



# Integration of Wave and Tidal Power in Coastal British Columbia

Presented by:  
**Justin Blanchfield**

Supervisors:  
Dr. Andrew Rowe and Dr. Peter Wild

# Case Studies

## 1. Wave Power Integration into the Ucluelet Area Grid

- Louise St. Germain, MASc, Nov 2005

## 2. Tidal Power Integration into the Queen Charlotte Islands/Haida Gwaii Grid

- Justin Blanchfield, In progress

# Case Study #1 – Wave Power

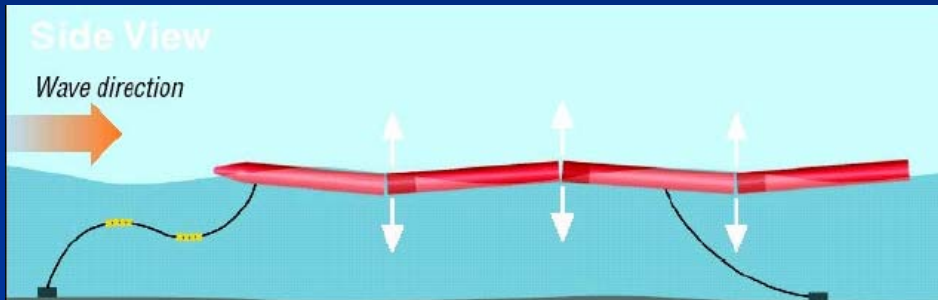
# Ucluelet Area Grid Properties

- Two 15 MW feeders
- Meet at Long Beach Substation (LBH)
- Total 30 MW at LBH



# Wave Energy Converters (WECs)

## Pelamis (US and UK Versions)

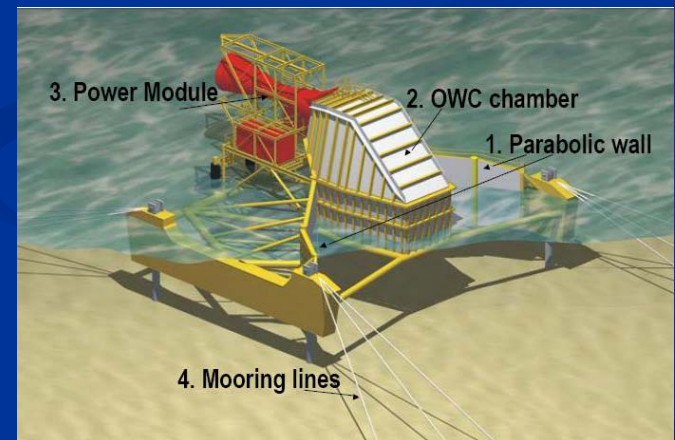


## LIMPET OWC



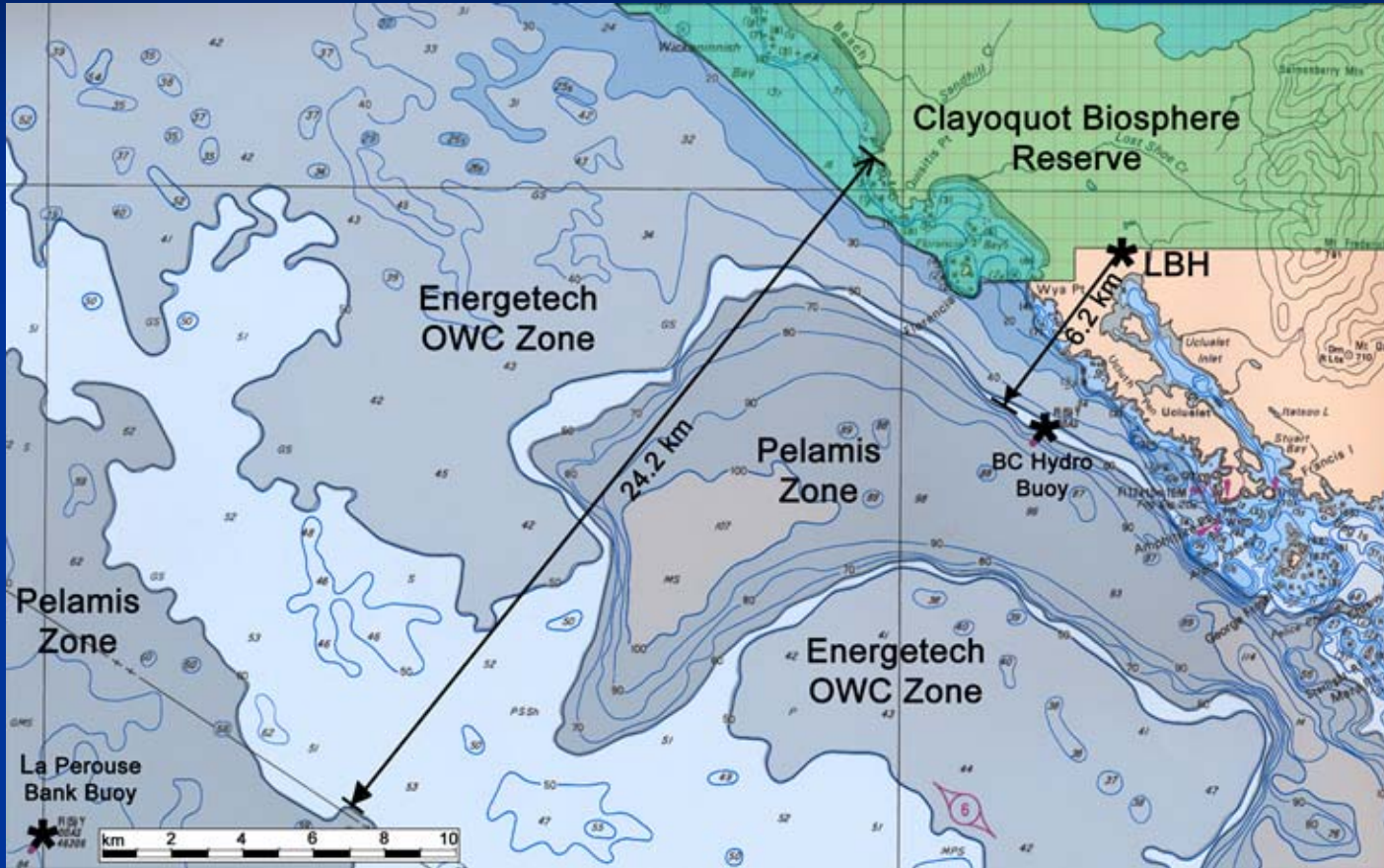
[www.dti.gov.uk](http://www.dti.gov.uk)

## Energetech OWC



[www.energetech.com.au](http://www.energetech.com.au)

# Map of Zones

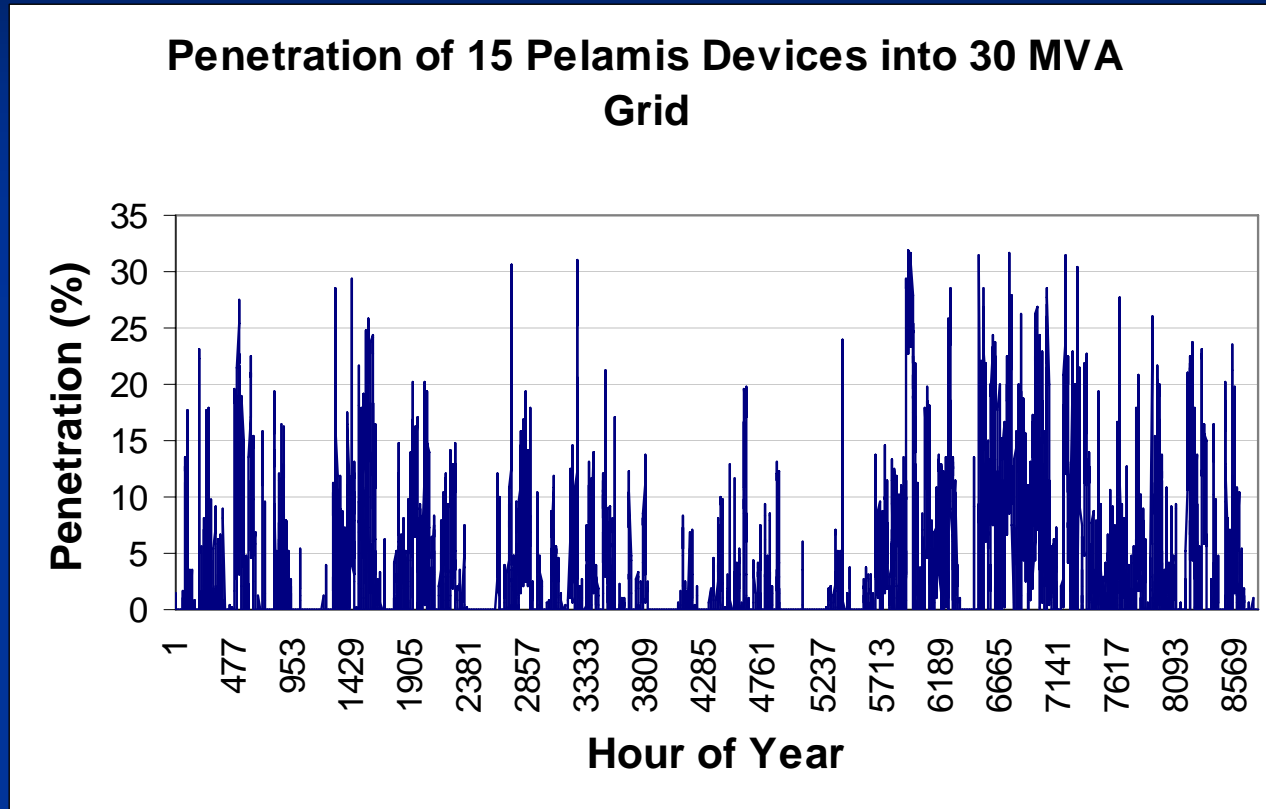


# Study Assumptions

- Penetration estimates based on existing 30 MW grid
- 30 MW feeder to area can sink or source any power flow
- 2300 households with typical BC residential hourly load profiles
- Minimize grid penetration and installed capacity

$$Penetration_i = \frac{P_{renewable}}{Capacity_{grid}}$$

# Grid Penetration

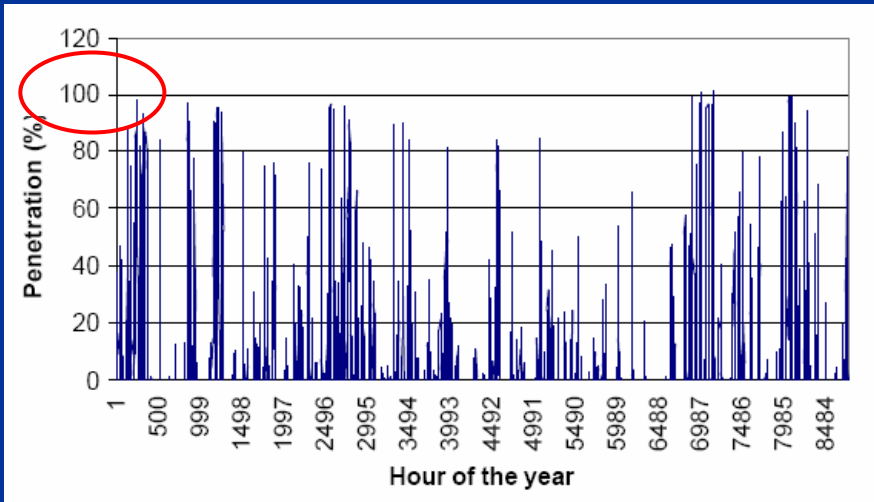


*Average power output = Average load*

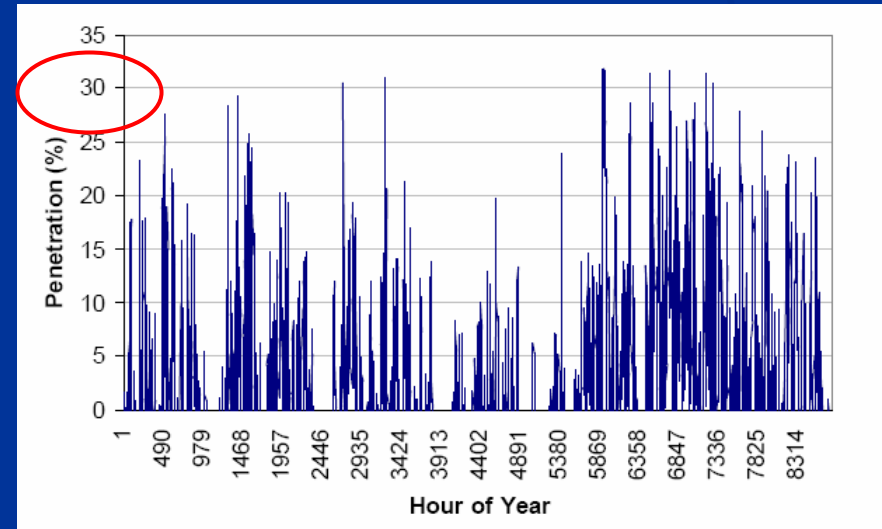
# Wind versus Wave

- Wave resource provides lower penetration levels

Penetration of 53 Wind Turbines



Penetration of 15 Pelamis Devices



# Effects of Grid Penetration Limit

	LIMPET		Energetech		Pelamis	
Penetration Limit	# Devices	% Load	# Devices	% Load	# Devices	% Load
30%	15	93.6	10	62.4	14	87.3
15%	8	49.9	5	31.2	8	49.9
10%	6	37.4	4	24.9	5	31.2
8%	5	31.2	3	18.7	5	31.2
5%	4	24.9	2	12.5	3	18.7
2%	2	12.5	1	6.2	2	12.5

# Key Findings

1. 11 to 17 MW installed capacity required to service entire load with WEC devices
2. Grid penetration high at these levels
3. Penetration lowered by:
  - Introducing storage, and/or
  - Decreasing installed capacity

# Case Study #2 – Tidal Power

# Existing Energy System

Two independent grids:

1. North grid:

- Diesel Generation (11 MW)

2. South grid:

- Diesel Generation (9 MW)
- IPP Hydro (6 MW)

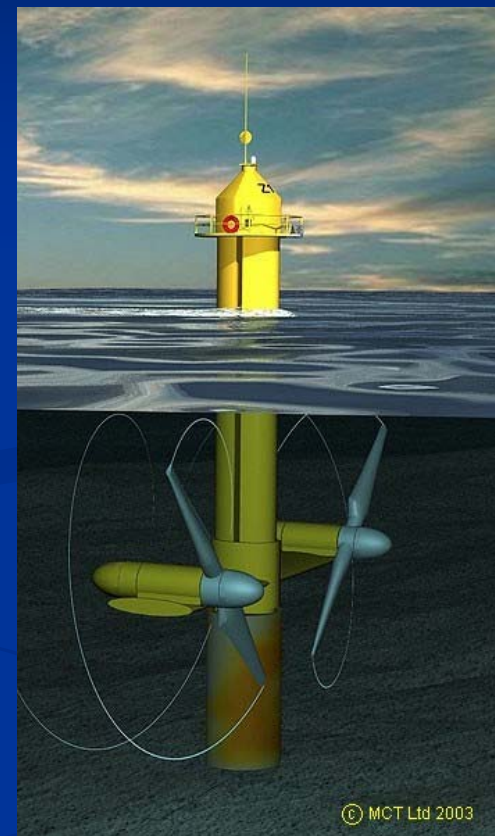
Cost of electricity: 0.17 and 0.21 \$/kWh



# Generation Technology

## Marine Current Turbines (UK)

- Best available data
- Currently developing a commercial scale 1 MW twin rotor turbine
- Cut in current velocity approx 1 m/s



[www.marineturbines.com](http://www.marineturbines.com)

# Resource Locations

## North Island

Parry Passage

Masset Sound/Masset Inlet

## South Island

Houston Stewart Passage

Cape St. James



# Potential Renewable Energy System

## Primary Power Sources:

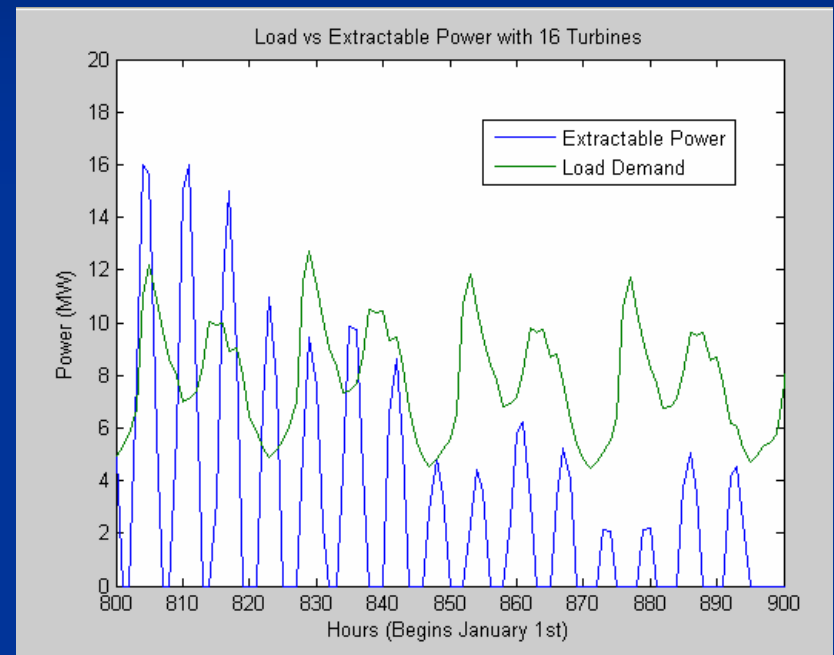
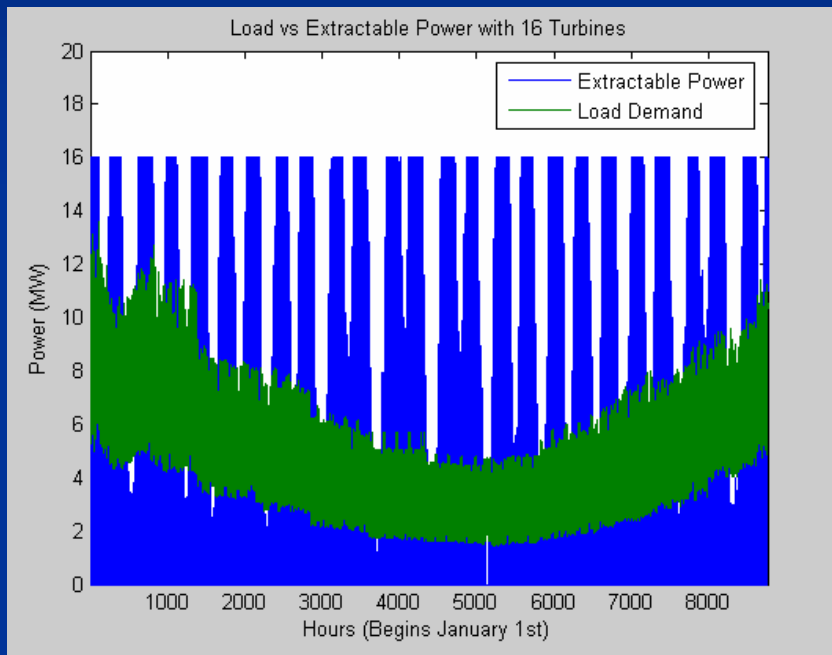
- Tidal farm (Masset Sound)
- Hydroelectric power plant

## Backup:

- Diesel Generators



# Case Study Results



# Case Study Results

Total annual energy production (GWh)	=	45.7
Total annual load (GWh)	=	44.6
Surplus power produced (GWh)	=	23.8
Load Not Met (%)	=	51
Maximum value of unmet load (MW)	=	13
Average load not met (MW)	=	2.6

# Backup Power Required

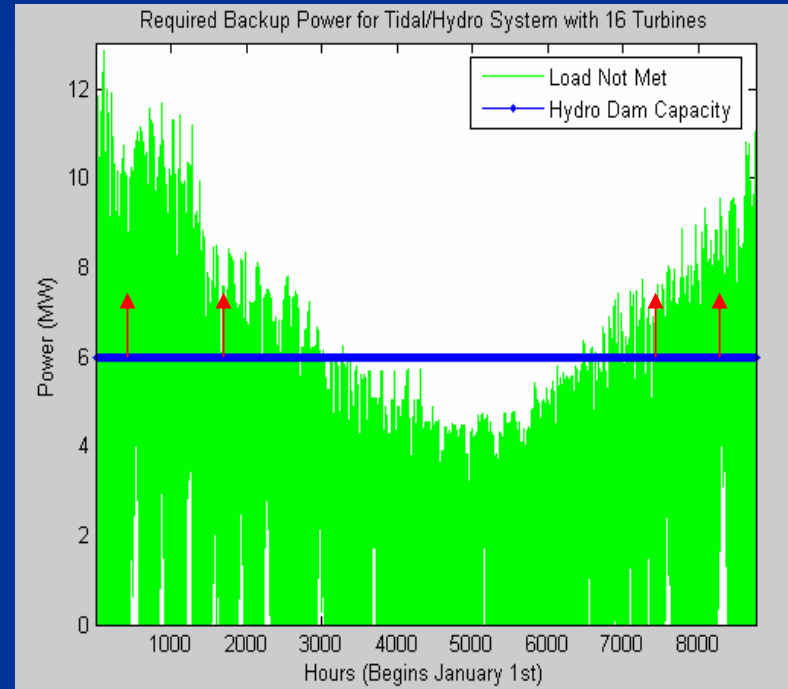
Diesel Generation reduced by 94%

Current System:

- 8,600,000 Liters/yr

Tidal/Hydro System:

- 516,000 Liters/yr



# Conclusions

1. Potential for tidal integration is promising
2. Future work is required:
  - Accurately assess current flows
  - Model the electrical grid, hydro dam, and diesel generators
  - Economic analysis
  - Emissions assessment

# Questions?



Thank you