### Challenges and Research Opportunities for EVs in Alaska

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#### ACEP is an institute of the University of Alaska Fairbanks

ACEP MISSION: Fostering development of practical, innovative, and cost-effective energy solutions for Alaska and beyond







#### **Cold Weather Issues for EVs in Alaska**



Report on expected cold weather impacts on EVs in Alaska based on literature review and experience of Alaska EV drivers.

#### Cold Weather Issues for Electric Vehicles (EVs) in Alaska





Photo courtesy of Kirk Martakis

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#### **Cold Weather Impacts**

Figure 1: Low temperature regimes for EVs

	Battery Physics			
-20C		0C 10	C ~2	1C
Freezing Danger	Slower charging/ discharging, higher internal resistance, possible degradation during charging	Possible degradation during <b>fast</b> charging	Ideal battery use temperatures	
Damage risk if no energy to heat battery	Lower power possible, lower range (up to 40%+), slower charging, energy used to warm battery and cabin	Lower range, slower charging	Possible Best range loss from cabin heating	<b>~</b> "
-4	F Operational Effects	32F 50	0F 65F ~	70F



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#### **EV** Temperature Map





https://acep.uaf.edu/projects-(collection)/bee.aspx



# Real World

- -27°F current temp
- Since last charge:
  - 51% Driving
  - 37% Climate settings
  - 12% Battery conditioning





#### Photo: Kirk Martakis



### **Crowd-Sourced Data**

Gathering data from privately owned passenger EVs and Tok School bus to investigate energy use vs. Temperature



Alaska EV Driving Data

Temperature (C)

y = -0.007x + (0.390)

0.22 kWh/mile at 25C

0.52 kWh/mile at -20C

0.66 kWh/mile at -40C



### **Crowd-Sourced Data**

Energy use while Parked is also a big factor - but less clear relationship w/ T for all vehicles



Temperature (C)





Web based calculator user selects community in Alaska and inputs driving information. Uses typical yearly temperature profile to calculate cost and emissions vs. ICE vehicle



#### **Alaska Electric Vehicle Calculator**

This is a calculator to find out how much it would cost to charge an EV at home in Alaska, and what the carbon emissions would be.

A comparison is also made to an internal combustion engine (ICE) vehicle.

Community and Utility data are taken from <u>http://ak-energy-</u> data.analysisnorth.com/

Select your community:





https://acep.uaf.edu/projects-(collection)/bee.aspx



# Tok School Bus – Solar charging!







#### **Pilots in the State**











Buses, garbage trucks, fleet cars, and many more!



#### **Electric Vehicles in the** UAA Institute of Social Arctic (EVITA) and Economic Research ACEP

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#### Goals

1. Identify perceived barriers to adoption, mechanisms for facilitating adoption, perceived usefulness, and potential uses of EVs.

2. Examine potential trade-offs between conventional and electric for rural vehicle users across specific use cases such as subsistence activities.



Participating communities: Galena Kotzebue **Bethel** 





NSF #2127171





# **Grid Impacts**



- Impacts on the existing grid and the cost of service?
  - How does penetration, clustering, battery size, charging rates impact feeders?
  - generation and transmission?
  - How do we site DCFC to minimize grid impacts, what are marginal costs?
    When does the incentive to charge in a "demand shadow" lead to efficient or inefficient outcomes for the grid as a whole?
  - Can utilities detect EV loads from AMI meter data?
- How can we use EVs to promote beneficial electrification as opposed to detrimental electrification?
  - Can impacts be minimized or grid assets optimized by managed charging? What technology is needed to shift EV charging loads?
  - How can EVs be used to increase penetration of non-firm renewable energy generators?
  - What are barriers to vehicle-to-grid (V2G)? From utilities? From vehicles and EVSE?
- Policy? Regulation/ rate structures/ legislation/ etc.





### Some practical takeaways so far:

- Current EVs are often uneconomical and don't reduce carbon emissions in many areas/uses in Alaska - generally due to energy use in extreme cold. Need solutions:
  - Occupant comfort insulation? other solutions to heat occupants? heat pumps not much help in extreme cold
  - Battery conditioning while parked can also use a lot of energy in low mileage vehicles - new chemistries or thermal management systems?





### Thank You!

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This project is part of the ARCTIC Program, an initiative supported by the Office of Naval Research (ONR). Details at: thearcticprogram.net



