Tidewalker Associates
energy · environment · community
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Tidewalker Associates, an energy development group in Trescott, Maine, held a preliminary permit from the Federal Energy Regulatory Commission (FERC) for the investigation of a tidal power site in Cobscook Bay from 2007-1010. Tidewalker applied for a successive preliminary permit in April 2010 and continues working on plans to construct and operate a tidal barrage (dam) at the entrance of Half-Moon Cove which is located between the communities of Perry, Eastport, and the Passamaquoddy Tribe Reservation at Pleasant Point. Tidewalker's project is being designed as a tidal power facility compatible with local electrical needs and with the potential to stimulate the economy by utilizing energy production on a regional basis. Tidewalker is also committed to maintaining the environmental integrity of the region and to sharing project benefits with local communities. This report addresses questions associated with the best use of the tidal resources of Cobscook Bay and Passamaquoddy Bay and attempts to place some balance on the review of an alternative proposal made by Ocean Renewable Power Company (ORPC). The report concentrates on a specific technical area which affects project feasibility and acceptability. Tidewalker has concluded that ORPC has grossly overestimated energy production, a factor which significantly determines economic viability.

Tidal Power in Downeast Maine

Since 2006, Ocean Renewable Power Company (ORPC) has conducted an effective public relations program chronicling the development of their current-driven energy technology. ORPC has also been successful in receiving grants from U.S. Department of Energy (DOE), Maine Technology Institute (MTI), and U.S. Coast Guard (USCG) while being able to obtain private investment. The total amount of support probably approaches close to twenty (20) million dollars for ORPC sites in Eastport, Maine and Alaska. What has been the net result of all this work? What are the realistic expectations?

During the same period, Tidewalker Associates of Trescott, Maine has been working on the development of a tidal dam near Eastport at a site physically compatible with ORPC plans. The Half-Moon Cove site will produce approximately nine (9) megawatts of tidal power compared to ORPC's plans for up to two hundred (200) megawatts of electrical generation. In their publicity notices, ORPC states that current-driven devices have less environmental impacts than a tidal dam mode of development. Tidewalker disagrees with this assertion based on information from recent technical reports and in consideration of the specific nature of the Eastport environment.

Tidewalker Associates is proposing a "run-of-the-tide" mode of operation which will not result in a reduction in the tidal range within Half-Moon Cove. During the past year, Tidewalker's focus has changed by concentrating on the use of the Gorlov Helical Turbine (GHT) designed by Dr. Alexander Gorlov. Tidewalker is also considering the use of a flexible dam to reduce material and construction costs and to enable more leeway in addressing environmental concerns. Tidewalker filed an application for a successive preliminary permit in April 2010 and is waiting for a decision from the Federal Energy Regulatory Commission (FERC) on a competing application which would utilize reversing turbines with pumping capabilities. Tidewalker rejected the pumping option since adoption of this method would require dependence on an external source of energy and would significantly decrease environmental acceptability based on a convoluted mode of operation. Dependence on an external source of electricity to maintain environmental conditions will require safeguards for back-up / emergency energy which deters from the model of a green facility and which adds project costs and complexity to the engineering design. Tidewalker continues working on the development of tidal power in Cobscook Bay (Maine) for the reasons outlined above.

Tidewalker has remained silent on the ORPC proposal. Internally, we have researched the subject matter and have questioned some of the publicity notices. The unique resource of Cobscook Bay and Passamaquoddy Bay refers to the tidal ranges which average eighteen (18) feet and not to the tidal currents created by the ebb and flow of the tides. In an ironic way, the fact that the tidal range varies from neap (12' tides) to spring (25' tides) conditions during a typical twenty-eight (28) day lunar cycle creates a problem for ORPC development efforts in terms of being able to supply consistent power levels. As a point of clarification, the term "spring" tide refers to the tide that occurs at or soon after the full moon and new moon, a phenomena occurring twice during a twenty-eight (28) day lunar cycle. Neap tides correspond with the presence of half moons and are the lowest tides occurring twice in a monthly lunar cycle.

Tidal current (i.e., hydro-kinetic) devices do not generate energy during an extended period of time before and after low and high tide. In the Passamaquoddy Bay region, energy generated from hydro-kinetic turbines during neap tides might be eight times less than the comparable production during spring tides. The difference between neap to spring tide conditions introduces a related problem associated to the ability of the generator to ensure a consistent supply of energy production both in terms of time duration and power levels during a 28-day lunar cycle due to the 8:1 ratio in comparative energy production between spring and neap tides.

Tidal dams have similar problems related with the absence of production before and after high and low tide, but the ratio of production during spring and neap conditions is only 2.5 as compared with 8.0 for current driven devices placed in Cobscook Bay and Passamaquoddy Bay. A tidal dam controls basin levels to increase potential energy and operates under higher equipment efficiencies than under the hydro-kinetic scenario.

For the Tidewalker proposal, a mode of operation has been formulated which does not change the tidal range within Half-Moon Cove. Under these conditions, project impacts are now concentrated on fish passage through the turbines and on boat access to the tidal basin with an approximate surface area of 1000 acres at high tide. For a tidal dam, equipment specifications and construction methodologies have been developed at other sites which provide the availability of “off-the-shelf” technology for immediate implementation instead of being dependent on a research & development component for hydro-kinetic devices.

ORPC has filed an incomplete license application with the Federal Energy Regulatory Commission (FERC) for permission to install five energy generating systems each with a capacity of one megawatt. The one megawatt array is comprised of four hydro-kinetic turbines each with an installed capacity of 250 kilowatts and with an effective area of 600 square feet. The basic ORPC turbine resembles an old-fashioned lawn mower with dimensions of around 60’ (width) by 10’ (diameter). In their FERC filing, ORPC has estimated a total project cost of thirty-eight (38) million dollars for five (5) megawatts of nameplate capacity.

ORPC plan to anchor their devices under the lowest low tide level in mid-channel and expect to generate 0.76 million kw-hours of electricity in a typical year from the basic unit; i.e., 250 kw with a peak efficiency of around thirty (30) percent. As a reference point for the amount of energy generated from the ORPC unit, 105 typical households consuming approximately 7200 kw-hours of electricity in a year would be able to utilize ORPC production under continuous operation which is not the case for hydro-kinetic generation due to an intermittent production schedule. In their energy calculations, ORPC has assumed units with an availability factor of 0.80 for a mode of operation which generates electricity at a rate proportional to the third power of current velocity. Under this relationship, eight times the energy will be derived from a six knot current than from a three knot current; i.e., cubing the resultant of six divided by three. This somewhat extreme dependence on velocity emphasizes the importance of selecting sites with substantial tidal currents.

In an attempt to reproduce ORPC calculations, Tidewalker determined from FERC files that ORPC used an approach based on characterizing a typical day of operation and then multiplying the results by 366 days to obtain annual energy production from their hydro-kinetic units. An illustrative basis for the approach is depicted below (Fig. 1) by plotting the average velocity range in knots versus two parameters for the 24-hour analysis day: (1) % of energy produced for a corresponding velocity range (Series 1); and, (2) % of time during the representative day corresponding to the presence of the respective velocity (Series 2). The energy % curve is reasonable since it resembles an exponential behavior (i.e., parameter to the third power); however, the time % curve is represented by a nearly flat-curve for low velocity values followed by spike observations for velocities greater than 5.3 knots. This relationship does not seem consistent with tidal observations and places greater value / weight on tidal currents greater than five knots for the bulk of the energy generation. This curve indicates that tidal currents greater than five knots will be present for 40 % of the time (year) which is not consistent with information provided in ORPC's filing with FERC on the pilot license application.

Since energy is proportional to velocity cubed, the presence of currents greater than five knots results in a distorted analysis of hydro-kinetic potential. Based on a review of ORPC data, the representative design tide seems to refer to a spring tide and the inherent utilization of extreme current values for the bulk of the estimated energy production. Under our analysis of the representative tidal function, ORPC estimates that approximately three quarters of energy production occurs when tidal currents are greater than five knots as illustrated below (Fig. 1) which then serves as the unit value for extrapolating production for one year.

In reality, neap tide operational levels should be included into a distribution function to represent the full spectrum, and not only optimum, conditions.

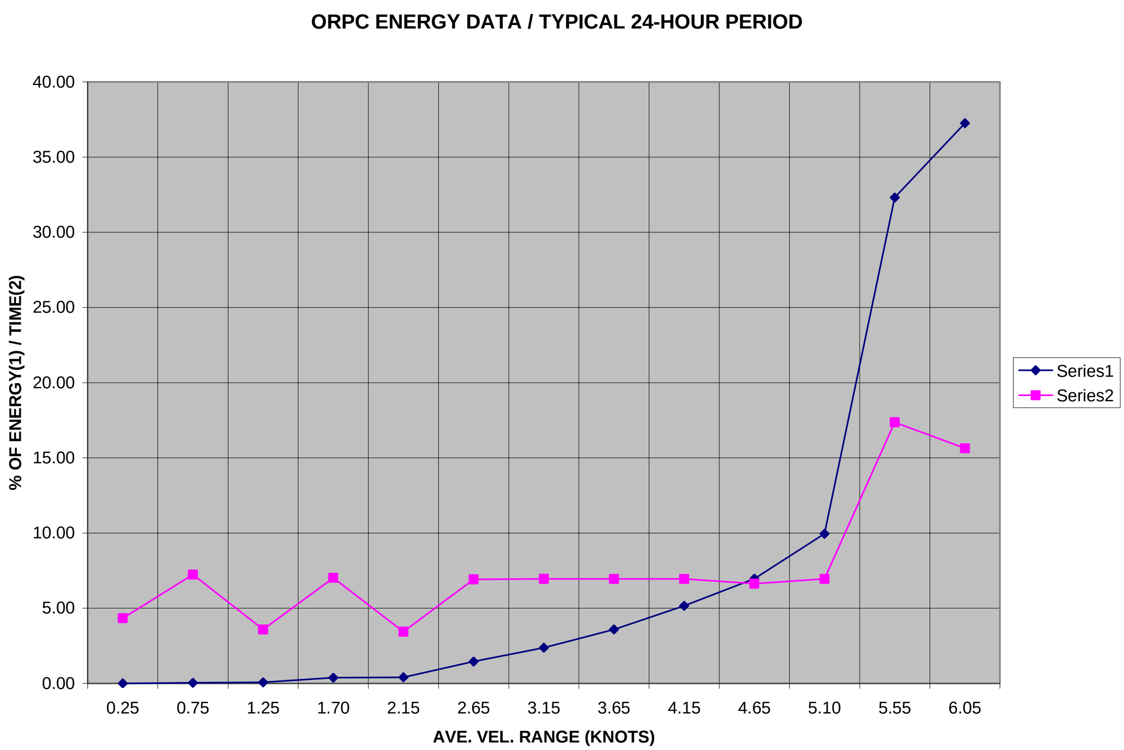

Figure 1: ORPC Data on Representative 24-Hr Tide (FERC)

Concerns with the accuracy of ORPC's annual energy calculation are magnified by taking the 24-hour characterization for production expectations and multiplying by 366 days to determine annual energy production. Based on best available information, the data depicted above represents the current profile under spring tide conditions but with an unrealistic expectation of having currents greater than five knots for nearly ten hours a day. Since production is eight times greater for a spring tide than a neap tide, ORPC's multiplication by 366 ignores relatively less production under neap tide conditions for the calculation of annual energy production. The simplification embodied in ORPC calculations might result in a value for annual production which is 2-3 higher than expected if the analysis included other than spring tide representations. For ORPC's representative design curve, the time weighted velocity is equal to 4.1

knots. A question remains, in our opinion, on the correct choice for ORPC's representative design curve since 4.1 knots is not a realistic average value.

A typical distribution of current velocity versus location from shore as measured at Western Passage for a spring tide for ORPC is depicted below. Please note that the time after high tide is denoted by lines with different formats and colors.

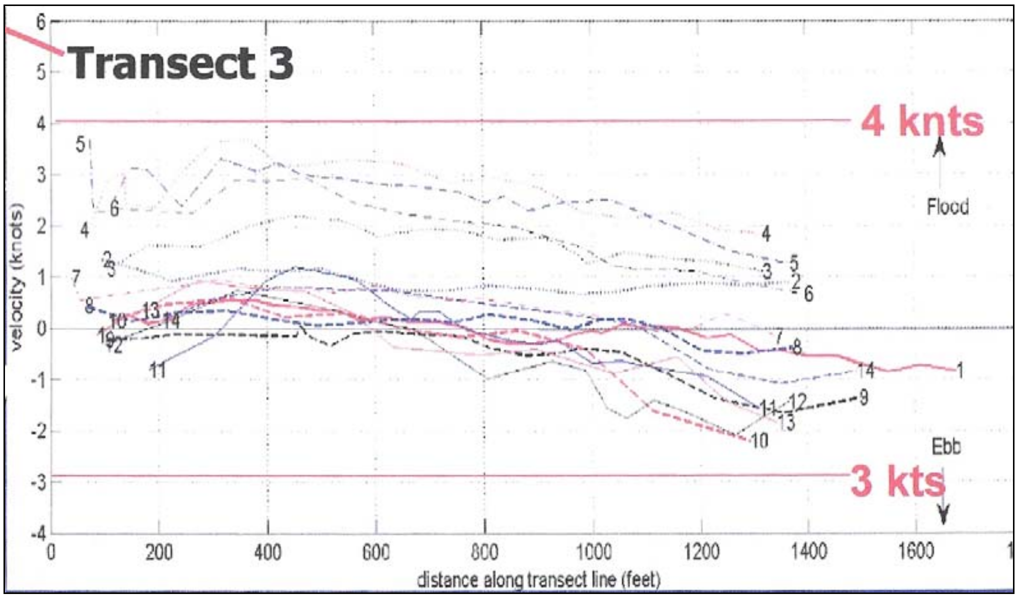

Figure 2: Spring Tide Velocity Measurements (ORPC)
Transact No. 3

This information was then used to prepare a velocity versus time curve for Transact No. 3 at 1200 feet from shore as depicted below (Fig. 3).

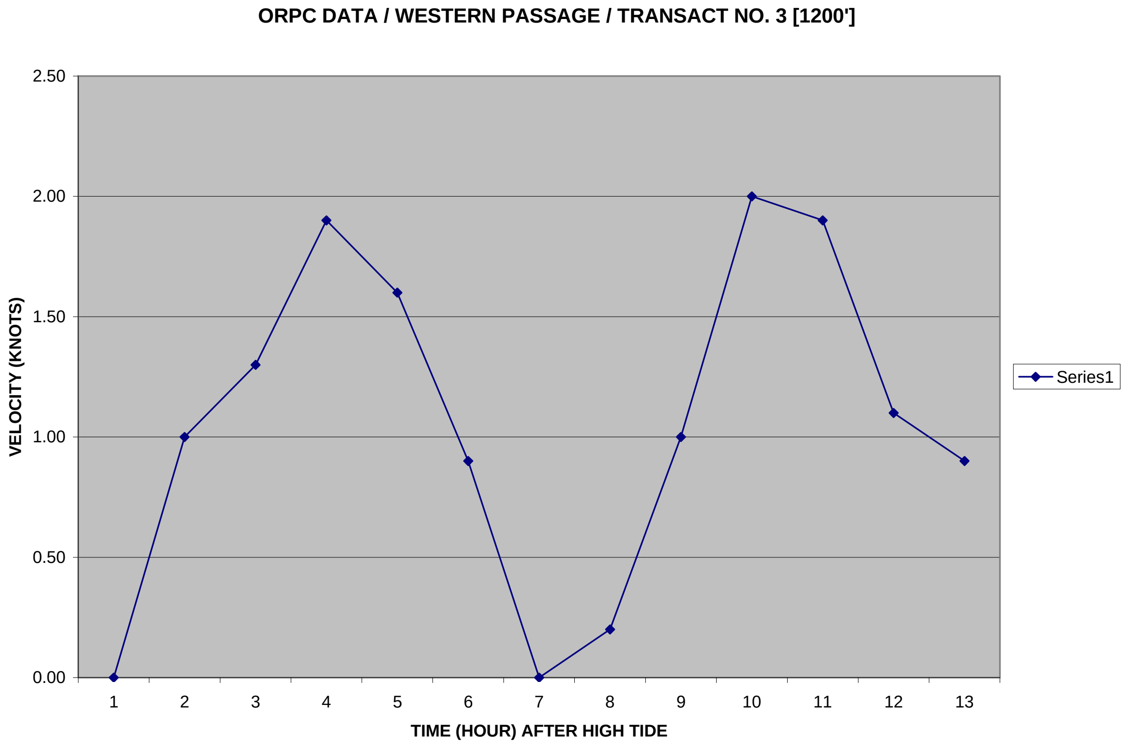

Figure 3: Extrapolated Data From Figure 2 @1200'

In an attempt to obtain a better velocity profile, additional measurements were conducted along a different transect (ORPC data) within the Western Passage area which resulted in better conditions for hydro-kinetic energy generation as depicted below. In this case (Figure 4), current velocities approach six knots for spring tide measurements which might have been used to prepare the representative curve derived by ORPC to determine a database for calculating annual energy production; however, ORPC still multiplied a daily estimate calculated under optimum conditions by 366 days in a year to arrive at the estimate appearing in their FERC filing of 23.November.2010 which seems to neglect lower production expectations for less than spring tide conditions.

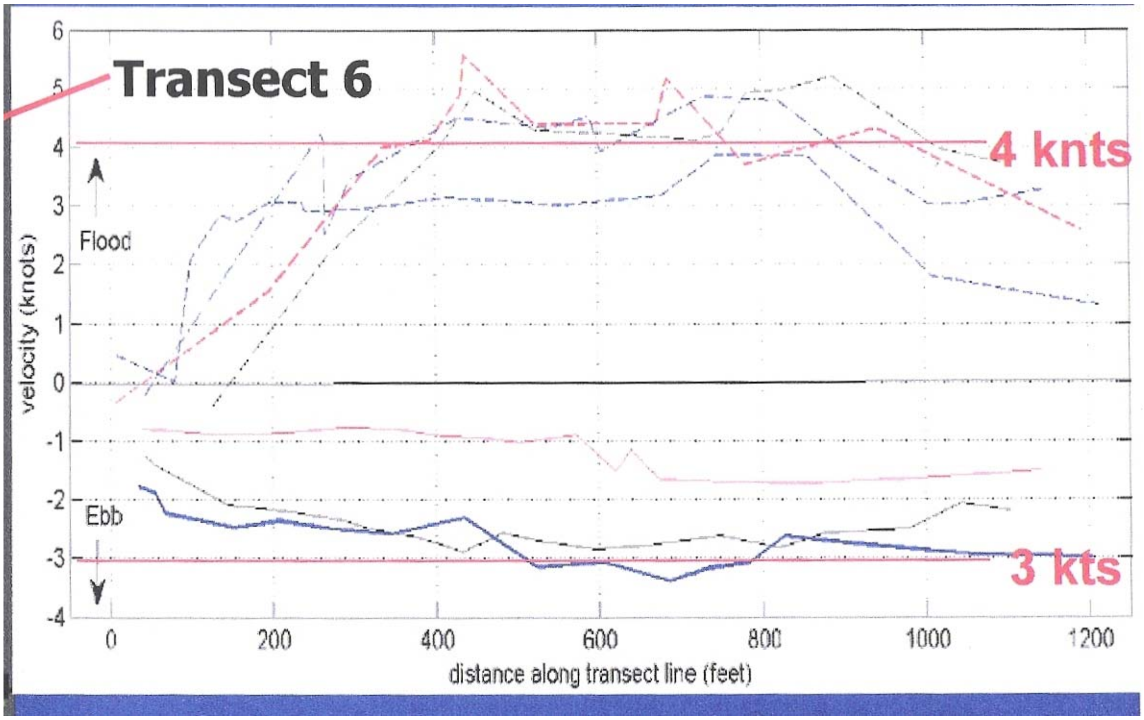

Figure 4: Velocity Measurements / Transact No. 6

For these reasons, Tidewalker believes that the ORPC calculations have grossly overestimated energy production by a multiplicative factor which could approach two or three based on the 8:1 ratio for spring to neap tide production and proportional ratios for average tides. From Figure 4, the following distribution is derived in Table 1. The "type" column refers to actual readings and to an interpretation ("interp.") when data is not available on Figure 4. The interpretation was accomplished by averaging nearest available readings with low tide and high tide values assumed as being slack conditions; i.e., velocity equal to zero.

Type	Time After Low Tide (hour)	Velocity (knots)	Time Weighted Average (hours)	% Time Velocity > 4 knots
interp.	1	1.53		
reading	2	3.06		
reading	3	4.44		
reading	4	5.50		
reading	5	4.63		
interp.	6	2.31		
	High Tide		3.58	50
interp.	8	1.44		
readings	9	2.88		
interp	10	2.59		
readings	11	2.31		
interp.	12	1.63		
readings	13	0.94		
	Low Tide		1.96	0

Table 1: Optimum Velocity Distribution (Spring Tide)

A plot of Table 1 is illustrated below (Fig. 5) as a representative design tide depicting spring tide conditions:

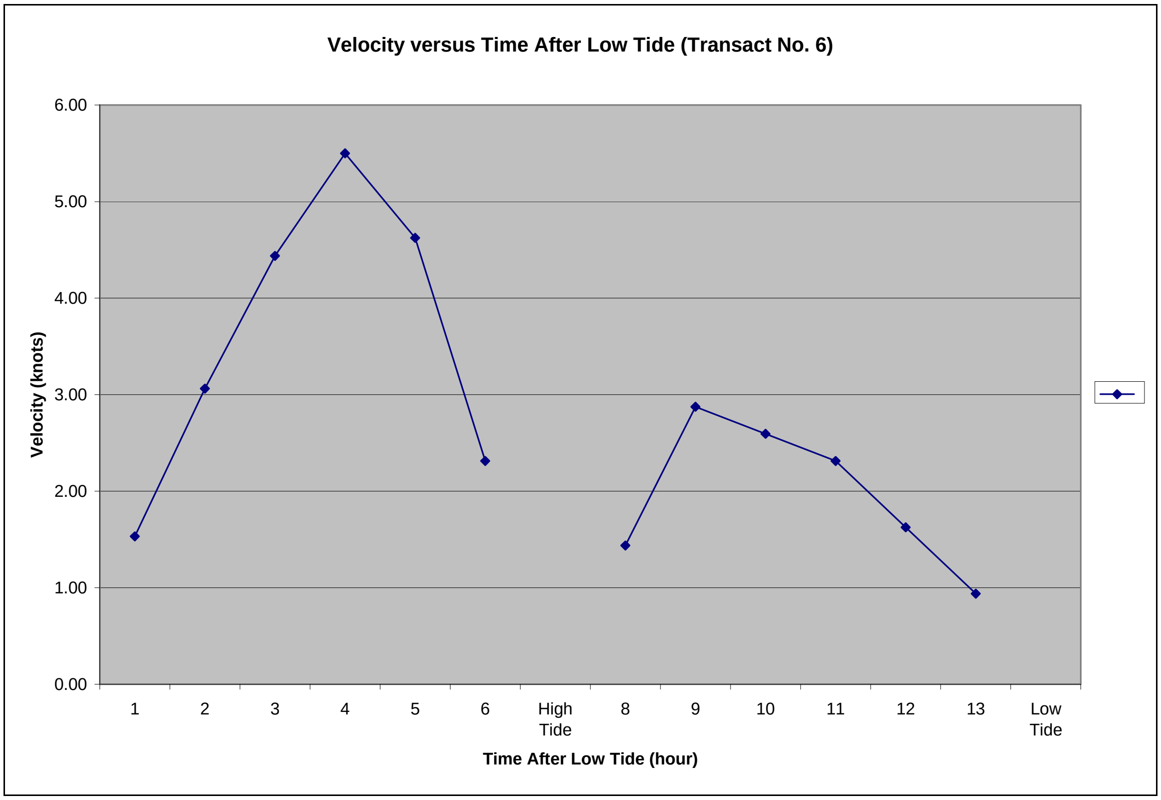

Figure 5: Velocity Versus Time (Transact No. 6)

The profile depicted in Figure 4 / 5 was used to calculate an annual energy production of 0.367 gw-hr with an installed capacity of 188 kw. The distribution illustrated in Figure 1 was then used to represent a normal tidal function with a period of 12 hours and 25 minutes. From this representation, Tidewalker calculated an annual energy production of 0.92 gw-hr with an installed capacity of 250 kw while using the same approximations used by ORPC for equipment specifications. In comparison, ORPC estimated 0.76 gw-hr for their basic hydro-kinetic device with the same installed capacity of 250 kw. In order to verify energy calculations, ORPC needs to provide their source of information for predicting current conditions along with a description of their methodology to calculate annual production. Based on best available information, the assumptions reflected in Figure 1 by ORPC seem to represent an optimistic characterization of available tidal flows. However, the major uncertainty refers to ORPC's decision to multiply spring tide estimates by 366 days / year in order to calculate annual energy production.

In summary of Tidewalker's concerns with the ORPC proposal, the following points are listed based on our limited knowledge of ORPC plans:

- Published annual energy production estimates seem overly optimistic without properly considering impacts of neap tide conditions
- Based on an estimated cost of thirty eight million dollars for the proposed 5 mW pilot project, the anticipated cost of energy will be higher than competitive values for other renewable energy projects
- Location of proposed ORPC array in Western Passage has not been analyzed with respect to potential impacts on Canadian resources; e.g., "Old Sow" / whirlpool
- Environmental impacts on endangered species (e.g., acoustic waves) have to be carefully considered in terms of statutory requirements due to presence of whales and Atlantic salmon
- Cumulative impacts of 100-200 arrays placed in Cobscook Bay are significant for existing fishing practices and for predictions on potential tidal range reduction
- ORPC design which is very similar to the GHT does not seem to be well suited to the dynamic current / tidal conditions of the Eastport area due to the use of a horizontal axis and due to the potential appearance of a non-uniform velocity profile over the length and height of an ORPC array
- Performance information collected from grants has not been readily available to determine technical feasibility of hydro-kinetic development in Cobscook Bay and Passamaquoddy Bay
- The installation of 100-200 ORPC arrays will require new and higher rated transmission lines

Based on our analysis, Tidewalker has concluded that the ORPC proposal will: (1) produce relatively expensive electricity; (2) create significant environmental impacts; and, (3) require a reduction in commercial fisheries activities. At least one of these concerns can be addressed by allowing an extensive review of ORPC's methodology for calculation annual energy production. TIdewalker has raised this concern in our discussion since it is an important factor in properly assessing the potential of hydro-kinetic devices in Cobscook Bay and Passamaquoddy Bay. Since institutional support is limited during a period of economic distress, an effort should be made to funnel assistance to projects based on accurate information. Projects with the lowest cost of production along with acceptable environmental impacts while emphasizing regional development objectives should receive priority attention.

In conclusion, nearly twenty million dollars has been spent on the ORPB turbine. Even with uncertainties regarding turbine performance, ORPC should have a relatively accurate estimate of energy production potential. Based on best available information (e.g., FERC filings), doubt seems to exist on the energy generation potential of the ORPC unit. Hydro-kinetic is a clean technology utilizing a renewable and predictable source of energy. ORPC needs to address economic and environmental issues which should be documented in a complete FERC application for a pilot project in Cobscook Bay and Passamaquoddy Bay.

During the same time period, Tidewalker continues work on a tidal barrage at the entrance to Half-Moon Cove. An obvious bias against hydro-electric dams plagues progress on the Tidewalker project even though a tidal barrage is drastically different than a conventional river dam on environmental impacts.

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