New Hydrokinetic Technology for Renewable Energy

Hydrovolts
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Agenda

- Hydrokinetic Energy
- Types of Turbines
- Canal Installations
- Energy Generation
- Economics
- Permits
- Demonstration Project
Hydrokinetic Energy

- **Velocity REALLY Matters**
- \(kWh/m^2 = 0.5 \times V^3 \times \%E\)
  - \((m^2)\) Swept Area in \(m^2\);
  - \((V)\) Velocity in \(m/s\); 1 \(m/s = 2\) knots = 3 \(ft/sec\)
- Efficiency: Increases with Blockage
Speed = Power

At 11 cents/hr, 1 kW/hr full time generation is worth $1000/yr
Types of Turbines

- **Paddlewheel**
  - Lots of superstructure and cost; flotsam fouling

- **Axial**: Propellers, screws
  - Hard to install and fit in canals

- **Cross-Axis**: Darius, Savonius, Gorlov, Flipwing
  - Vertical position is hard to install in canals
Paddlewheels
Axial Turbines
Cross-Axis Turbines
Hydrovolts Flipwing Turbine

- Unique underwater paddlewheel
- Simple construction, easy installation
- Level or spillway installation
- Can actually be a check structure
Hydrovolts Turbine

Replaces this:

With this:
Canal Installations

**Level Flow**
- Like river installation - easier
- Lower velocity and energy
- Can block flow if slope is too small

**Check Structures and Spillways**
- More complex installation
- Head / height = high velocity and energy
- Turbines cannot block flow
Energy Generation

- **Level Flow Example**
  - 5 kW / turbine x 10 / mile = 50 kW / mile
  - Over 800 irrigation districts supplied just by BuRec
  - About 50% appear to have about 20 miles of suitable canal
  - 400 districts x 20 miles/district x 50 kW/mile = 40 MW

- **Spillway Example**
  - 20 kW / turbine x 20 check structures/canal = 440 kW/canal

- **So:** *Real Energy, But Depends on Geography*
Economics

- **Key Factors:** Velocity, Cap Factor, Energy Cost
- **Huge Variability Between Regions**
- **Best Value in High-Cost, Off-Grid and Peak Pricing Regions**
Value to Customer

- Standard 10 kW turbine in good site with electricity cost of 11 cents / kW hr earns about $7000 / yr
- Turbine cost $20,000, 15 year product life
- Maintenance ~ $1000 / yr
- Payback is 4 years; then earn $6000 / yr for 11 years
- Plus: It’s renewable – sell carbon credits, get grants, incentives, financing

Compare Electricity Costs
- Cal. & New England > 16 cents
- UK renewables > 25 cents
- Global average: 15 cents
- Remote sites > 80 cents
Permits

- **Canal Installations Need Few if Any Permits**
- **Natural Streams/Rivers Need LOTS of Permits**
- **Connected to Interstate Grid?**
  - FERC Conduit Exemption < 5 MW applies in canals
  - Simple application, no fee
- **Interconnection**
  - Individual turbines < 10 to 20 kW = net metering
  - Depends on local utility
  - Like small solar or wind – no big deal (maybe)
Environmental Issues

- Canals have few issues – it depends
- Turbine designs have different fish impacts
- Drag designs have least impact

Flipwing Turbine Rotor
Can’t Hurt Fish
Markets

- Canals are found around the world
- Most regions pay much more for power than NW
- Demand for local renewable power is strong and growing

- Big subsidies for renewables and economic development
- Many international organizations ready to promote and fund
Expansion Markets

- Regional Systems
  - New England water mills
  - Canals in Europe, India, SE Asia

- Sector-Specific Water Channels
  - Drinking Water Supply
  - Wastewater Discharges
  - Thermal Power Cooling Water
  - Mining
Jobs

- Small turbines can be mass produced
- Volume reduces price increases sales
- Since most of machine is sheet metal, build most of it locally near customers
- Global market and potentially huge sales
Flipwing Turbine Canal Demonstration, Roza Irrigation District, Sunnyside, WA 7/05/10
Objectives

- Prove that the Flipwing turbine can be installed in a canal in one hour
- Prove that the prototype can operate for 24 hours unattended
- Learn how to improve the turbine and prepare for next demo
Flipwing Turbine
Prototypes
Demonstration Project

- The Roza Irrigation District operates many miles of canals in the Yakima River Valley
- They like idea of renewable energy from their canals
- They allow Hydrovolts to use their canal as a test site
Demonstration July 2010
Deploy with Crane
Safety First

- Downstream Safety Man
- Life Jacket
- Rescue Float
- And a lot more
Installed in One Hour
Turbine operated steadily; Rotor had no weeds on it; The frame caught weeds; Future turbines have no frame.
Flipwing turbine will have fully submersed waterproof generator

Trade-off analysis
- Rotor shaft has low RPM
- Low RPM generators are big, heavy, costly
- Fast RPM generators are small but need a reliable and waterproof speed increaser

Hydrovolts has found unique solution (proprietary!) to be released in 2011
What About Florida?

- Tidal channels should be ignored
  - Not enough useful power
  - Extreme permitting and stakeholder challenges
- Artificial water channels
  - Canal structures and concrete-lined channels
  - Large cooling water or wastewater discharges
- Offshore buoys and sensors
  - Use small turbines to power valuable sensors
  - Small turbines can have very high value
    - Good R&D and design application
Hydropower To Go