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THOR's Power Method for
Hydrokinetic Devices

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Purpose, Objectives, & Integration

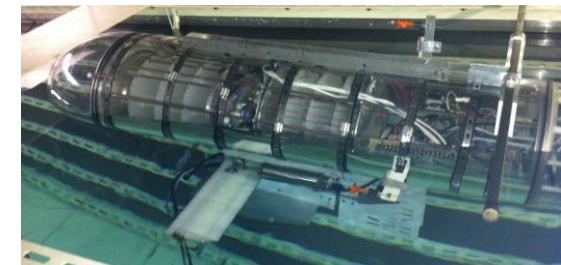
Project Objective: Demonstrate the significant increase in net capacity factor (NCF) resulting from operating a hydrokinetic device in accord with THOR's Power Method (TPM) – a constant speed, variable depth method of operation that provides power regulation via depth change, not via conventional rotor blade pitch angle change.

Challenges / Problems:

- (1) Construction/Operation of an open channel re-circulating water flume capable of producing programmable time-variant inverse velocity sheer water current profiles in the test section – such a hydrodynamic testing facility does not exist – until now. There are 24 independently 'throttle-able' 2hp electric motors located on 'shelves' at varying depths.
- (2) Design/construction and operation of a tethered variable depth ocean current turbine scale model with a fully functioning control system capable of executing THOR's Power Method. The primary software feedback loop senses power output from the onboard generator/rotor and changes depth of the model to track a constant (rated/full) power output as water current conditions change – hence constant speed, variable depth method of operation.



THOR's Open Channel Re-Circulating Ocean Current Flume. Water depth speed profiles can be tailored to simulate various flow conditions.



THOR's Scale Model Ocean Current Turbine with fully functioning control system and integral on-board power generator

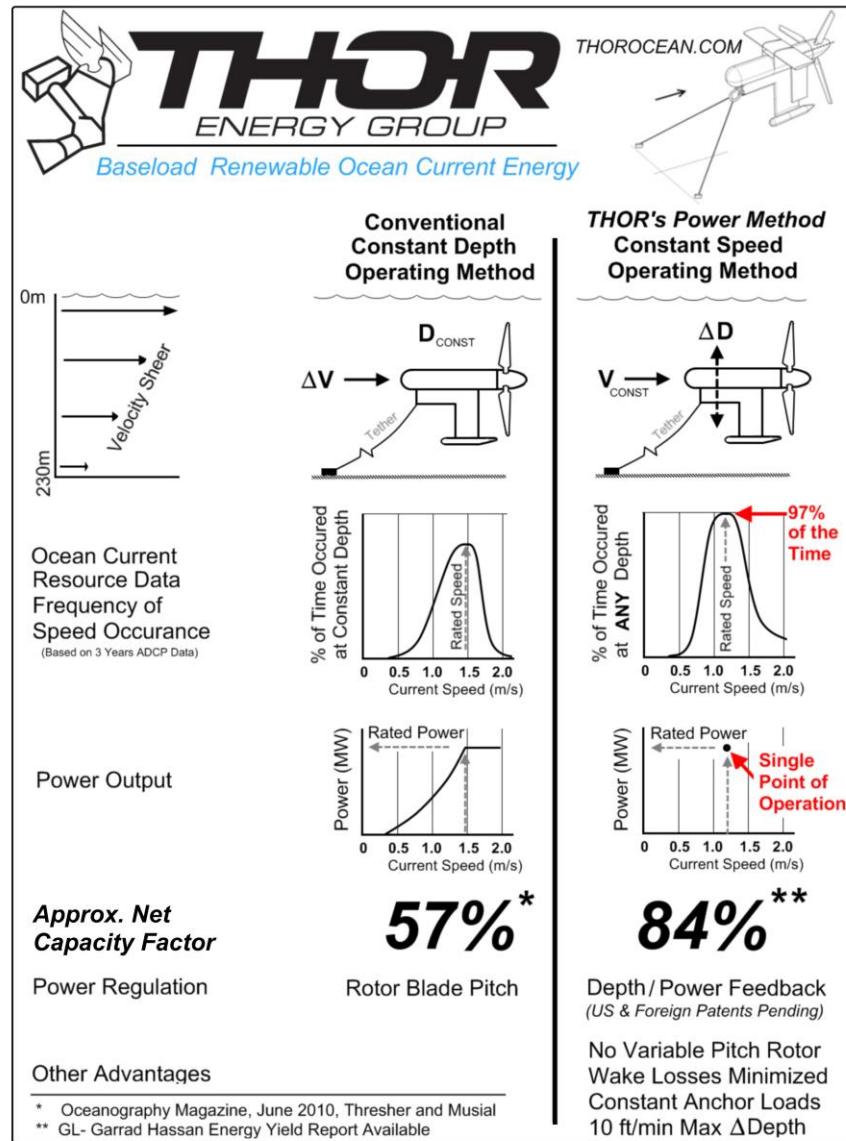
Technical Approach

THOR's Power Method:

Previous ocean current resource assessment work from available ADCP data indicates that a single ocean current speed (about 1.3 – 1.5 m/s) is present somewhere in the water column (top 200 meter depths) over 97% of the time. THOR's Power Method causes the ocean current turbine to change depth (depth regulated power control) to track this ever-present single speed. Third party independent energy yield analysis confirms increase in NCF's from 50% (using conventional pitch regulated power control) to above 80% (using THOR's Power Method).

Four-Step Technical Approach

- (1) Build and operate a re-circulating ocean current flume with programmable inverse velocity sheer water current profiles that mimic typical ocean currents.
- (2) Complete design and construction of a functional 1:50th scale model. The scale model includes a fully functioning control system with onboard power generator/rotor. The control system includes various sensors and control effectors that modulate lift, weight and drag in order to execute THOR's Power Method.
- (3) With the involvement of Virginia Tech, complete numerical control method simulations, then code, and implement the control algorithms into the scale model that will operate in the ROC-Flume in varying inverse velocity shear current conditions.
- (4) Conduct a systematic scale model testing program in the ROC-Flume using time varying ocean current conditions that fluctuate and resemble the ADCP data – and verify the scale model's ability to continuously output full power as the model changes depth.



Schedule

- Initiation date: Sept. 2010
- Planned completion date: Mar. 2010
- Milestones: Flume Completion Apr. 2011, Model Completion Aug. 2011, Initial Model in Flume Runs Sep. 2011

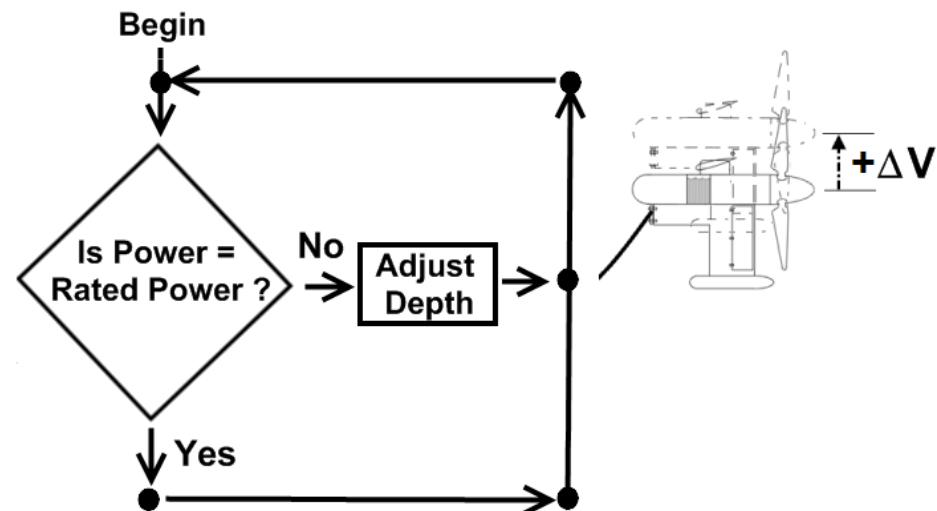
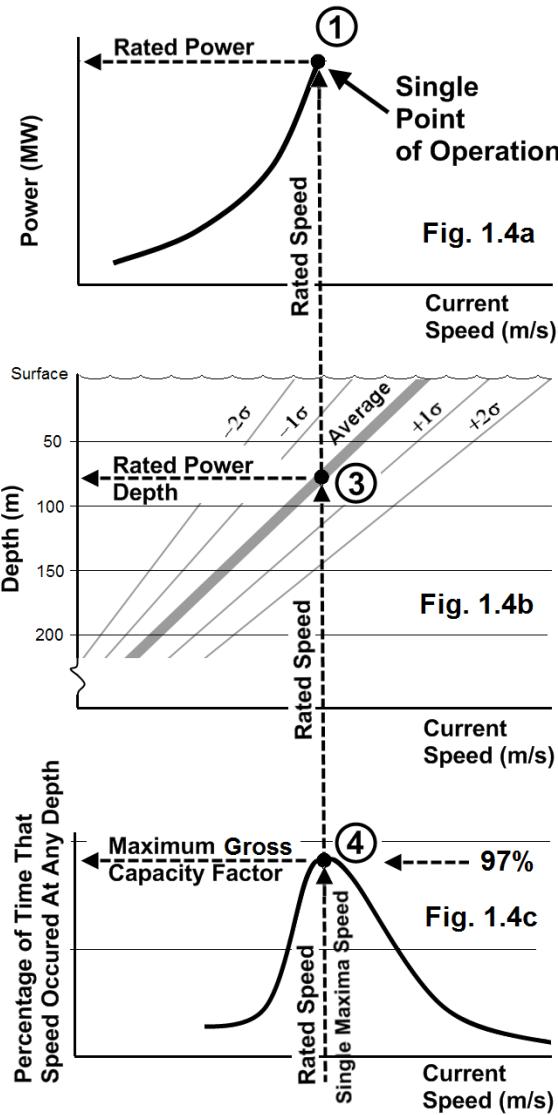
Budget:

- On Schedule
- Approx. 80% Funds expended to Date (Sept 2011)

Budget History

FY2009		FY2010		FY2011	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$0	\$0	\$31,326	\$10,275	\$311,000	\$103,000

THOR's Power Method Additional Technical Description



Simple Control Algorithm