TECHNICAL CHALLENGES TO RENEWABLES INTEGRATION AS SEEN BY ALASKA VILLAGE ELECTRIC COOPERATIVE

Alaska Village Electric Cooperative

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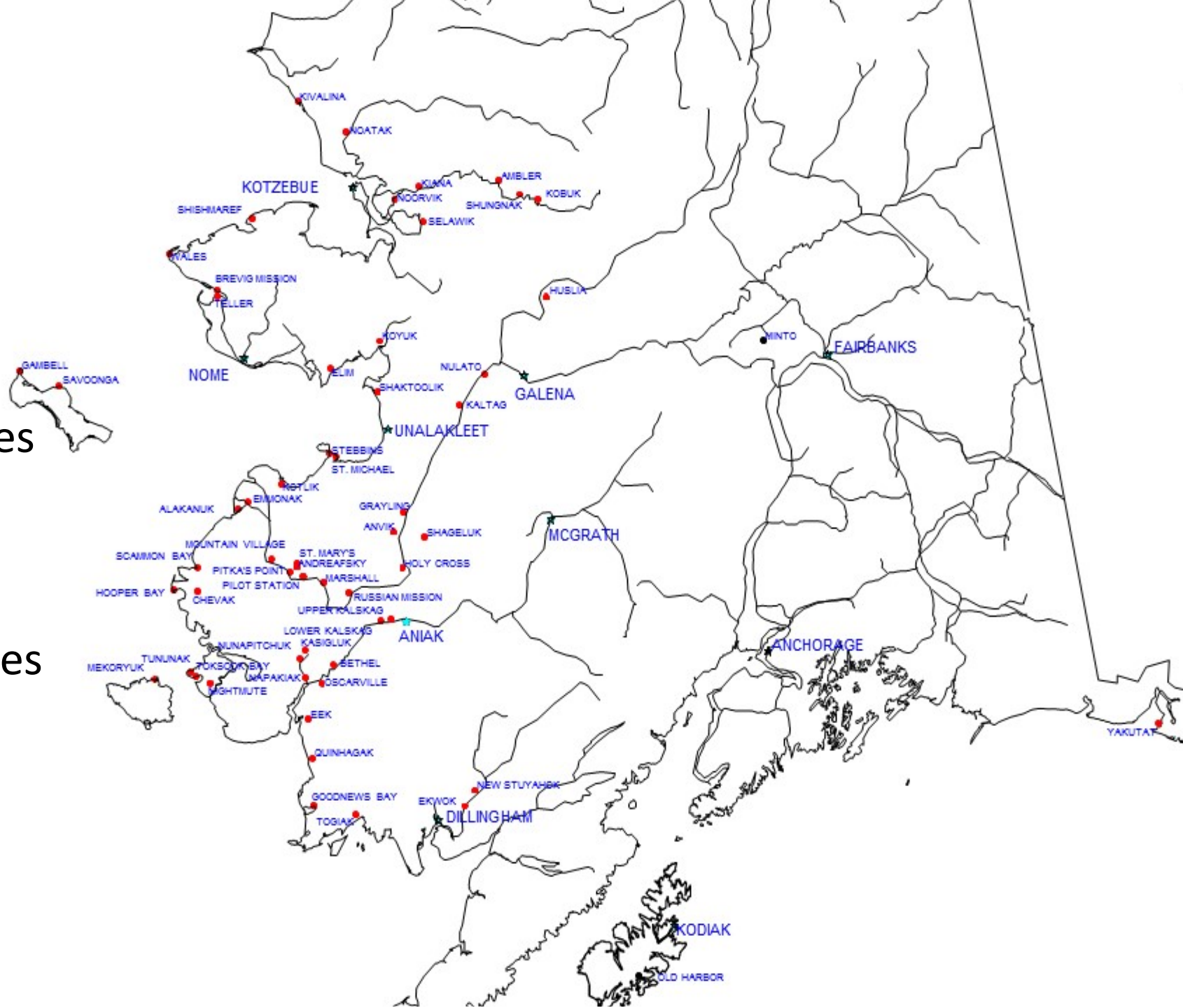
AVEC

ALASKA VILLAGE ELECTRIC COOPERATIVE

- Member-owned rural electric cooperative
- 58 microgrid communities across Alaska served
- 49 power plants
- 12 wind-diesel hybrid systems serving 19 villages
- 170+ diesel generators 100kW to 2.2MW
- Average Village Loads 46kW to 4.8MW



1. Solar. Is it scalable? How does it integrate? Prices continue to drop. Let's see...

- Our sunshine is mostly in the summer, when loads are low, so not much solar can be installed without exceeding low penetration limits on small village microgrids.
- Our summer sunshine goes around in circles, and so non-active simple arrays only capture a small percentage of summer sunshine.
- Active arrays, that would provide much better summer generation, have difficultly surviving Arctic winters.

Low Penetration Solar can be a no brainer except…

- Except that the cost of installed solar panels vs the amount of Alaska sunlight makes economics challenging.
- Our sunshine is mostly in the summer, when loads are low, so not much solar can be installed without exceeding low penetration limits on small village microgrids.
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Medium Penetration Solar…

- Medium Penetration Solar starts to affect the operation of the powerplant
  - Increases the variability of the powerplant load
  - Creates operational difficulties and usually inefficient diesel operation.
  - The cost of additional controls must be factored in.

High Penetration Solar…

- The holy grail of high penetration is to be diesels off. That requires even further complex powerplant systems. Installing these is not economic without a sufficient number of diesel-off hours per year.
- Achieving that requires the following:
  - Further drops in solar panel costs so that an excess of panels can be installed facing in multiple directions achieving all day delivery of power.
  - Or, Arctic survivable active arrays that can track the sun in the summer.

But Don’t Solar Costs just keep dropping?

- Solar Cost keeps dropping, but we are not the best location for solar, so as it becomes economic in other areas, demand will ramp up and soak up all production, delaying the much cheaper solar prices required for economic installations in Alaska.

Wind is still the renewable of choice for AVEC.

- 900 KW EWT in St Mary's is currently capped at 150 kW until the intertie is completed to Mountain Village is completed and the system dispatcher is installed for better control.

Wind is still the renewable of choice for AVEC's communities.

- Pros…
  - The wind resource is more available in the winter when the winds are highest, which matches our village loads that are highest in the winter.
  - Controllability of wind turbines has improved in recent years (smoother, easier to dispatch).
  - Larger, more cost effective turbines are now available for arctic installations (more bang for the buck).

Wind is still the renewable of choice for AVEC's communities.

- Cons…
  - Larger turbines provide more power, but the power system has to be prepared to use the larger blocks of power efficiently.
  - Spinning Reserve is more of a concern. Wind is unpredictable, we need better 5 minute out predictions or we need a GBS. Otherwise we will have outages when diesels are overloaded and diesels-off operation becomes nerve-racking.
  - Larger Systems can make use of larger blocks of wind power more easily, so ***how do we connect more villages together?***
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Interties

- Intertying communities has led to the large grids seen elsewhere in the world because they operate more efficiently. Interties have not been done much in Alaska outside of the rail belt though…
  - Small loads
  - High costs
  - Difficulty of installation
  - Poor terrain and access
  - Bad weather
- But large renewables provide more incentives for interties…

Interties

- Wind in multiple villages provide softer changes in wind power, so powerplant reaction becomes more predictable.
- Since large turbines are more cost effective than small turbines, the only way to utilize these turbines in smaller communities is to connect more communities together.
- Since overhead lines between villages are very expensive (as much as $80 per foot), are subject to weather damage and need long term maintenance, AVEC is revisiting using armored cables between villages.

Cable for Interties

- AVEC is revisiting using armored cables between villages but there have been issues in the past.
  - Cables generate hard to neutralize “charging current” or reactive VARs that must be absorbed somehow. In the past this was done with large compensating reactors which were expensive and power hungry. Now we can install inverter voltage regulators at each end point to efficiently absorb these VARs and regulate voltage to boot.
  - AVEC is looking at armored cables costing $10-$20 per foot. The price is being kept down by only transmitting single phase. The inverter already mentioned can phase convert the single phase power to three phase at the village end point where distribution is already three phase.
  - Cable install would be done in the winter intentionally in wet terrain, allowing the cable to naturally sink deep into the ground come spring. The density of the cable will allow it to sink further it into the soil as time passes.

Cable for Interties

- Medium Voltage Direct Current transmission may only be several years away. The single phase cable being specified would be perfect for ultimate conversion to MVDC transmission.


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