Environmental Monitoring of Hydrokinetic Energy Projects in Alaska

Jeremy Kasper
Alaska Hydrokinetic Energy Research Center
P. Bradley, P. Duvoy, J. Johnson, N. Konefal, J. Schmid, A. Seitz

July 2015
Outline

- AHERC - the Alaska Hydrokinetic Energy Research Center
- Intro to hydrokinetic power generation
- Hydrokinetic opportunities and economics in Alaska
- Resource evaluations and demonstration projects in Alaska
- Challenges
- Open questions
- Future directions
The Alaska Hydrokinetic Energy Research Center

Resides within the Alaska Center for Energy and Power (ACEP), a division of the UAF Institute of Northern Engineering

Research, technology development, and information resource on marine and river hydrokinetic (MHK) energy for state, federal and local entities

Focus on understanding interactions between the environment and hydrokinetic technology.

- Baseline hydrodynamic studies (measurement & modeling)
- Developing supporting technology and methods (environmental observation platforms, modeling and infrastructure)
- Develop and disseminate data and information needed by stakeholders to make informed decisions.
- Educate students and public on pertinent issues
Core AHERC team and close collaborators

- J. Kasper (AHERC Director, Physical Oceanography)
- A. Seitz (UAF-SFOS, Fisheries)
- J. Johnson (Geophysicist)
- P. Duvoy (Res. Pro.)
- J. Schmid (Res. Engineer)
- N. Konefal (Res. Engineer)
- M. Mueller Stoffels (ACEP, Director of Power systems Integration Lab)
- A. Kulchitsky (UAF-INE, Computer Scientist)
- J. Holmgren (platform design and construction)
- James Durst (Alaska Department of Fish and Game)
- P. Bradley (ADF&G)
- K. Stafford (UW-APL)
- UAF SFOS
Hydrokinetic Energy Technology

- MHK 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”
- A niche technology with great potential in Alaska
Hydrokinetic Turbines

*Pulse tidal* hydrofoil

*New Energy*: Encurrent

*VIVACE*: vortex induced vibration

*Marine Current Turbine*

*Ocean Renewable Power Company*

*Turbine images used with permission*
Wave Energy Converters

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:
Alaska’s Hydrokinetic Opportunities

- Attractive to MHK developers
  - High cost of energy
  - Villages with proximity to rivers, waves and tidal currents
  - Tidal resource near railbelt
  - State support (grants and direct funding)
  - Community interest in renewables

### Annual Average Cost of Power in Alaska (2010 dollars adjusted from 2001 ISER report)

<table>
<thead>
<tr>
<th>Location</th>
<th>Cost/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statewide</td>
<td>$0.22—$0.94</td>
</tr>
<tr>
<td>Railbelt</td>
<td>$0.14</td>
</tr>
<tr>
<td>Alaska Village Electric Corporation</td>
<td>$0.52</td>
</tr>
<tr>
<td>Continental U. S.</td>
<td>$0.09</td>
</tr>
</tbody>
</table>

(Ref. 2 & 3)
Alaska’s Hydrokinetic Opportunities

Issued and pending preliminary FERC permits

Economics of hydrokinetic power production at selected Alaskan locations (2010 dollars)

<table>
<thead>
<tr>
<th>Location</th>
<th>Est. renewable cost/kWh</th>
<th>Est. current Cost/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Igiugig (River)</td>
<td>$0.68</td>
<td>$0.73</td>
</tr>
<tr>
<td>Eagle (River)</td>
<td>$0.68</td>
<td>$0.47</td>
</tr>
<tr>
<td>Whitestone (River)</td>
<td>$0.19</td>
<td>$0.14</td>
</tr>
<tr>
<td>Knik Arm (Tidal)</td>
<td>$0.11</td>
<td>$0.14</td>
</tr>
<tr>
<td>Yakutat (wave)</td>
<td>$0.28</td>
<td>$0.31</td>
</tr>
</tbody>
</table>

FERC staff, March 13, 2012

1 Alaska's Hydrokinetic Opportunities

Issued and pending preliminary FERC permits

Economics of hydrokinetic power production at selected Alaskan locations (2010 dollars)
Alaska Resource Studies

- Statewide assessment (UAA)
- False Pass tidal resource assessment (APICDA, ORPC, UAA, Benthic Geo.)
- Kvichak River resource assessment (ORPC, UAF, LGL)
- Yakutat wave resource assessment (CBY, UAF, USACE, RME, EPRI)
- Cook Inlet resource assessment (NOAA, ORPC)
- Detailed Tanana River Test Site (TRTS) characterization (UAF, ORPC, TerraSond)
In-River Hydrokinetics – Igiugig (Kvichak River)

- At mouth of Lake Illiamna
- Relatively little debris and ice
- Good resource identified
- 2 turbine demonstration projects in 2014
- Continued ORPC demonstration in 2015. Including:
  - Video observations of fisheries (LGL)
  - Acoustic environment (UW)
  - Hydrodynamic measurements (UW)
Results of Fish Monitoring

No adverse effects observed.

No adverse environmental effects have been observed.

Fish observed during video reviews (most upstream and downstream cameras only) appear to swim harmlessly away from the device.
2014 Results - Fish and Wildlife

• No wildlife interactions.

• Few fish. 32 events / 555 blocks = .07 per 10 min block.

• Able to ID about 2/3 of fish, most of which were pinks.

• Most were milling/pass by; no through, no obvious avoidance.
  
  • Most fish were individuals, not schools.
  
  • Able to see turbine from upstream, downstream.
  
  • Can’t infer timing b/c intermittent operation.
Nenana, AK

Goals: Assess interactions between the river environment and hydrokinetic technology

* River hydrodynamic measurements and modeling (power resource: summer & winter, sediment, turbulence)
* Fish populations and behavior
* River debris (conditions & mitigation methods)
* Turbine performance testing
^ Sonar monitoring for fisheries and debris
^ Physical fisheries sampling for trauma

*Baseline studies completed
^ In progress
Turbine Test at the Tanana River Test Site

Turbine Test Platform and RDDP  Oceana Turbine Testing
Fisheries Sampling Methods: River Margin

Picture courtesy of Todd Paris - UAF
Mid-channel Methods
Mid-channel Methods

- Frame Trawl
  - Top of water column
  - Middle of water column
  - Bottom of water column

Funding:
Alaska Energy Authority
Denali Commission
ORPC Alaska
University of Alaska Fairbanks
Sonar (in progress)

- High frequency (900 kHz) imaging sonar combined with
- Low frequency 120 kHz split beam

Problems include:
- Signal scatter from sediment and turbulence
2015 MHK Device Evaluation
Projects

- UAF will test a 5 kW MHK device at TRTS this summer
- Oceana, Inc. will test at AHERC’s TRTS in 2014 and 2015
  - UAA performing hydro-sedimentological monitoring
  - UAF & ADF&G Fisheries monitoring
- ORPC will continue testing in Igiugig

Image courtesy of Oceana, Inc.
Demonstration projects (PAST & PLANNED)

- Ruby – Yukon River (YRITWC, 2010)
- Eagle – Yukon River (AP&T, 2010)
- UAF – TRTS (ongoing)
- Oceana, Inc. – TRTS (AEA, 2014, 2015)
- BRI, ORPC Inc. – Kvichak (AEA, 2014, 2015)
- RME, Yakutat (2015)
Is hydrokinetic energy generation in Alaska feasible?

- Probably but will not solve rural Alaska’s energy crisis (there is not a single solution)
- Need to make advances quickly but systematically with minimal missteps to avoid “image problems” down the line
  - Long term testing of MHK devices needed in order to
    - gather economic, O&M, efficiency, fisheries and further environmental data during testing
A special thanks to: the City of Nenana, the Nenana Tribal Council, Jason Mayrand, Victor Lord, Robin Campbell, Inland Barge Service, Charlie Hnilicka, Ruby Marine Inc., Matt Sweetsir, Crowley Marine Services, Endil Moore, Jon’s Machine Shop, Monty Worthington (ORPC), Bill Staby (RME), City and Borough of Yakutat (Bill Lucey, Skip Ryman, Ian Fiske), Ned Hansen (Oceana), Jonathan Colby (Verdant Power) and Tom Ravens (UAA)
Works Cited


