Sustainable Community Energy

Integration of Renewable Energy Systems to Improve
Energy Self-Reliance for Remote Rural Communities

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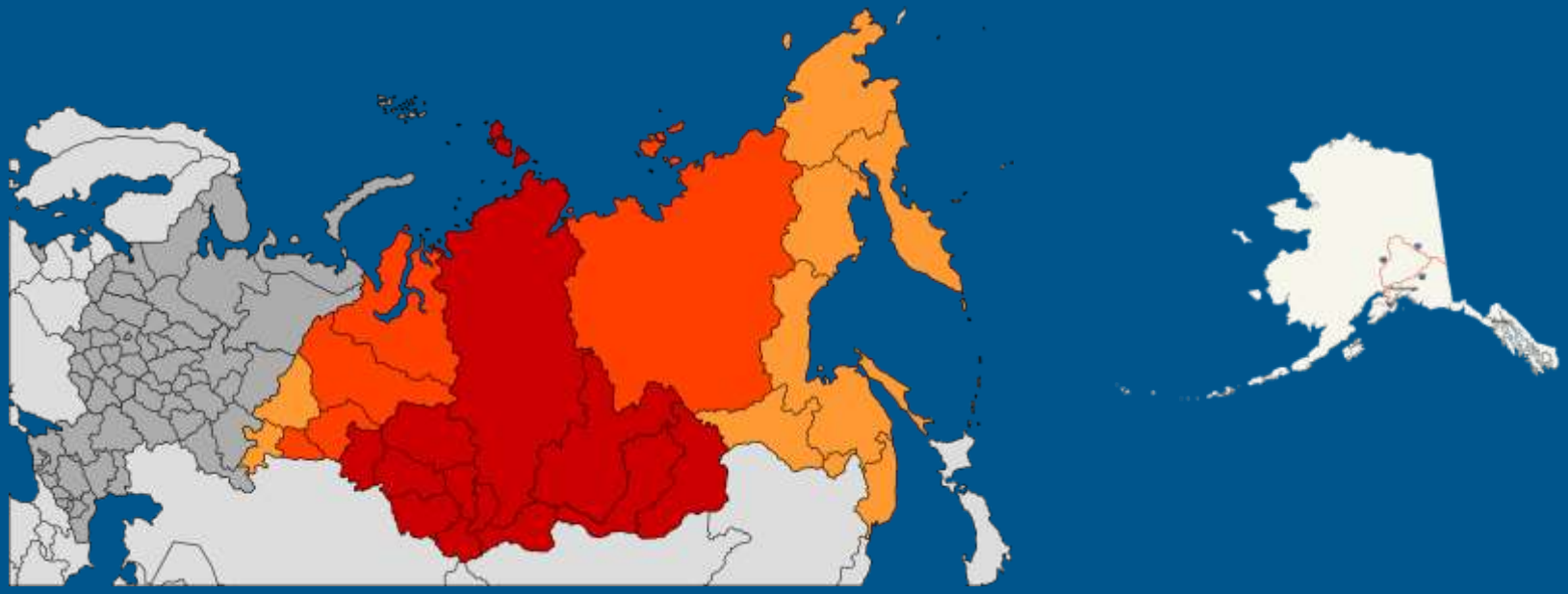
The State of Alaska



- ✓ 1,171,000 km² (compared to ~`3,083,000km² for Sakha Republic)
- ✓ Population density is 0.5 person/km² (Sakha Repulic is 0.8person/km²)
- ✓ ~750,000 residents, half live in Anchorage
- ✓ Largest state in the U.S.

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Alaska Realities

- High energy costs
- Fragmented electric grid
- Limited road network
- Harsh & changing climate
- End of supply lines
- Stranded resources
- Dispersed population

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Electric power in rural Alaska costs 17 – 70 rubles/kWhr

Diesel for heating costs 53 – 120 rubles/liter

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Erosion from fall storms - Shishmaref

Icebreaker supported fuel delivery to Nome

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Rural Alaska – Western Alaska

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Rural Alaska - North Slope

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Rural Alaska - Southeast

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Alaska has 14 hydropower plants (both storage and run of river), most are located in Southeast Alaska

Rural Alaska - Interior Alaska

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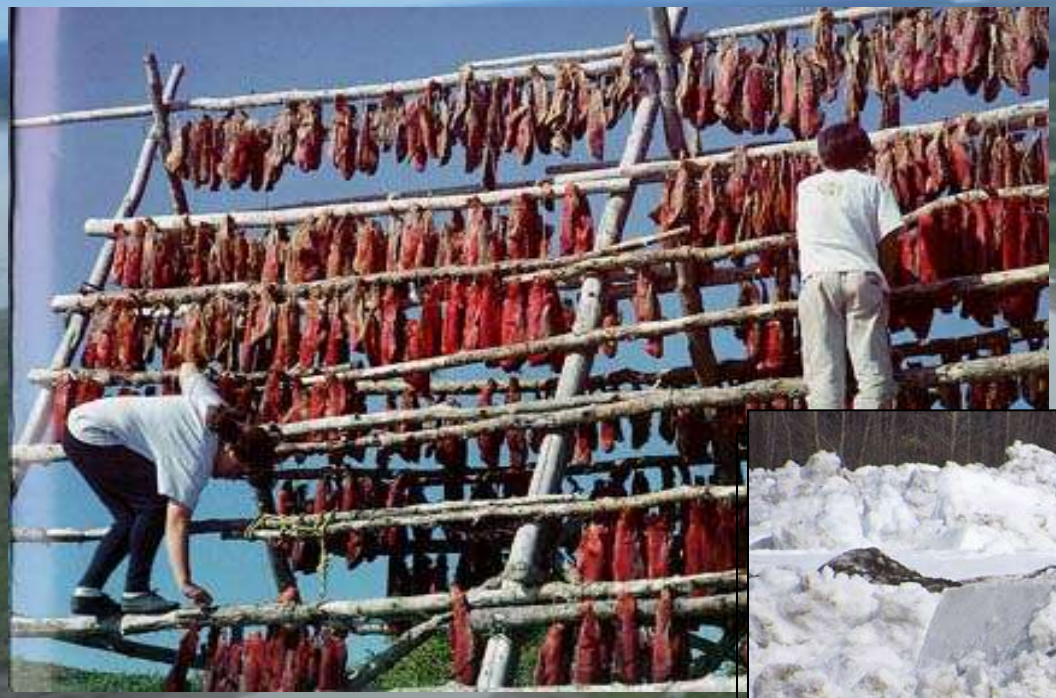

Rural Alaska runs on diesel (and some renewable energy)

Remote off-grid microgrids in Alaska

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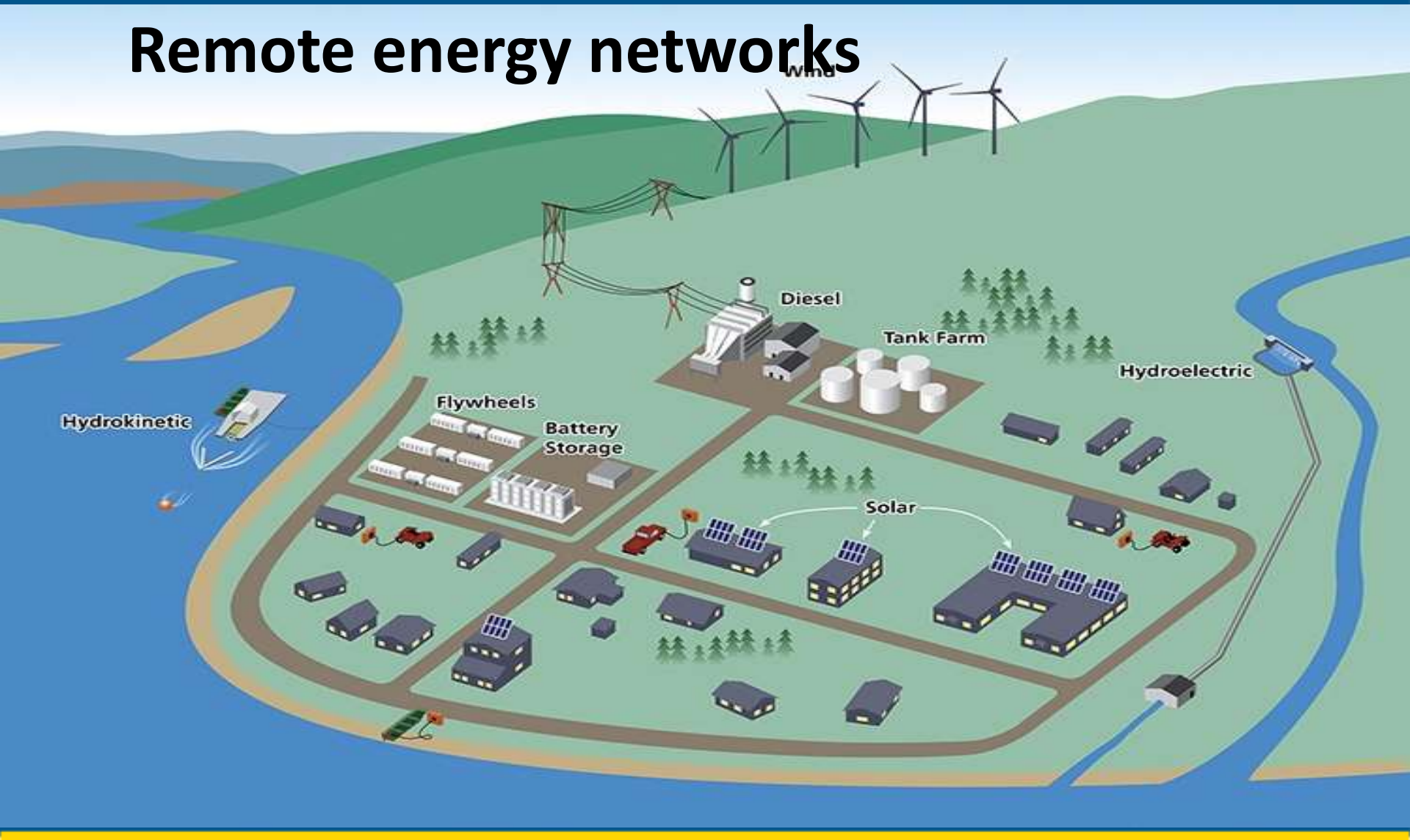
Remote ~~off-grid microgrids in Alaska~~

Remote energy networks



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Alaska has been investing in Energy Infrastructure

Over the past decade, Alaska has invested more money per capita in renewable energy projects than any other state in the country. Here are some examples of the 70+ systems operating in Alaska today:

Kodiak has achieved 100% renewable penetration with hydro-wind-battery-flywheel system (above)

There were 3 hydrokinetic turbines installed in Alaska this summer, including the community of Igiugig (above)

St Paul wind farm – operating on 100% wind at times for 15 years (right)

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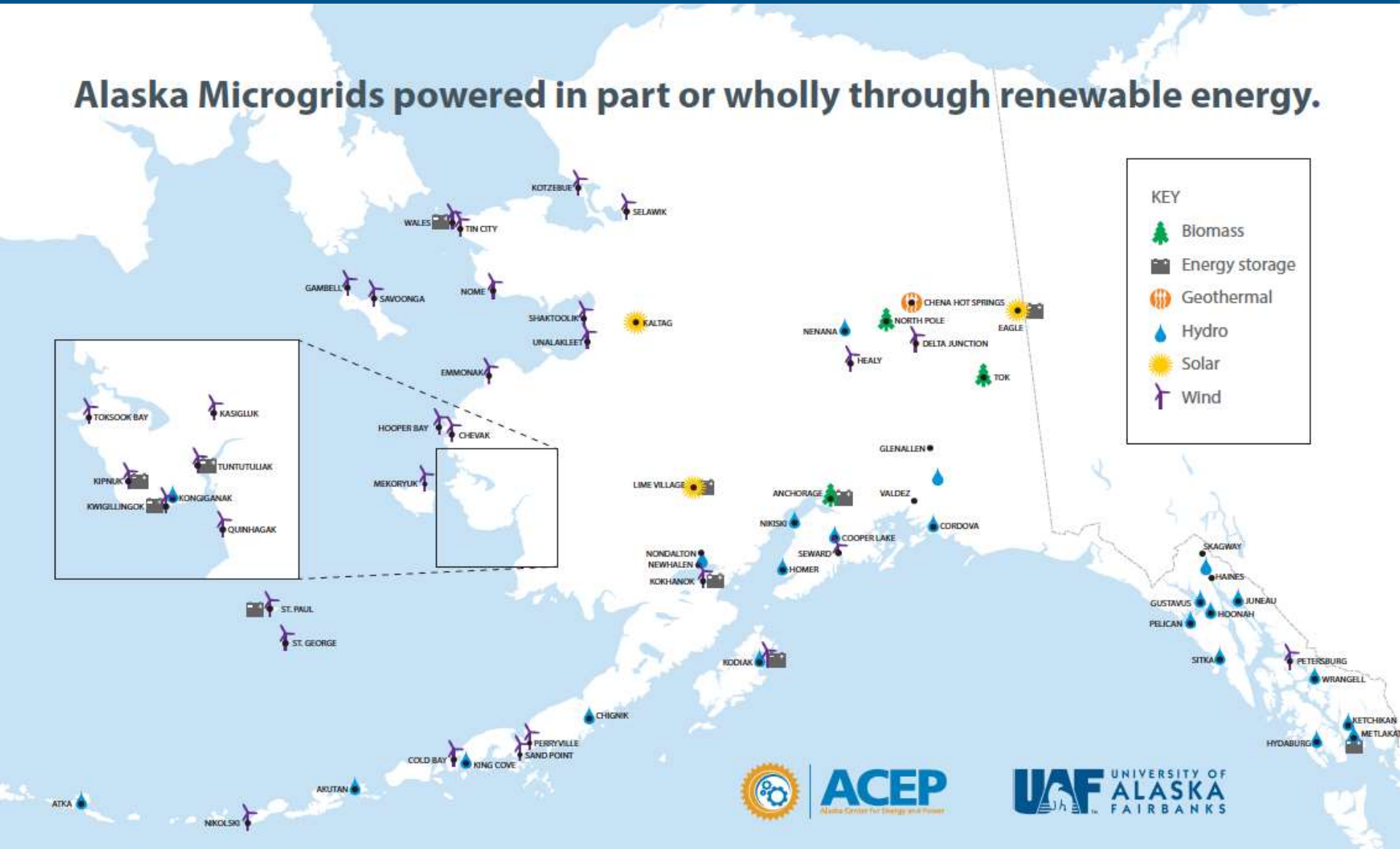
Drivers for Alaska Investment

- Disparity in energy costs between urban and rural areas
- Funding available through revenue generated through oil and gas industry
- Grass roots effort led by NGO Renewable Energy Alaska Project (REAP) to develop programs to support development – Renewable Energy Fund and Emerging Energy Technology Fund
- Next step is developing tools to incentivize more private investment in Alaska energy projects

70 (of 250) Communities in Alaska are powered in part through renewable energy



Low Temperature Geothermal

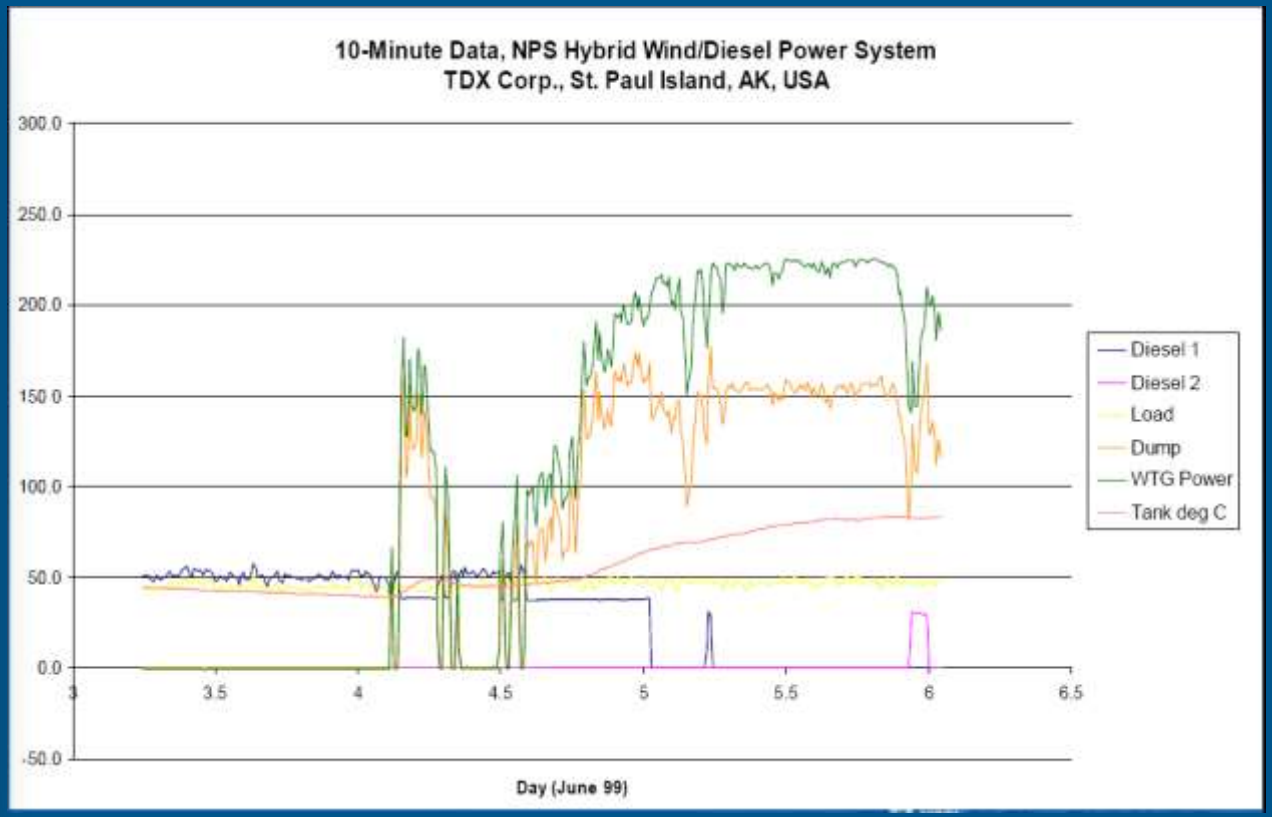
400 kW Power Generation from ORC with 72 C fluid, plus year round greenhouse and refrigeration

Chena Hot Springs

St Paul Island

Up to 100% renewables – 15 yrs of operation

Wind + Diesel + Synchronous Condenser + Thermal dump loads



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Kodiak Island: 100% renewable generation

Hydropower + Wind + Energy Storage (Battery and Flywheel)

Tuntiluliak, Kongiginak, Kwig: Wind Heat System

Diesel off with wind + energy storage + distributed heating

Images: Left: *20+ thermal electric stoves installed in elder and low income homes; Windmatic direct drive turbines (30-40% wind penetration annually)*

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Eagle Hydrokinetic Energy Project

25 kW system provided diesel off 100% power to Eagle Village

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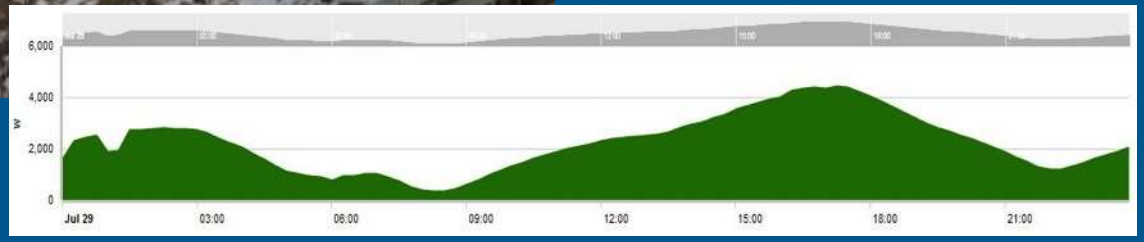
Solar energy – gaining in popularity

Deering, Alaska
Population = 125 residents , 10 kW. Multi-directional array produce consistent power throughout day (and night)



24 hours output in July

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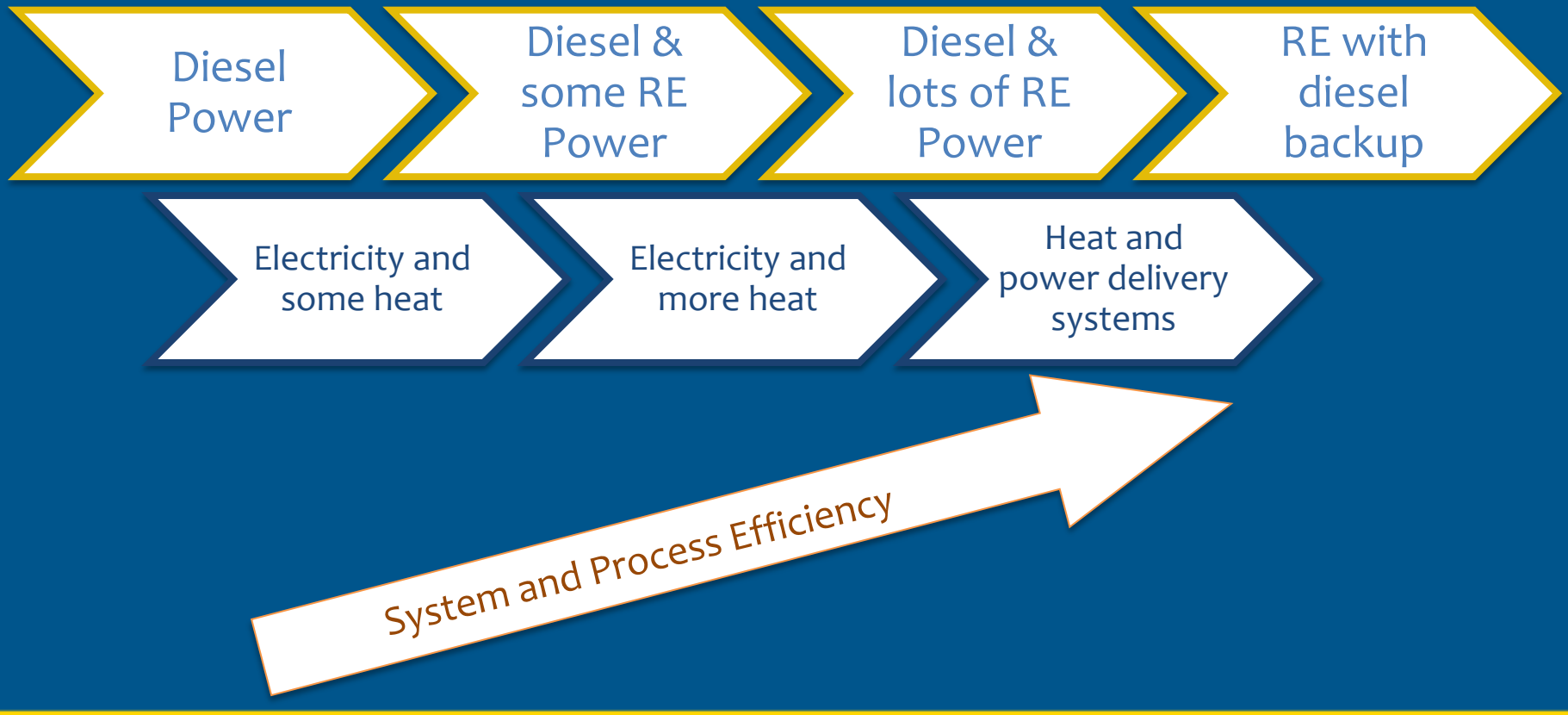
Small Scale Biomass for Heat and Power

Tok School Biomass Project
(125 kW power + heating)

Objectives and Trajectories

- Increase utilization of local resources
  - Practical, cost effective, sustainable, reliable, resilient



Power System Integration Lab/ Program

Lab recreates a remote microgrid at full power levels (500kW)

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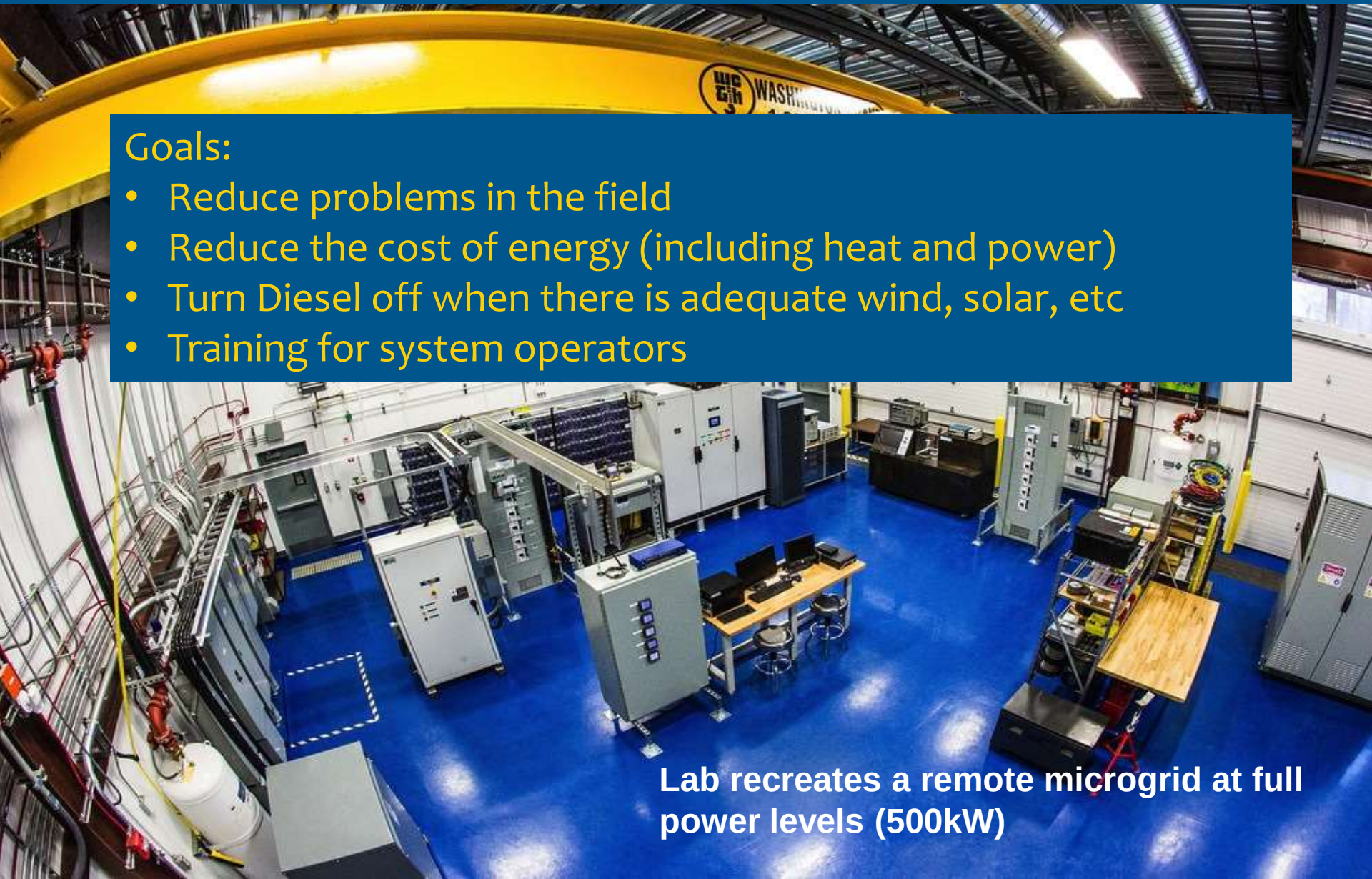

Goals:

- Reduce problems in the field
- Reduce the cost of energy (including heat and power)
- Turn Diesel off when there is adequate wind, solar, etc
- Training for system operators

Lab recreates a remote microgrid at full power levels (500kW)

Example: Flywheel/controls integration

Customer:

- Hatch Engineering (Canadian Company)

Testing of:

- Williams/Ktsi Flywheel

  (Power quality mitigation strategies and power smoothing)

Example: Flywheel/controls integration

System has now been installed at the Raglan Mine in Northern Quebec (Canada)

Remote Energy Networks Training Program

- Proposed as a 'project' under the US Chairmanship of Arctic Council
- Inspired by Iceland's UNU Geothermal Training Program
- Bring people from around the arctic together for specialized training in integrating renewables with remote energy networks
- 8 week webinar series, followed by 3 weeks in Alaska for a combination of field and classroom training
- Summer 2016 – will be looking for applications from interested fellow beginning soon