Coastal HYDROPOWER

Very Low Head (VLH) Turbine

OWA Emergent Hydro Workshop

May 2011

Confidential CHC Information

Coastal Hydropower Corp.

Science and Nature in Harmony for the Responsible Development of our Water Resources

- Commercialization of low-head turbine deployment and open-flow water turbine technologies in rivers, canals and ocean current regimes
- Expertise and investment capital for rapid commercial turbine deployment
- 2 years of low-head turbine deployment R&D
- 3 years of tidal turbine technology development patents and other related technologies

CANADIAN PROJECTS LIMITED

Coastal HYDROPOWER

Sustainable Energy Engineering

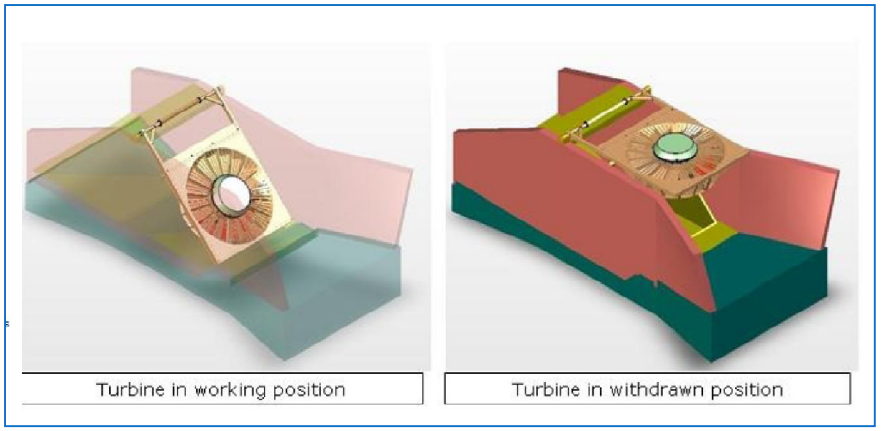
Hydro *Wind* *Solar*

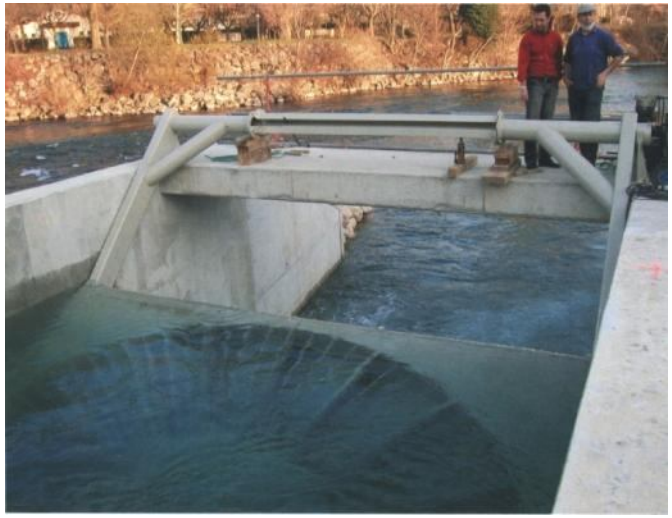
Very Low Head ("VLH") Turbine

Development Story:

- Developed in France and Canada.
- Double regulated Kaplan turbine with slow rotating 8 bladed runner
- Designed for low head <5 m that was previously commercially unfeasible
- Fits into existing water control structures
- Eliminates high cost conventional civil works ~ 50% of typical hydro plant costs
- Short development timeframe - simple design with low impact attributes can allow projects to be done in about a year instead of typical hydro project of 3 - 6 years

Very Low Head Turbine





Application:

- Existing structure sites
- Head: 1.4 – 5.0 m
- 4 Sizes: 3.5, 4.0, 4.5 & 5.0 m dia.
- Capacity: 350 kW – 500 kW / unit
- Flow: 10 - 30 m^3/s.
- High w2w Efficiency : ~ 80%
- Lifts for floods & maintenance
- Interconnects to low voltage distribution lines or off-grid

Very Low Head Turbine

Technology Attributes:

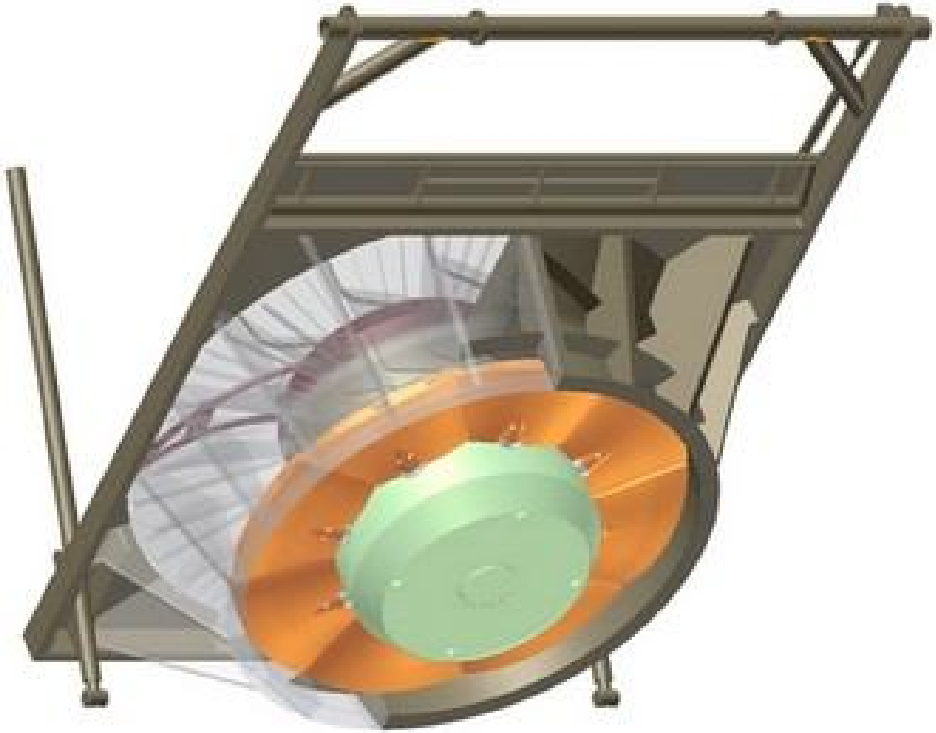
- Use PMG synchronous generator (direct-drive – variable speed)
- Incorporates trash cleaning system
- Low Environmental Impact:
  - Fish Friendliness (site tested & verified in France)
  - Silent operation
  - Very low visual impact (below deck/ mostly submersed)
- Coastal has deployment methods for adaptation to North America

Holistic Design

- Single element design includes:
  - Turbine
  - Generator
  - Gate
  - Trashrack & Cleaner
  - Fish Passage (~100%)
  - Lift System

- Fits in existing gate bays with minimal modifications

VLH Turbine



VLH Turbine Installation

After site assembly of the unit and mounting brackets simply lower into place

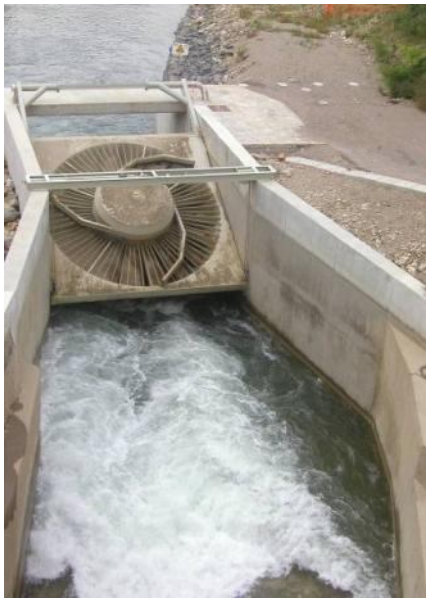
Cranage of the 26 T VLH into its final location

Rotation of the VLH to its inclined working position

Initial Operations

17 units are now deployed

Over four years of full scale operation in France



VLH Turbines Installed - Europe

References VLH

February2010

Site	Turbine Type	Nom Output	River	Customer
Millau*	DN 4500	410 kW	Tarn	Forces Motrices de Farebout
La Roche*	DN 3550	140 kW	Mayenne	SHEMA (EDF)
Clairvaux*	DN 3550	278 kW	Aube	CHBC S.A.R.L.
Huningue 1*	DN 3550	198 kW	Canal Huningue	Forces Motrices de Huningue
Huningue 2*	DN 3550	142 kW	Canal Huningue	Forces Motrices de Huningue
Les Barrets*	DN 3550	386 kW	Garonne	SNC APAS
Moncey*	2 DN 3550	207 kW	Ognon	Nature Energie S.A.R.L.
Frouard*	DN 4500	400 kW	Moselle	SHF
L'Ame*	DN 3550	145 kW	Mayenne	SHEMA (EDF)
Vila D'Alme	DN 3550	357 kW	Brembo (Italy)	STE-ENERGY
Montodine	DN 4500	500 kW	(Italy)	STE-ENERGY
Marcinelle	2 DN 3550	323 kW	Sambre (Belgium)	Merytherm
Terrasson	2 DN 4000	448 kW	Vezere	Energie Verte de Terrasson
Lipki	4 DN 5000	360 kW	Oder (Poland)	INECO Sp.

*Commissionned

VLH Turbine Operation

Upstream view of the VLH
in the empty inlet channel

VLH in Operation

Low Environmental Impact

Designed specifically to have low environmental impact which facilitates ease of approval and rapid development deployment

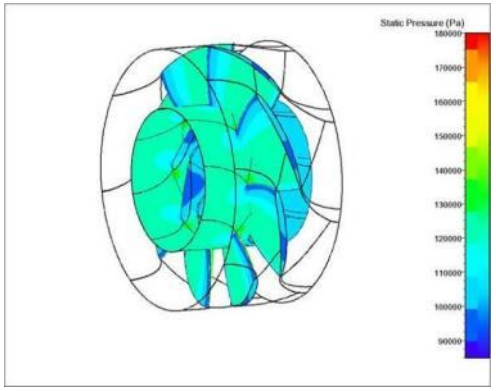
- Fish-friendly
- Minimal footprint
- No flow diversion
- Silent operation
- Low visual impact
- Low impact on heritage and cultural values

Fish Friendliness

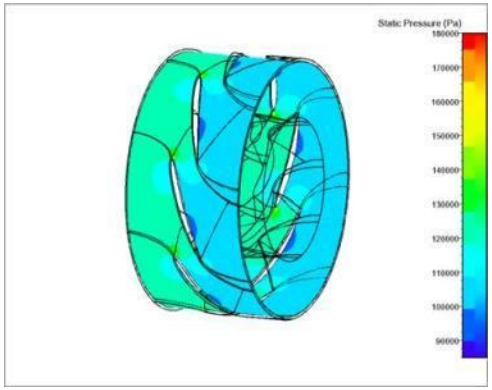
CFD Analysis

CFD Analysis show the VLH fulfils all criteria for fish friendliness:

1) **Peripheral Speed**
   Acceptable: 6 to 12 m/s VLH: 4.5 to 8 m/s
2) **Minimum Pressure**
   Acceptable : 69 kPa VLH: 94 kPa
3) **Maximum Pressure Variation**
   Acceptable: <550 kPa/s VLH: 80 kPa/s
4) **Max Flow Velocity Variation**
   Acceptable: <180 m/s/m VLH: 10 m/s/m
5) **Blade to Discharge Ring Gap**
   Acceptable: <2.0 mm VLH: <2.0 mm



Pressure values on runner according to hub distance



Fish Friendliness

Full Scale Live Testing

Tests have been done in France with live Eels and Salmon smolts

Recovery system

Recovery Platform

Injection Device

Eels size 0.7 up to 1.2 m

Eels Injection

Recovering eels with a dipnet

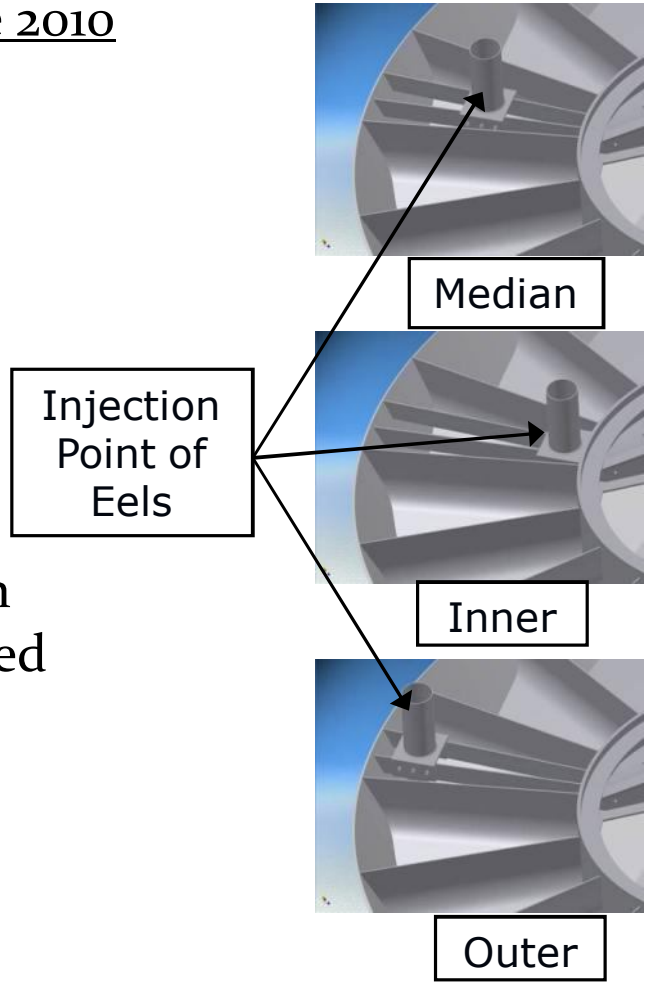
Fish Friendliness

Full Scale Live Testing

Latest tests performed at Frouard, France - Late 2010

Peer Reviewed Report Released - March 2011

- 200 eels were injected at 3 locations
- Recaptured eels were observed for 24 to 48 hours to check for internal injuries
- Careful visual inspection showed superficial injuries in 2% of the specimens
- Over 200 other fish entered the turbine from the river during the testing and were captured downstream - All Survived



Survival Rate : 100%

Market Opportunity

- **112** sites have been identified across **Canada** for VLH deployment so far
- ~ 2,000 undeveloped dams in **Ontario** are likely suitable for power generation. Potential for low head hydro in Ontario is ~ 7,000 MW. Small projects under 1 MW have not been fully assessed specifically but are expected to add substantially to this potential.

- **US:** DOE estimates more than 80,000 dams and water control structures in the US, 2,400 of those presently have power generation. Unpowered dams and weirs could amount to an additional 73,000 GWh per year.

Challenges for VLH Technology

- VLH Adaptation for cold climate operations through implementation of the VLH Cold-climate adaptation package
- Regulatory Acceptance with a modified approval process suitable to accommodate rapid VLH deployment
- Fish Testing / Monitoring in North America to prove performance with local species

VLH Deployment in Ontario

Key Points:

- Access to a new innovative technology for hydropower generation
- Generation at very low-head sites (<4m) previously not considered feasible
- Can generate 100's of MW's from existing structures across Ontario/Canada
- VLH technology has a very low environmental impact when deployed at existing structures & is fish friendly
- Cooperation and support is required to implement the VLH in NA
- Need to demonstrate the VLH technology in NA to gain understanding
- This investment & successful implementation enables us to tap a significant new source of renewable energy in Ontario/Canada/NA
- Regulatory regime for this emerging technology needs to be streamlined

Questions?