 mm gallons
- **Diesel value at $4.00/gallon**: $1,524 million
- **Annual cost of electricity/heat**: $3,084 million
- **Expenditure in 20 years**: $61.7 billion
Southcentral Alaska is running out of gas and must import LNG or pay 2 – 3 x Henry Hub rates to provide for utility needs.

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. Air quality is a major issue.

Growing energy demands in emerging economies will continue to apply upward pressure on the cost and supply of petroleum fuels.

Energy is scarce and expensive and will become even more so
A Solution: The Alaska Grid

- Large scale, high efficiency gas-fired generation
- HVDC transmission to move power across Alaska
- A grid to deliver large-scale renewables to end-users
- Abundant power for
  - North Slope operations
  - Fairbanks and other Railbelt communities
  - Remote mines, military and processors
  - Heat and power for rural communities
What is HVDC?

- A highly efficient means to move electrical power over long distances. The technology has evolved tremendously in recent decades.

- In use since the 1950s. The transmission line is inexpensive but the converter stations are expensive.

- The original technology, with very high cost converter stations, made it impractical for distances of less than 300 miles.

- Recent technology advances have greatly reduced the cost of converter stations, making HVDC a viable option to move bulk power in many applications. Technically, it offers many attributes not practical in AC transmission systems.

- Low Losses - similar to those of a gas pipeline.
### HVDC has been in use since 1954

<table>
<thead>
<tr>
<th>Power (MW)</th>
<th>Voltage (kV)</th>
<th>Length (Miles)</th>
<th>Year Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cahora Bassa</td>
<td>1930</td>
<td>±533</td>
<td>887</td>
</tr>
<tr>
<td>Pacific Intertie (WA to CA)</td>
<td>3100</td>
<td>±500</td>
<td>850</td>
</tr>
<tr>
<td>Utah-California</td>
<td>1920</td>
<td>±500</td>
<td>490</td>
</tr>
<tr>
<td>Quebec-N. England</td>
<td>2000</td>
<td>±450</td>
<td>925</td>
</tr>
<tr>
<td>Three Gorges-Shanghai</td>
<td>3000</td>
<td>±500</td>
<td>662</td>
</tr>
<tr>
<td>Xiangjiaba-Shanghai</td>
<td>6400</td>
<td>±800</td>
<td>1294</td>
</tr>
</tbody>
</table>

HVDC: CONNECTING THE WORLD
The Footprint of HVDC is Smaller than AC

ITAIPU
2 x 6300 MW Circuits

3 x 800 kV AC
6300 MW

2 x ±600 kV DC
6300 MW

China: Three Gorges HVDC v AC

HVDC
500 kV
6000 MW

400 MW AC
3,000 MW DC

HVAC
500 kV
6000 MW
IN EUROPE

HVDC: CONNECTING THE WORLD
HVDC: CONNECTING THE WORLD

IN NORTH AMERICA
IN CANADA

Manitoba Hydro

• Similar dimension/scale
• 500+ miles
• 68% of all power transmitted via HVDC

HVDC: CONNECTING THE WORLD

• 1972 Phase 1 - Manitoba Hydro began delivery of 1,620 MW from Nelson River Hydro sites to Winnipeg via a 500 mile HVDC line
• 1985 Phase 2 - additional 1,800 MW added via a 580 mile long HVDC line
• 2017 Phase 3 - 800 mile HVDC line 5 GW from Hudson Bay to Winnipeg

• 20% of the HVDC line routes go through areas of discontinuous permafrost. Foundations and maintenance programs were designed to deal precisely these conditions.
HVDC: CONNECTING THE WORLD

IN ASIA

Xiangjiaba-Shanghai

- 1,250+ miles
- 8,000 MW
- $3.7 Billion
- Planned for 2014
From a 2008 Study for the Denali Commission
Alaska Grid – Phase 1

2,000 MW Power Plant at the North Slope

- Provide electricity for North Slope activities
- Replace mechanical gas-fired systems with electric
- Provide avenue to integrate Arctic wind power

- Capital Cost: $2.5 Billion
- Delivered cost of power: $0.05/kWh
Alaska Grid Phase 2

HVDC transmission to Fairbanks

- Power for GVEA – adequate to provide space heat
- Adequate energy for Fort Knox
- Adequate energy for Livengood mining district

- Capital Cost: $1.65 Billion
- Delivered cost of power: $.05 + $.015 = $.065
Alaska Grid Phase 3

HVDC transmission to West Coast

- Adequate energy supply for Ambler mining district
- Power for Red Dog mine
- Power for Kotzebue/Nome area (electricity and heat)
- Pathway for West Coast wind power

- Capital Cost: $900 Million
- Delivered cost of power: $.065 + $.107 = $.172 (40% of capacity) $.12 (85% of capacity)
Alaska Grid Phase 4

HVDC transmission to Y-K area

- Adequate power for Donlin Gold
- Adequate power for Bethel and surrounding area

- Capital Cost: $510 million
- Delivered cost of power: $.065 + $.058 = $.123 (40% of capacity) $0.098 (85% of capacity)
HVDC transmission to South-Central

- Adequate power to supplement local generation
- Pathway to move hydropower from Susitna
- Pathway to integrate tidal/geothermal power

- Capital Cost: $1.2 Billion
- Delivered cost of power: $.065 + $.022 = $.087
COMBINED PROJECT COSTS

2GW Power Plant
$3/MCF gas; 7%/30 year money
@ 80% capacity = 14 billion kWh

Current Alaska Sales = 6.5 billion kWh

5GW Power Plant
Phases 1-5 $6.76B
+ 3GW increase in capacity $3.75B
$10.5B
@ 80% capacity = 35 billion kWh
What Else is Under Consideration?

- Susitna-Watana Dam: $6.50B
- Susitna Access: $0.50B
- Railbelt Transmission Upgrades: $1.00B
- Fairbanks LNG Trucking: $0.43B
- Bullet Gas Line from NS: $8.20B

Total: $16.63B
## CURRENT UTILITY PROJECTS

<table>
<thead>
<tr>
<th>Project</th>
<th>Capacity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVEA - Healy Restart</td>
<td>50MW</td>
<td>$100M</td>
</tr>
<tr>
<td>CEA/ML&amp;P - SCPP</td>
<td>183MW</td>
<td>$359M</td>
</tr>
<tr>
<td>CEA Beluga - Standby</td>
<td>(200MW)</td>
<td></td>
</tr>
<tr>
<td>MEA - Eklutna</td>
<td>180MW</td>
<td>$250M</td>
</tr>
<tr>
<td>HEA - Soldotna/Nikiski</td>
<td>90MW</td>
<td>$150M</td>
</tr>
<tr>
<td>ML&amp;P Plant 2 - Replacement</td>
<td>120MW</td>
<td>$225M</td>
</tr>
<tr>
<td>ML&amp;P Plant 2 - Standby</td>
<td>(220MW)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>$1,084M</strong></td>
</tr>
</tbody>
</table>

Almost no additional electric generation capacity
UNMET ENERGY NEEDS

- North Slope Operations: 300 MW
- Gas Turbine Conversion: 1000 MW
- Pipeline Operations: 100 MW
- Ambler Mining District: 300 MW
- Red Dog/Nome: 100 MW
- Donlin Creek: 180 MW
- Refining/Smelting: 500 MW
- Processors: 100 MW
- Value-Add: 200 MW
- Server Farm: 500 MW
- Electric Heat: 500 MW

Total: 3780 MW

Affordable cost of energy is the answer!
DO WE COMPETE WITH GAS EXPORTS?

North Slope gas reserves are 235 trillion cubic foot (tcf)

• 0.8 MW project uses 38 bcf/year - 1.14 tcf in 30 years (0.5%)
• 1.7 GW project uses 76 bcf/year - 2.28 tcf in 30 years (1.0%)
• 2.5 GW project uses 113 bcf/year - 3.4 tcf in 30 years (1.5%)
• 5.0 GW project uses 226 bcf/year - 6.8 tcf in 30 years (2.9%)

We can have our cake and eat it too!
The Benefits of Connecting Alaska

- Reduce the number of power plants
- Consolidated loads improve economics of connecting to other generation sources such as the Railbelt or a statewide grid
- Larger loads make renewables like wind or hydro feasible locally
- A transmission grid allows large scale development of wind, hydro, geothermal etc. to serve loads across the state

Toksook Bay – Tununak intertie
Let’s ship “Made in Alaska” not “Pieces of Alaska”

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