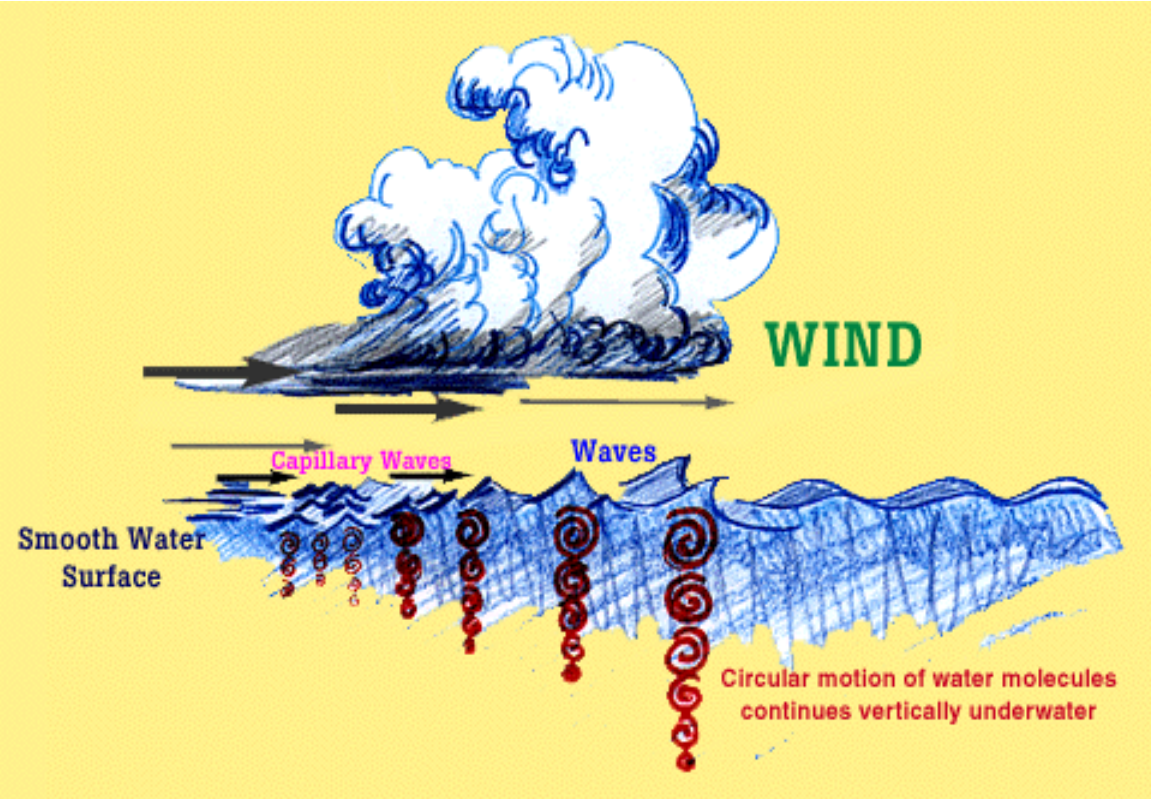
EPRI 2004
Wave Power Feasibility Study

Final Project Briefing

March 15, 2005

EPRI

Waves



Waves are a concentrated form of solar energy

Technology to convert wave energy to electrical energy is in its starting phase

> 1000 Patents

< 2 MW Installed

Active Gov't RD&D Program in Europe and Australia

No Gov't RD&D Program in the U.S.

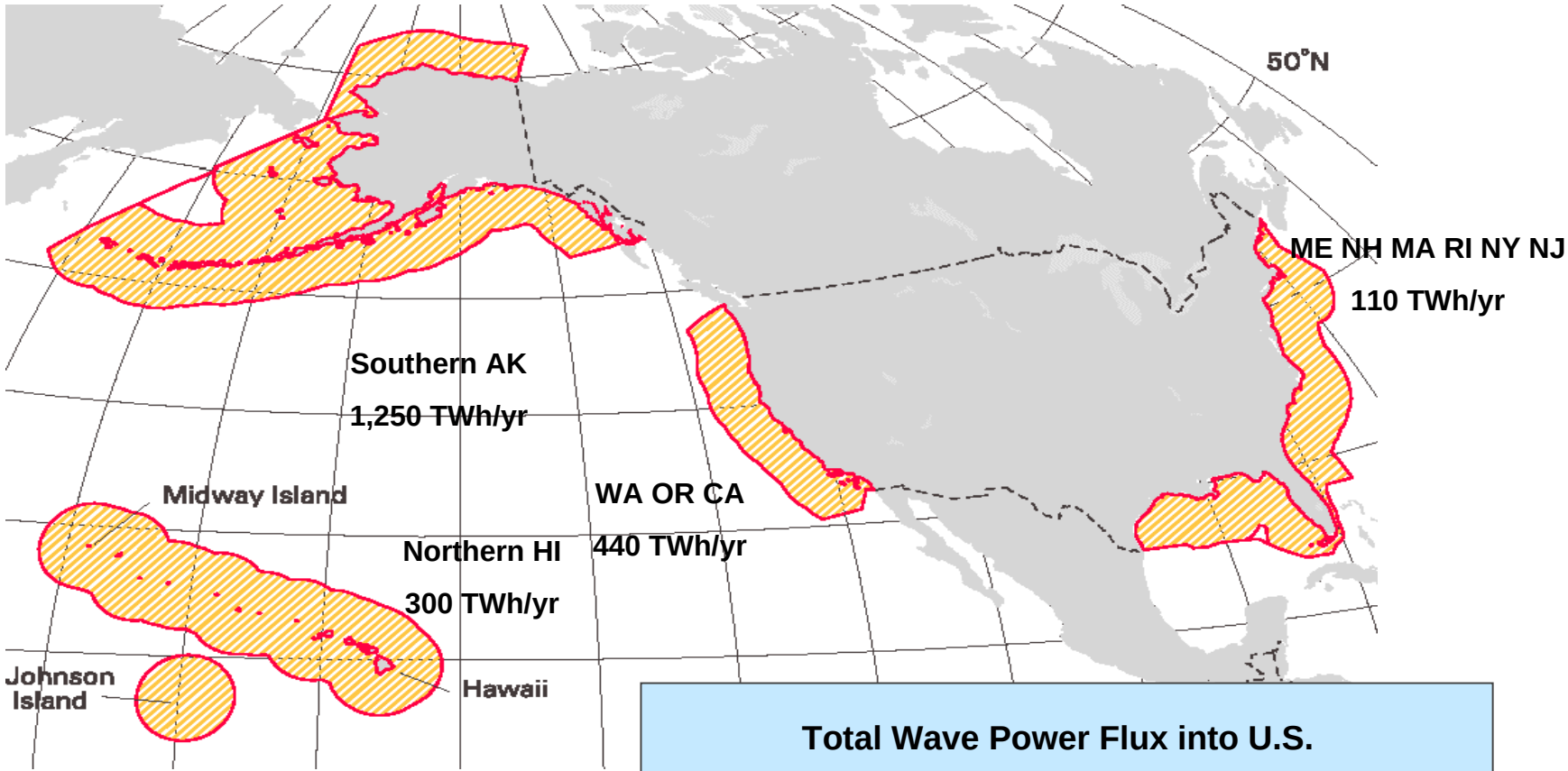
Technical and Economic Feasibility Demonstration in the U.S. is the Next Needed Step in the Technology Development Process

EPRI 2004 Wave Energy Feasibility Study

- Techno-Economic Rationale for Investing in Wave Energy Technology is a Function of its Potential Commercial Viability
- Elements of Project Definition Study
  - ID and characterize potential sites
  - ID and assess wave energy conversion devices
  - Design and estimate performance and cost of pilot demonstration plant (500kW – 40% capacity factor)
  - Extrapolate to 90 MW – 40% capacity commercial plant
  - Assess techno-economic viability of commercial plants
  - ID and assess environmental and regulatory issues

Study makes a compelling case for investment in wave energy RD&D

Wave Power into U.S.



Total Wave Power Flux into U.S.

~ 2,100 TWh/yr which is about

1/10 of total US hydroelectric generation in 2003

A SIGNIFICANT RESOURCE

Site Identification and Characterization

State	County	Harbor	Grid Interconnection
CA	San Fran	San Fran	Ocean Beach Water Treatment Plant
HI	Oahu	Honolulu	Makai Pier, Waimanalo Beach
ME	Cumberland	Portland	Old Orchard
MA	Boston	Boston	Wellfleet Dist Line
OR	Douglas	Coos Bay	Gardiner Substation
WA	Makah Bay	Neah Bay	Makah Bay Dist Line

Avg Annual Power Flux	CA	HI	ME	MA	OR	WA
(kW/m) of wave crest length	20.0	15.2	4.9	13.8	21.2	26.5

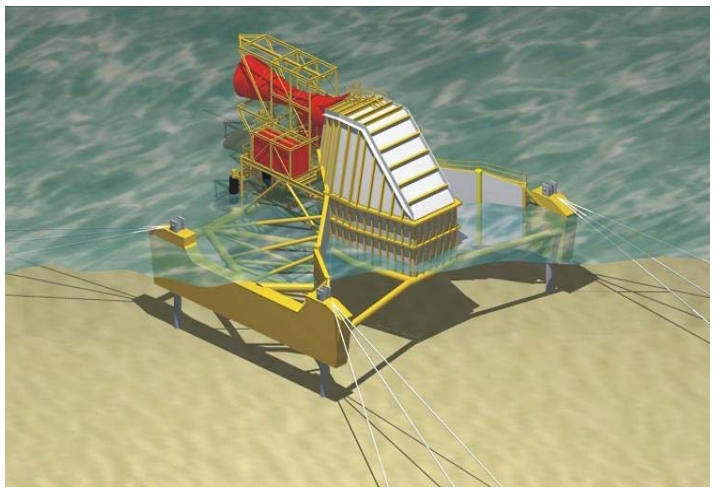
4 General Types of Wave Energy Devices

Point Absorber

Attenuator

Terminators

Oscillating Water Column



Overtopping

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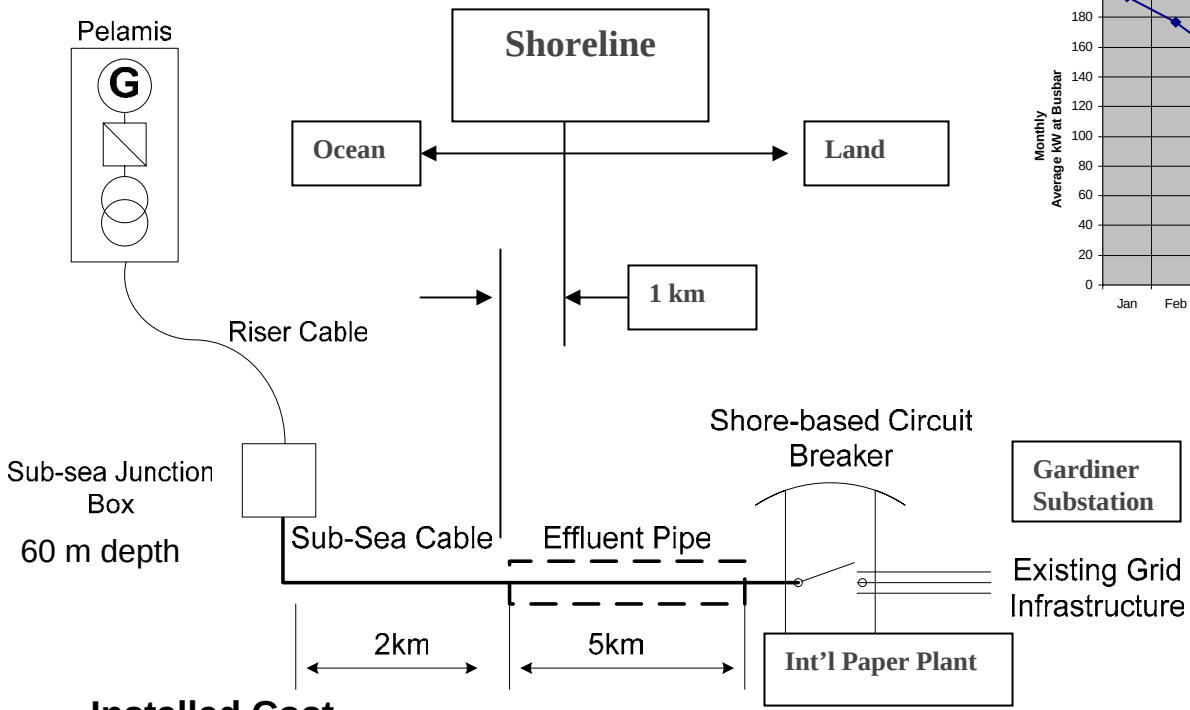
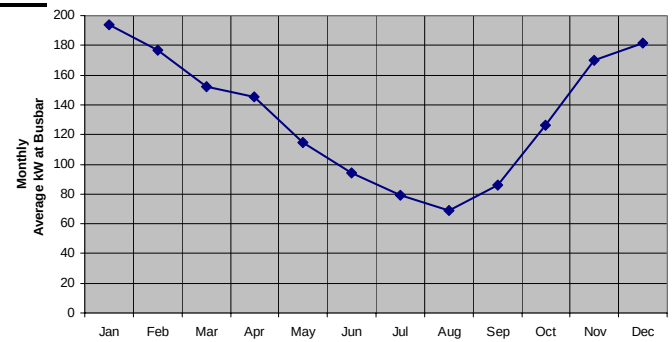
Pilot Demonstration Wave Power Plant

Douglas County Oregon – OPD Pelamis Device





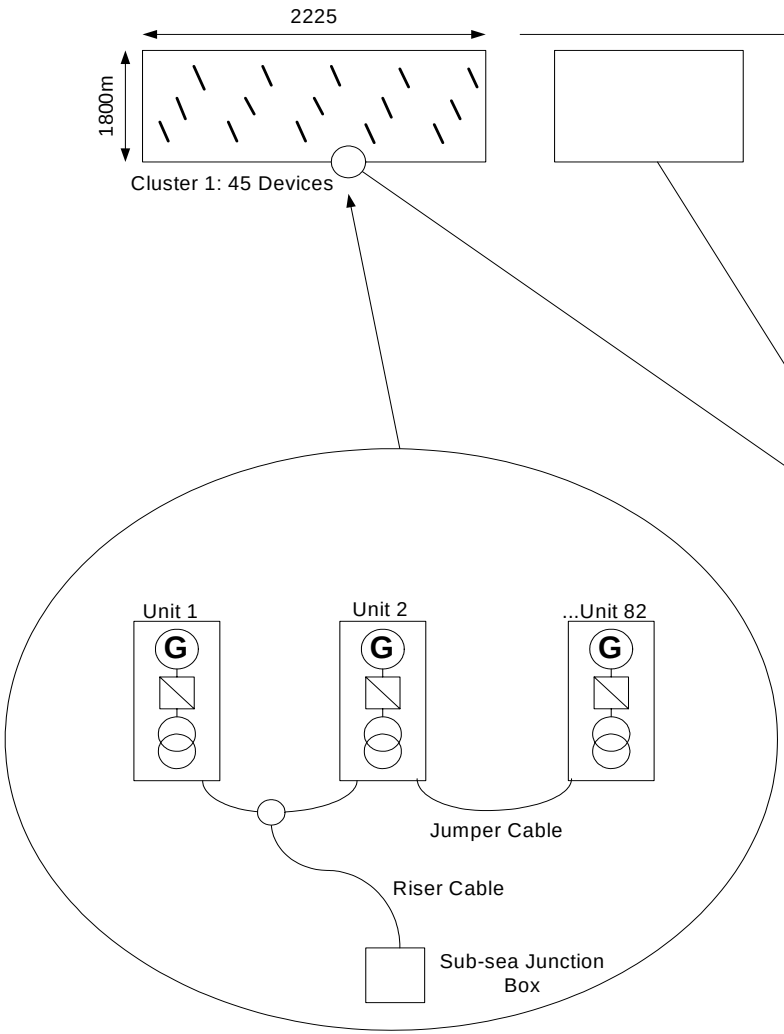
Energy = 1101 MWh/Yr

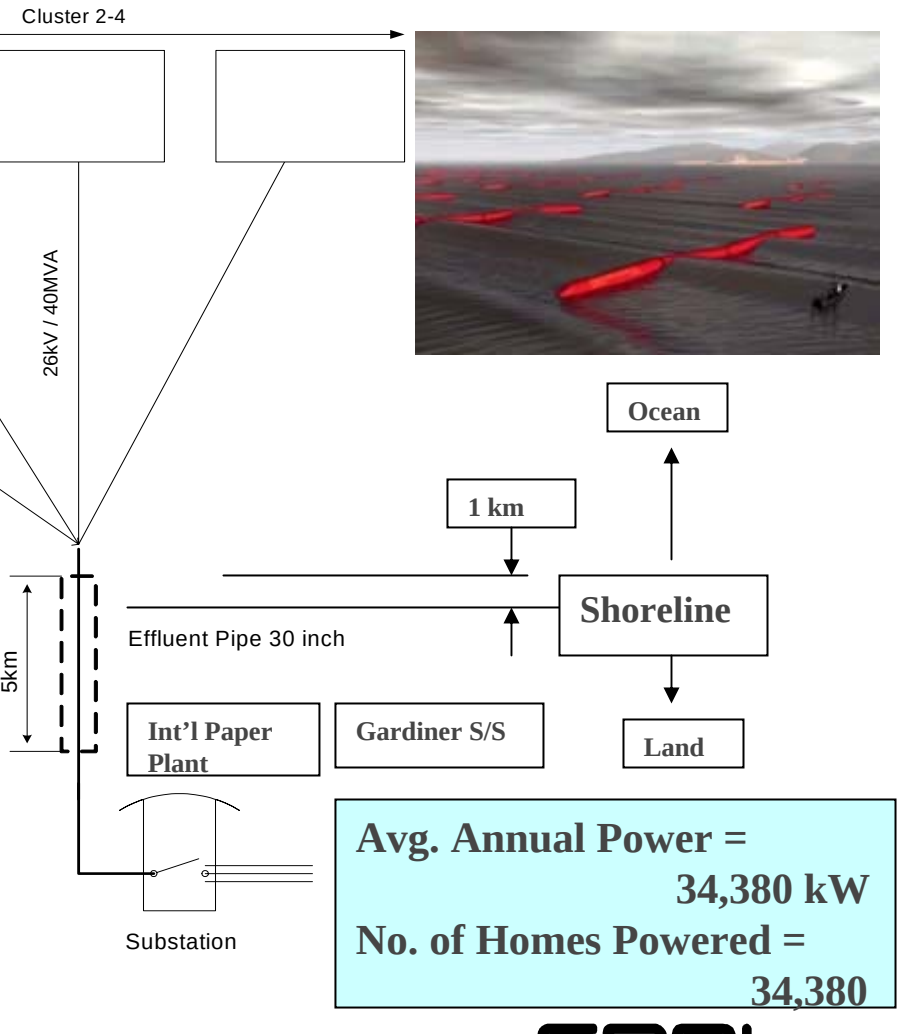
Installed Cost

• Onshore Grid I/C	$580,000	• Mooring	$243,000
• Subsea Cables	$300,000	• Installation	$699,000
• Pelamis PCM	$1,535,000	• Const Mgmt & Com	$420,000
• Steel Sections	$850,000	• **Total**	**$4,627,000**

Commercial Wave Power Plant

Douglas County Oregon Example – 300,000 MWh/yr – 90 MW Rating – 180 Pelamis Devices each rated at 500 kW

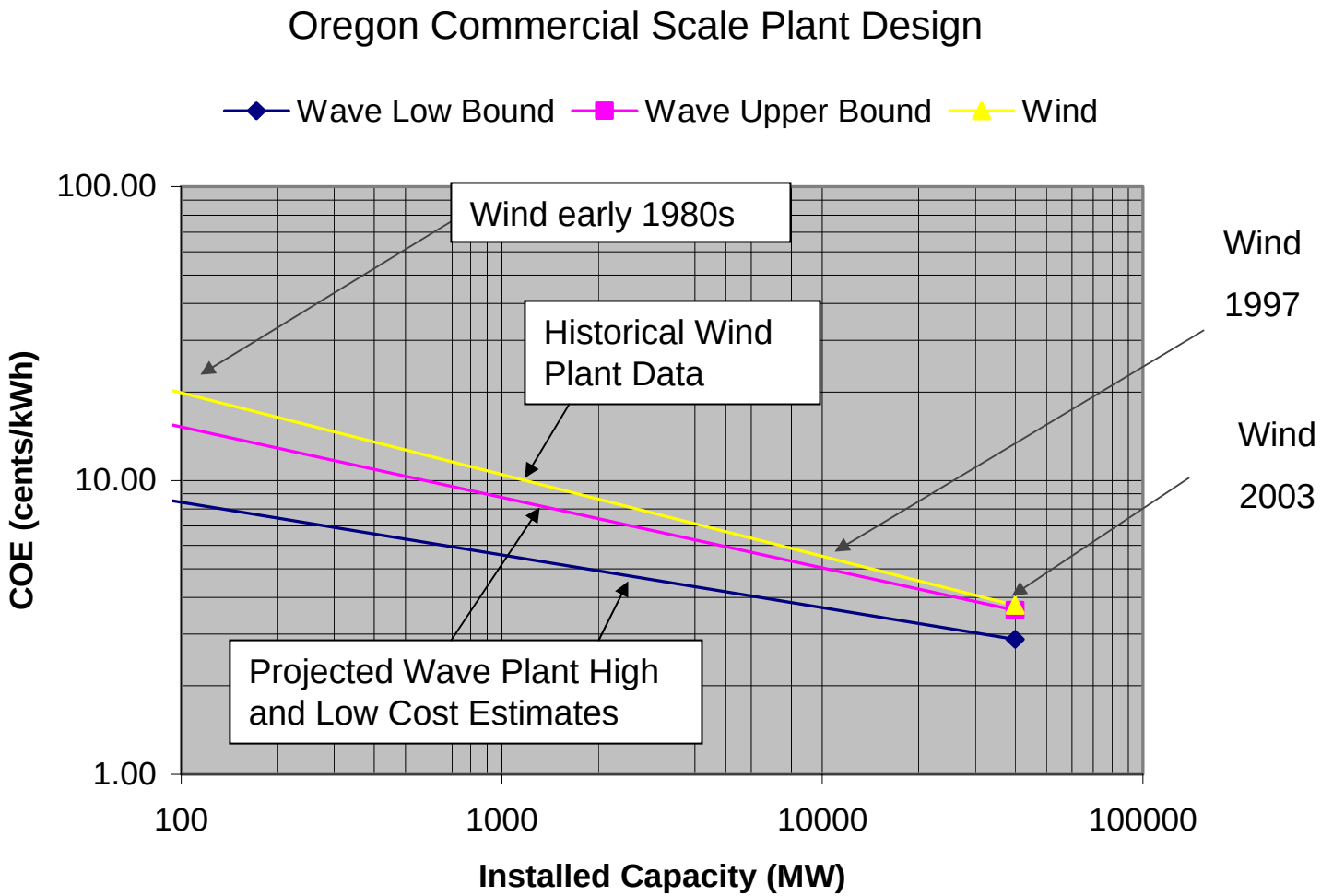




Avg. Annual Power = 34,380 kW

No. of Homes Powered = 34,380

Cost of Electricity (COE) as a Function of Cumulative Installed Capacity (Learning)



Non Economic Benefits

- Given proper siting, converting wave energy to electricity is one of the most environmentally benign ways to generate electricity

- Wave energy offers a way to minimize Not-In-My-Back-Yard (NIMBY) Issues

- Because wave energy is more predictable that direct solar insolation and wind, there is a higher probability that it may be dispatchable

Conclusions – Techno Economic Forecasts(1)

- Northern California and Hawaii have both excellent wave climate, coastal infrastructure and high electricity prices
- Oregon has excellent wave climate and coastal infrastructure, but low electricity prices
- Washington has excellent wave climate, but poor coastal infrastructure and low electricity prices
- Massachusetts has good wave climate in the winter, but poor in the summer, high electricity prices and a REC market
- Maine has a poor wave climate – a good wind site is forecasted to be techno economically favorable to wave energy for the state of Maine

Conclusions

- There is a compelling case for investing in wave energy RD&D to answer many application questions such as:
  - What device type and size is best?
  - What capacity factor is optimum?
  - Will the installed cost of wave energy achieve its potential of being less expensive than wind energy?
  - Will the O&M costs of wave be as high as predicted?
  - Are the performance and cost estimates accurate?
  - What is the reliability, maintainability and availability?
  - What are the effects on marine life and the coastline
  - What is its ability to survive storms?
  - What is its ability to operate over a 20 year or so life?

Recommendations – Needed Actions

- Encourage pilot feasibility demonstration projects
- Encourage R&D at Universities
- Encourage the Federal Government to Support RD&D
  - Leadership for a national ocean energy program
  - Operate a national offshore ocean energy test facility
  - Development of standards
  - Joining the IEA Ocean Energy Program
  - Leading the streamlining of permitting processes
  - Studying provisions for incentives and subsidies
  - Ensuring that the public receives a fair return from the use of ocean energy resource
  - Ensuring that development rights are allocated through a fair and transparent process taking into account state, local and public concerns