Alaska Center for Energy and Power

Solar Panel

Institute of Northern Engineering

Power Systems Integration Lab

Alaska Hydrokinetic Energy Research Center

Information, Research & Technology Resource

ACEP - Alaska Center for Energy and Power
Power System Integration Lab/Program

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)
Power System Integration Lab/Program

- 320 kW Cat C-15 diesel, w/Woodward EasyGen 3200
- 125 kW Detroit 50-Series, w/Woodward EasyGen 3200
- 100 kW Wind Turbine Simulator (induction)
- 313 kW ABB PCS100 Inverter
- 540 VDC/1000 Ah Absolyte VRLA Battery
- Two reactive 250 kW LoadTech Loadbanks
- Fault simulator and solar simulator under development
Diesel-Off Operation (emphasis)

• Requires alternative:
  – Voltage source
  – Reactive power-support
  – Inertia

• Energy storage
  – Spinning reserve (seconds)
  – Bridging (minutes)
  – Shifting (hours+)

• Significant additional fuel savings

• Reduced O&M on diesel generators

ABB PCS100 Grid forming inverter and 0.5MW battery bank
Example: Flywheel/controls integration

Customer:

- Hatch Engineering
  (Canadian Company)

Testing of:

- Williams/Ktsi Flywheel
  (Power quality mitigation strategies and power smoothing)
Example: Diesel Waste Heat Recovery

ACEP is working on improving diesel powerhouse efficiency by capturing wasted heat from the exhaust or jacket water and using it to generate additional power using organic rankine cycle technology.

Technology Impact
2012: Initial testing conducted at UAF

Community Impact
2013: ACEP partnered with Tanana Chiefs Conference and AP&T to install a unit in Tok (funded through the Denali Commission).

State Impact
2014: 3 units installed at the Powerhouse in Unalaska projected to save $214k annually

Global Impact
ACEP’s publications on this technology are bringing worldwide attention to Alaska communities as first adopters of innovative ideas.
AHERC: applied research organization focused on rapid results

1. Systematically identify challenges faced by hydrokinetic generation (e.g., debris, grid integration, fisheries, icing)
2. Identify and RAPIDLY develop solutions to challenges
3. Assemble team to address challenges

- J. Kasper (AHERC Director, Physical Oceanographer)
- J. Johnson (Geophysicist)
- P. Duvoy (ACEP Res. Eng.)
- N. Konefal (ACEP Res. Eng.)
- A. Seitz (UAF-SFOS, Fisheries Oceanographer)
- S. Jump (Fisheries Undergraduate)
- M. Mueller Stoffels (ACEP, Power systems Integration)
- A. Kulchitsky (UAF-INE, Computer Scientist)
- J. McGlynn, Energy Solutions for Developing Nations
- J. Holmgren (Jon’s Machine Shop)

http://acep.uaf.edu/programs/alaska-hydrokinetic-energy-research-center.aspx
Hydrokinetic Energy Technology

- Hydrokinetic devices convert kinetic energy of wave, tidal or river currents into electrical power
  - Turbines are placed in areas of strong currents
  - Wave absorbers placed in high energy wave environments
- Dams not required
- MHK technologies are pre-commercial -- “emerging technology”
- Niche technology with great potential for Alaska
Hydrokinetic Turbines

Pulse tidal* hydrofoil

New Energy*: Ecurrent

Marine Current Turbine*

Ocean Renewable Power Company*

VIVACE*: vortex induced vibration

*Turbine images used with permission
Wave Energy Converters

Point Absorber


Oscillating Wave Surge Converter

Attenuator

Overtopping

Air is compressed inside chamber

Capture Chamber
Alaska has:
- 90% of U.S. tidal current energy
- 40% of U.S. river current energy
- 40% of U.S. wave energy

Alaska’s Hydrokinetic Opportunities

Information sources:
<table>
<thead>
<tr>
<th>Location</th>
<th>Potential (TWh/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Coast</td>
<td>250</td>
</tr>
<tr>
<td>East Coast</td>
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<tr>
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<td>Puerto Rico</td>
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<tr>
<td>Alaska</td>
<td>620</td>
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</tbody>
</table>
Hydrokinetic Power

The Power per unit of cross-sectional area:

$$P_{sp} = \frac{1}{2} d_w V^3$$

- $P_{sp}$ - specific power (W/m²)
- $d_w$ - density of water (kg/m³)
- $V$ - current velocity (m/s)
Demonstration projects (PAST & IN PROGRESS OR PLANNED)

- Ruby – Yukon River (YRITWC, 2010)
- Oceana, Inc. – UAF’s TRTS (UAF, UAA, AEA, 2014, 2015)
- BRI, Kvichak (AEA, 2014)
- Tanana
- Whitestone (Delta Junction, design)
- ORPC/False Pass (Tidal, planning)
- ORPC Kvichak (DOE ongoing)
- UAF TRTS (2016)
- Yakutat (Wave, planning)
Challenges: Debris

Disrupts operations, and creates maintenance and safety issues.

Examples:
- Ruby 5 kW turbine demonstration
- Eagle 25 kW AP&T Demonstration
- Fort Simpson 25 kW New Energy demonstration
AHERC focus on enabling technologies
Debris Video (Debris Diversion)
Turbine Test at the Tanana River Test Site (2014 & 2015)

Turbine Test Platform and RDDP

Oceana Turbine Testing
Challenges: Ice

Winter River Measurements

Maximum measured winter velocities
0.5-0.8 m/s

UAF AHERC
Challenges: Ice

Winter Current Velocity

Velocity Profile: Tanana River: 1-15-2010

6. Johnson et al.
Solution?

Floating Fiber Optical Cable: Kvichack River

Floating cable

Surface ice
Is hydrokinetic energy generation in Alaska feasible?

- **YES:** will not solve rural Alaska’s energy crisis (there is not a single solution)
  - Lots of promise for small scale, seasonal operation (MINING)
  - ABS Alaska and others are developing/selling commercial systems
- Village/micro grid scale: need to advance quickly and systematically to avoid predictable missteps
  - Long term testing needed
  - Gather economic, O&M, efficiency, fisheries and further environmental data during testing
Acknowledgements

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Works Cited


