

Hydrokinetic Power for Rural Alaskan Communities

Alaska Center for Energy and Power
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6:30 PM, Noel Wein Library
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Hydrokinetic definition

- Hydro—Water
- Kinetic—movement
- A Hydrokinetic devices is one that tries to extract energy from the movement of water
- Either in rivers, or in tidal areas
- Device is anchored and placed in strong currents



Energy in Water

- For traditional hydroelectric, a dam stores water, and releases it a little bit at a time.
- Energy is stored as gravitational potential energy ($E = \rho gh$, where ρ = density, g = gravitational constant, and h = height)
- Higher dams make more energy with the same volume of water
- Water is not moving in the impoundment area, so energy is not from motion
- 1 cubic meter of water per second flowing from a dam of 100 meter height gives about 980 kW of power



Kinetic Energy in Water

- $E = \frac{1}{2} mv^2$
- $m = \rho V = \rho Av$
- $E = \frac{1}{2} \rho Av^3$
- The energy of moving fluid depends on the cube of the velocity
- Critically important to measure the fluid velocity profiles in order to assess the energy that can be extracted



Energy vs. velocity

m/sec	kW/m2	Miles/hour	Knots
1	0.5	2.24	1.94
2	4	4.48	3.88
3	13.5	6.72	5.82
4	32	8.96	7.76
5	62.5	11.2	9.7
6	108	13.44	11.64
7	171.5	15.68	13.58
8	256	17.92	15.52
9	364.5	20.16	17.46
10	500	22.4	19.4

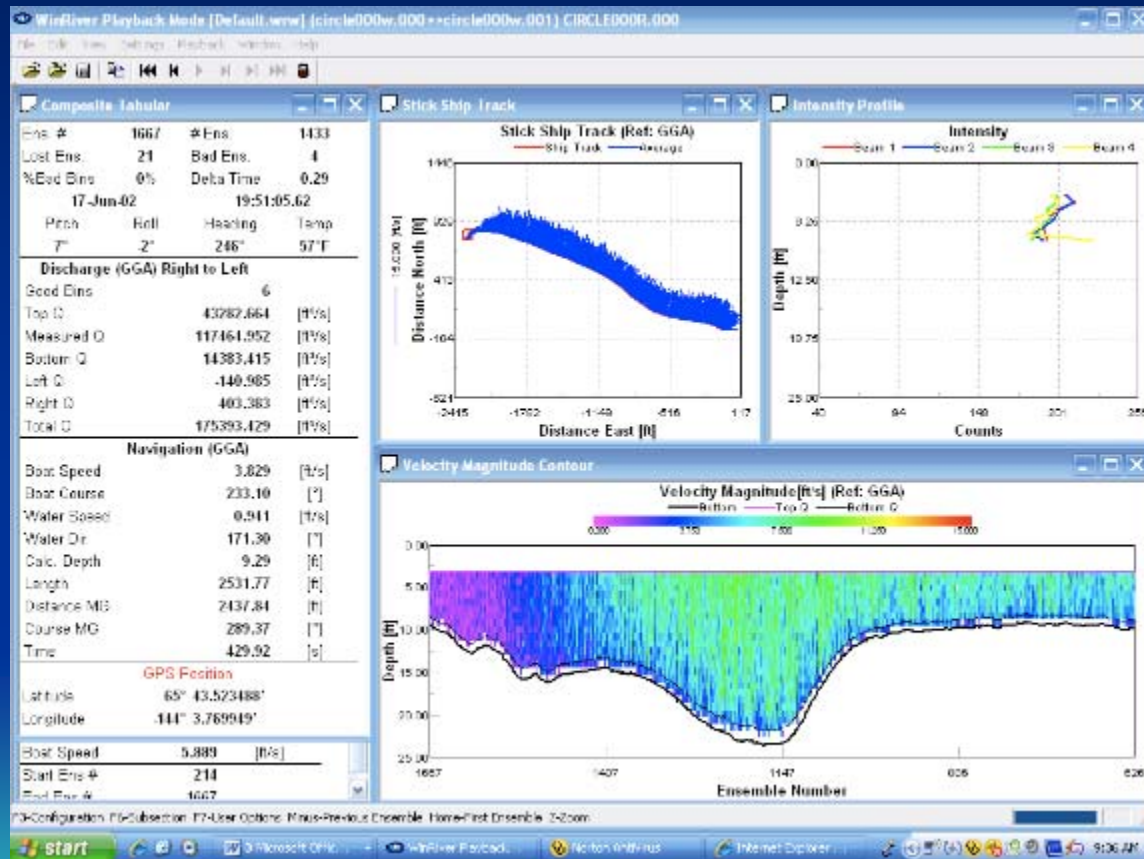


How fast does water flow in our rivers?

- At the Yukon River Bridge, flow rates are about 1-2 meters/sec
- Obtaining accurate velocity profiles of river cross section is very important for assessing the energy potential of hydrokinetic devices



River Profile (Ruby Project)



Do Hydrokinetic Devices Make Sense?

- Even though the energy in the water is free, it cost money for the hardware to capture it.
- Can enough energy be captured over the lifetime of a hydrokinetic device so that the power is cheaper than diesel power?
- Depends on initial capital, Operations and Maintenance costs, and lifetime



Where are devices operating?

- EPRI web site—summary of hydrokinetic devices from suppliers around the world
- Overall view—nothing is working as well as it needs to yet
- In Alaska, three proposed projects
 - UEK device in Eagle (APT)
 - ORPC device in Nenana (ACEP)
 - Small device in Ruby (Yukon Tribal Watershed Council)



UEK Device for Eagle

- Made of Fiberglass (in a boat shop)
- Tested by towing in the Chesapeake Bay
- No long term demonstration in a real river yet.
- Plan for deployment next summer (2009)



ORPC device



Ruby Device



Alaskan issues

- FERC permits issued on a first come/first serve basis
- Fish (probably not a significant problem for adult salmon, but other fish may be affected)
- Ice movement during break-up
- Water flow rates under ice in winter (maximum power demand is during winter)
- Logs and debris
- Abrasive nature of silt in water
- Anchoring in Alaskan rivers



Conclusions

- Not clear if hydrokinetic devices will be part of our long term energy solution
- Need for demonstrations showing cost and reliability data
- Need for better understanding of environmental issues
- ACEP test bed in Nenana
- More presentations on line at <http://www.alaska.edu/uaf/cem/ine/aetdl/conferences/2008.xml>

