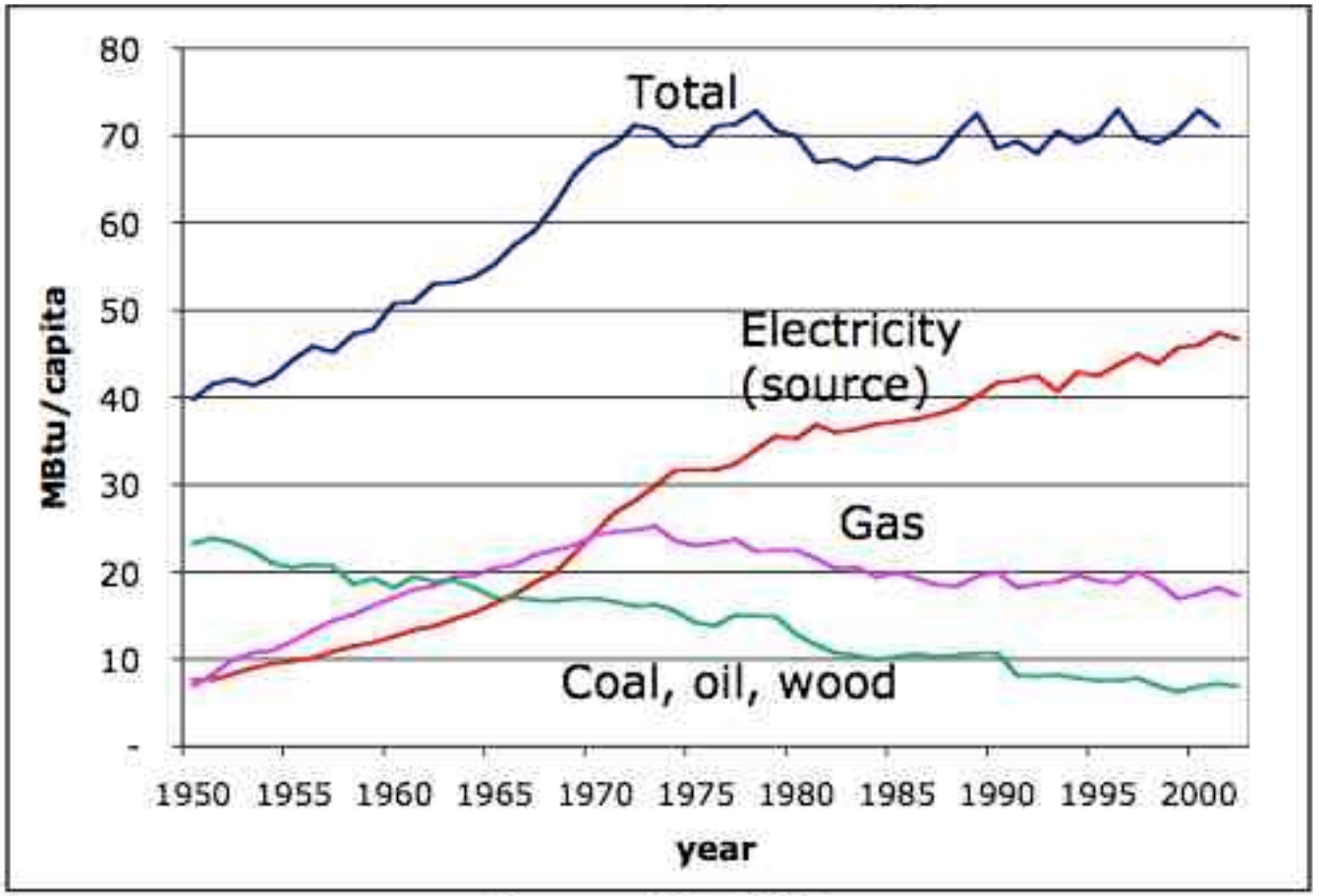
Jed Smith – Advanced Research Corporation

Wave Energy

The Technical Perspective

Why pursue wave energy



US Residential Energy Use Per Capita

Source: EIA 2003, USDOE

Wave Energy Density Myth

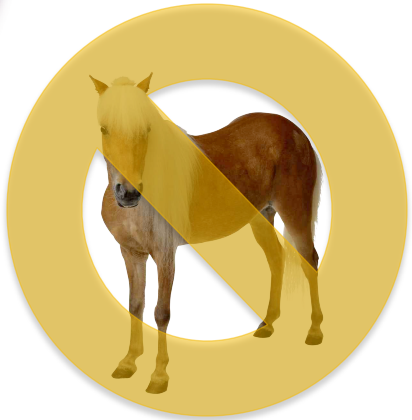
Do the energy density claims of many developers hold water?

Calculating potential power

$$P_{wave} = \frac{\rho g^2}{64\pi} H_{m0}^2 T_e$$

$$P_{wind} = \frac{\rho}{2} A V^3$$

$$P_{horse} = 1_{Horse\_Power} \cong 745.7 watts$$



Where the hype comes from…

$$\rho_{water} = 1000 \frac{kg}{m^3}$$

$$P_{wave} = \frac{\rho g^2}{64\pi} H_{m0}^2 T_e$$

$$\rho_{air} = 1.2 \frac{kg}{m^3}$$

$$P_{wind} = \frac{\rho}{2} A V^3$$

Compare different technologies

GE **3600kW**
Wind Turbine

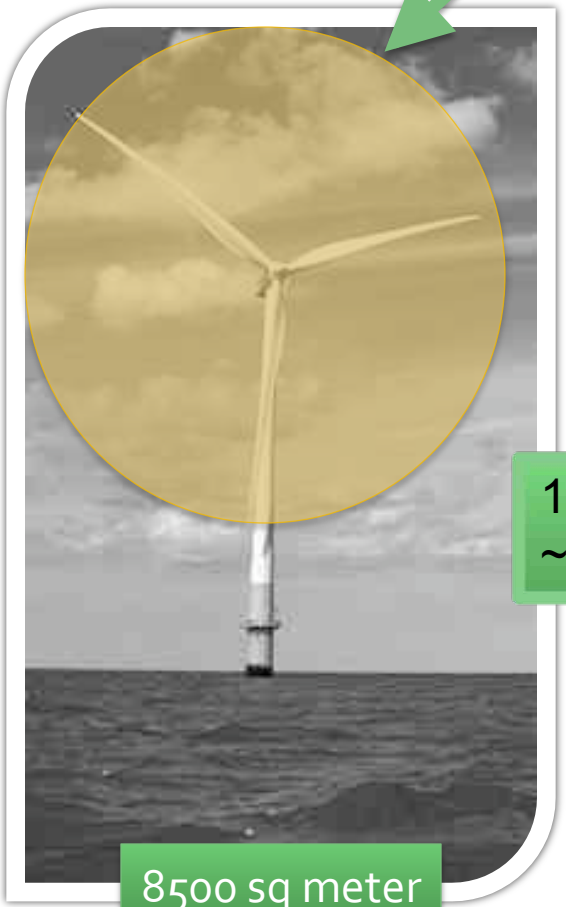
VS

OPT **150kW**
PowerBuoy

Capturing the Energy

GE **3600kW**
Wind Turbine

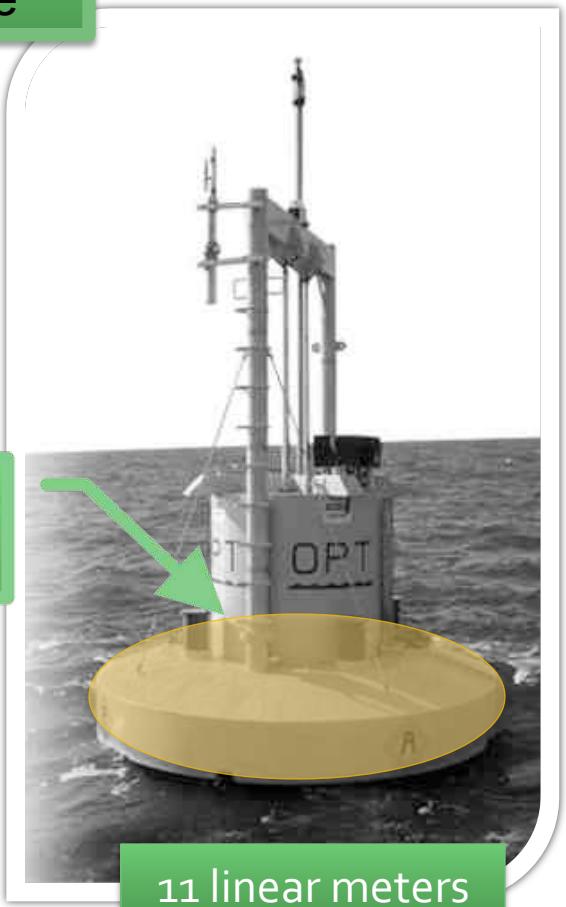
111 meter diameter
290 tonne turbine



8500 sq meter

11 meter diameter
~200 tonne turbine

OPT **150kW**
PowerBuoy



11 linear meters

Max Possible Energy to Extract

$$P_{wave} = \frac{\rho g^2}{64\pi} H_{m0}^2 T_e$$

$$P_{wave} \approx 500 * (3m)^2 * 10s = 45kW$$

$$P_{wave} * OPT = 45kW * 11m_{OPT} = 495kW$$

$$P_{wind} = \frac{\rho}{2} A V^3$$

$$P_{wind} \approx 0.6 * 1m^2 * (10m/s)^3 = 600kW$$

$$P_{wind} * GE = 600kw * 8500m^2 = 5{,}100kW$$

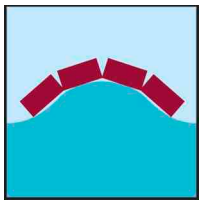
Wave Energy Density Myth

- Wave energy densities are much higher than wind energy density on average
- But capturing wind energy it done with long slender blades that rotate, covering huge areas
- While current wave energy devices require large floats, plates or other structures that can not be swept over huge areas

Image from :www.wallpaperbase.com/sports-surfing.shtml

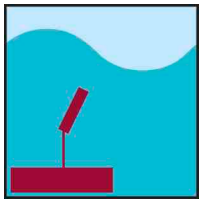
Everybody has a unique idea

Grouping the ideas

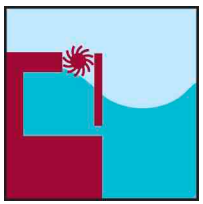


Attenuator

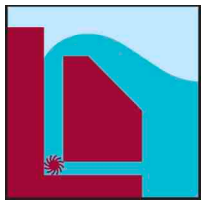
Point Absorber



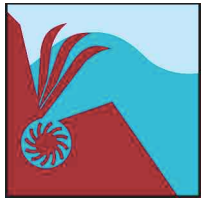
Oscillating Wave Surge Converter



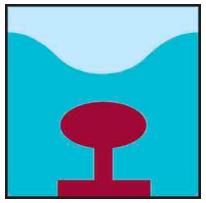
Oscillating Water Column



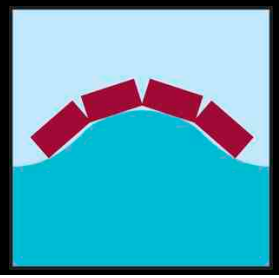
Overtopping Device – Wash-up



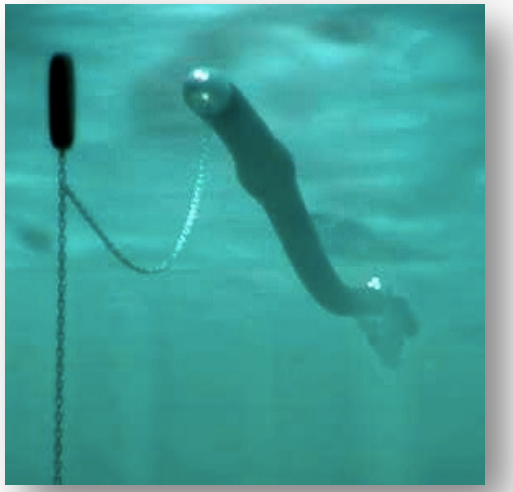
Overtopping Device – Flush-in



Submerged Pressure Differential



Attenuators



Energy Conversion

On the device
Magnetic

→ **Hydraulic**

On shore
Hydraulic

Main Construction Material

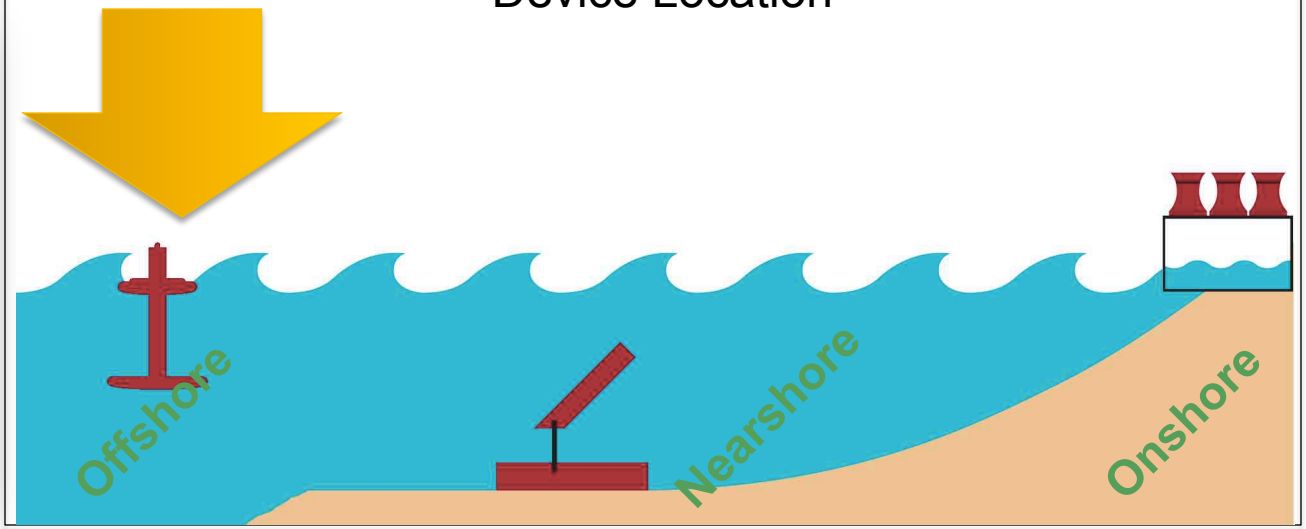
→ **Steel**

? **Composite**

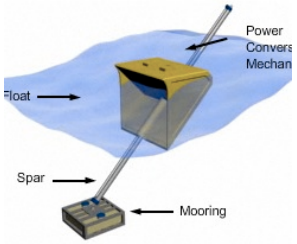
? **Concrete**

→ ? **Rubber/Foam**

Device Location



Point Absorbers



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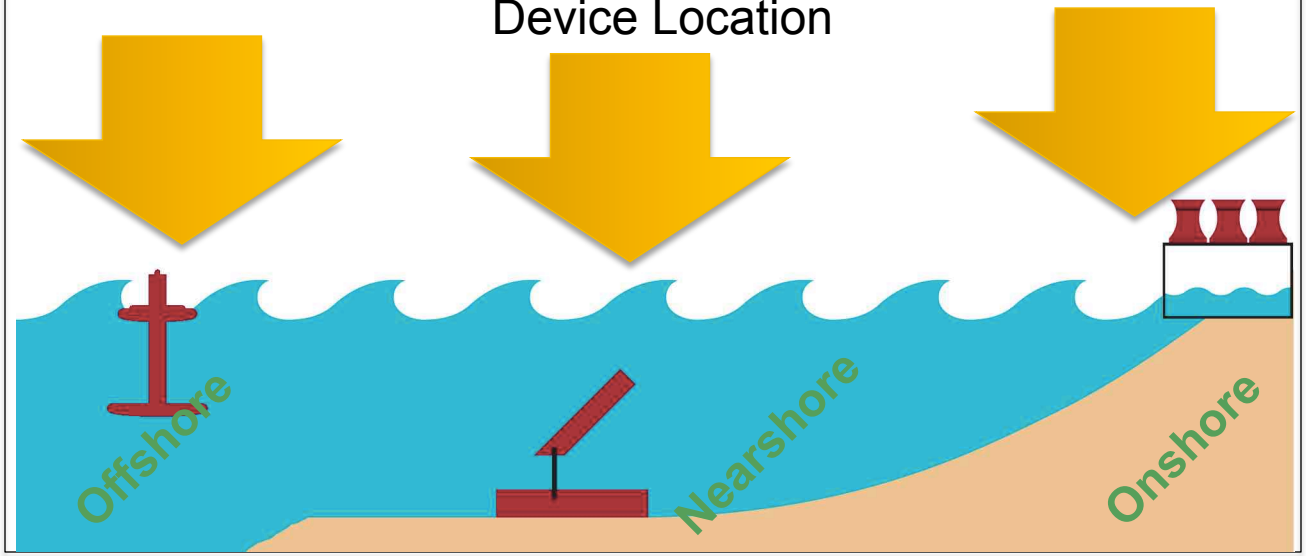
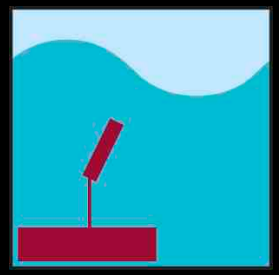
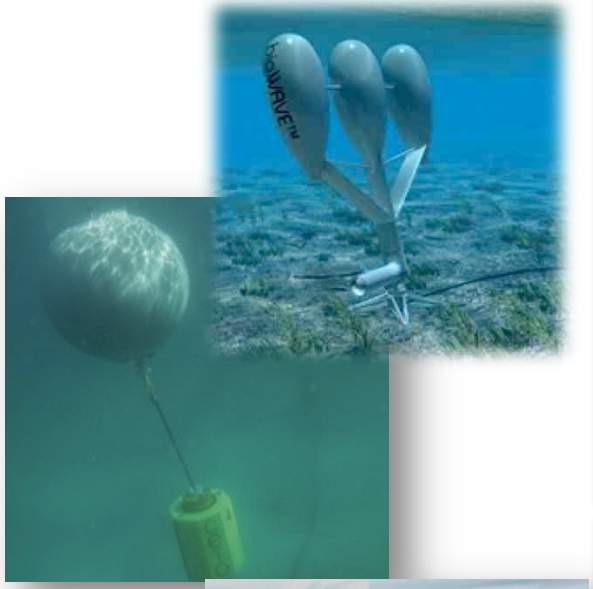




Oscillating Wave Surge



Energy Conversion

On the device
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Hydraulic

On shore
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Main Construction Material

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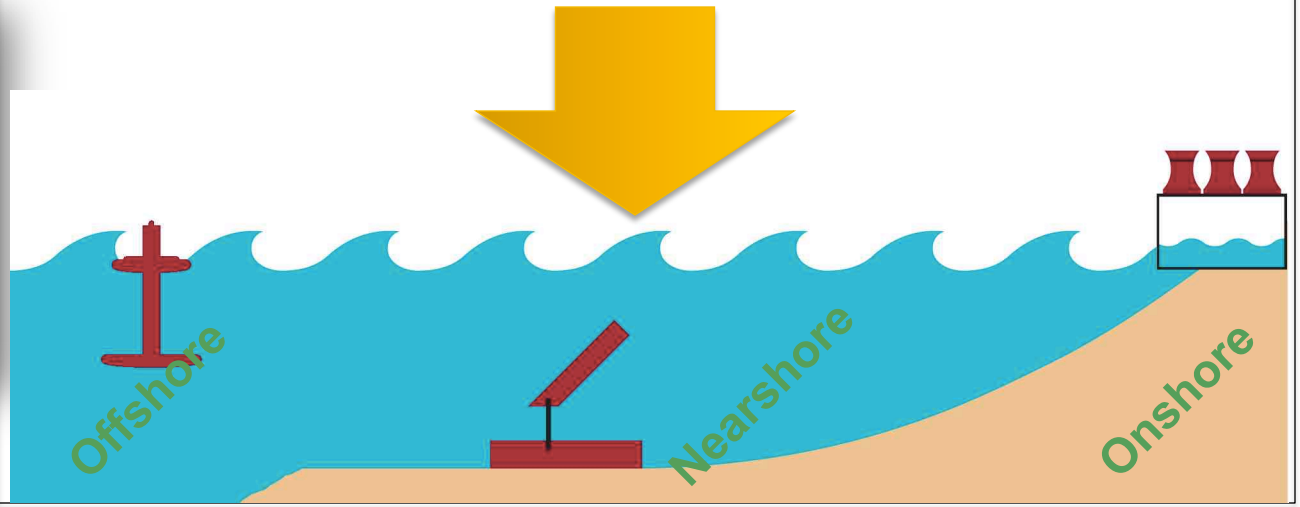
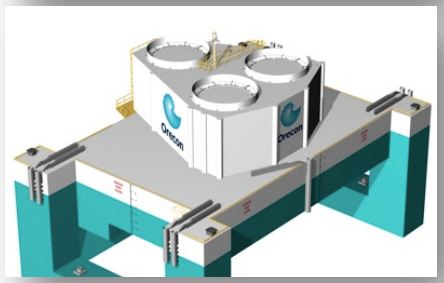
Device Location



Oscillating Water Column



Energy Conversion

On the device

Magnetic

Hydraulic

On shore

Hydraulic

Main Construction Material

Steel

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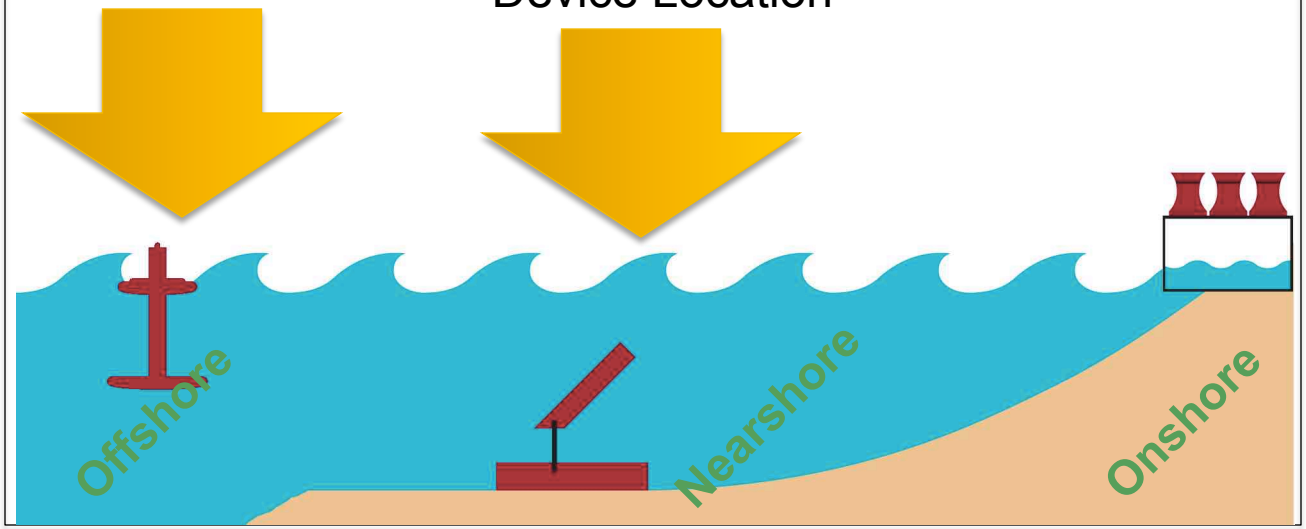
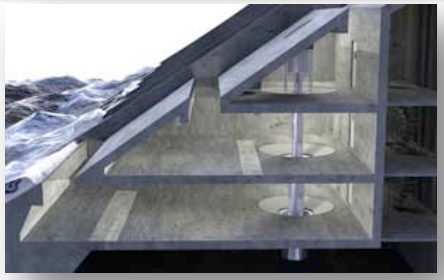
Device Location



Overtopping Devices



Energy Conversion

On the device

Magnetic

Hydraulic

On shore

Hydraulic

Main Construction Material

Steel

Composite

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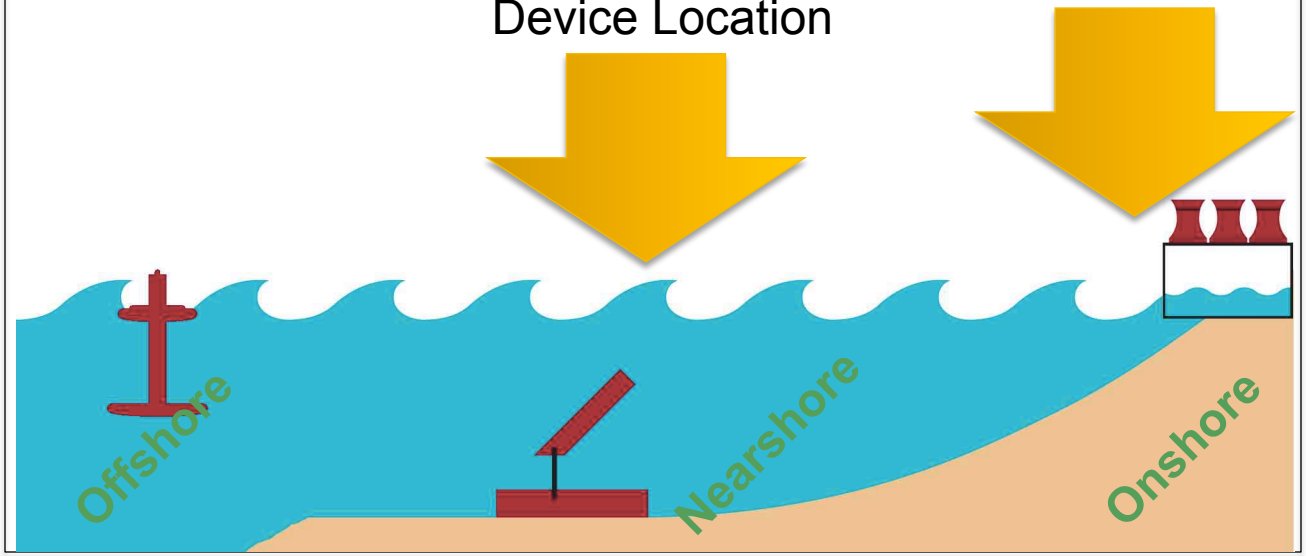
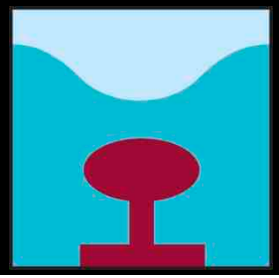
Device Location





Submerged Pressure Differential

Energy Conversion

???

On the device

- Magnetic
- Hydraulic

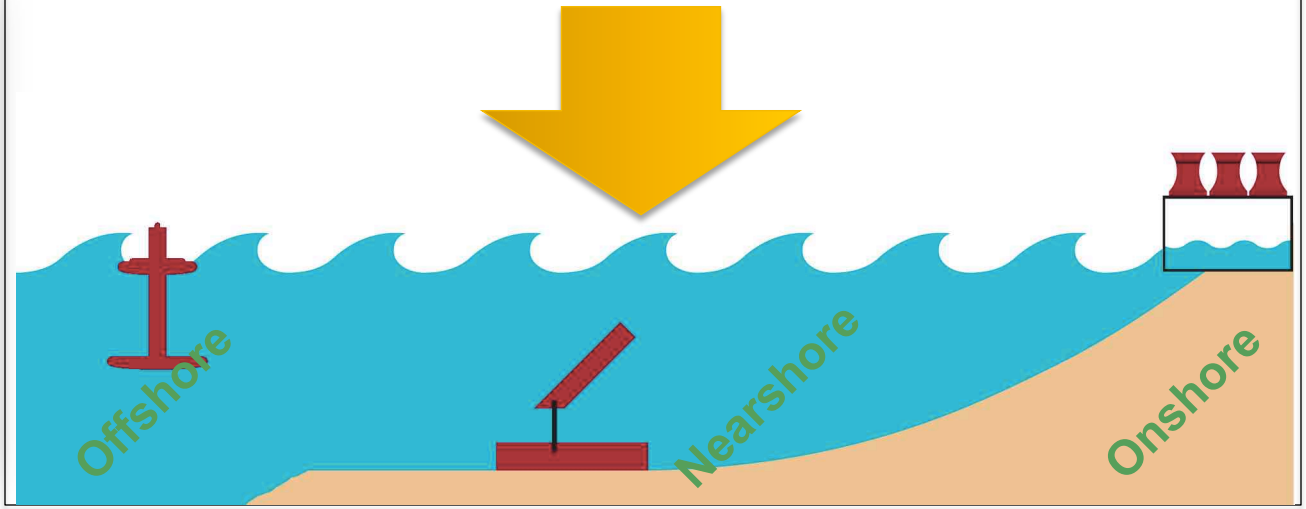
On shore

- Hydraulic

Main Construction Material

- ? Steel
- ? Composite
- Concrete
- Rubber/Foam

Device Location



Everybody has a unique idea

Current designs use readily available technology.

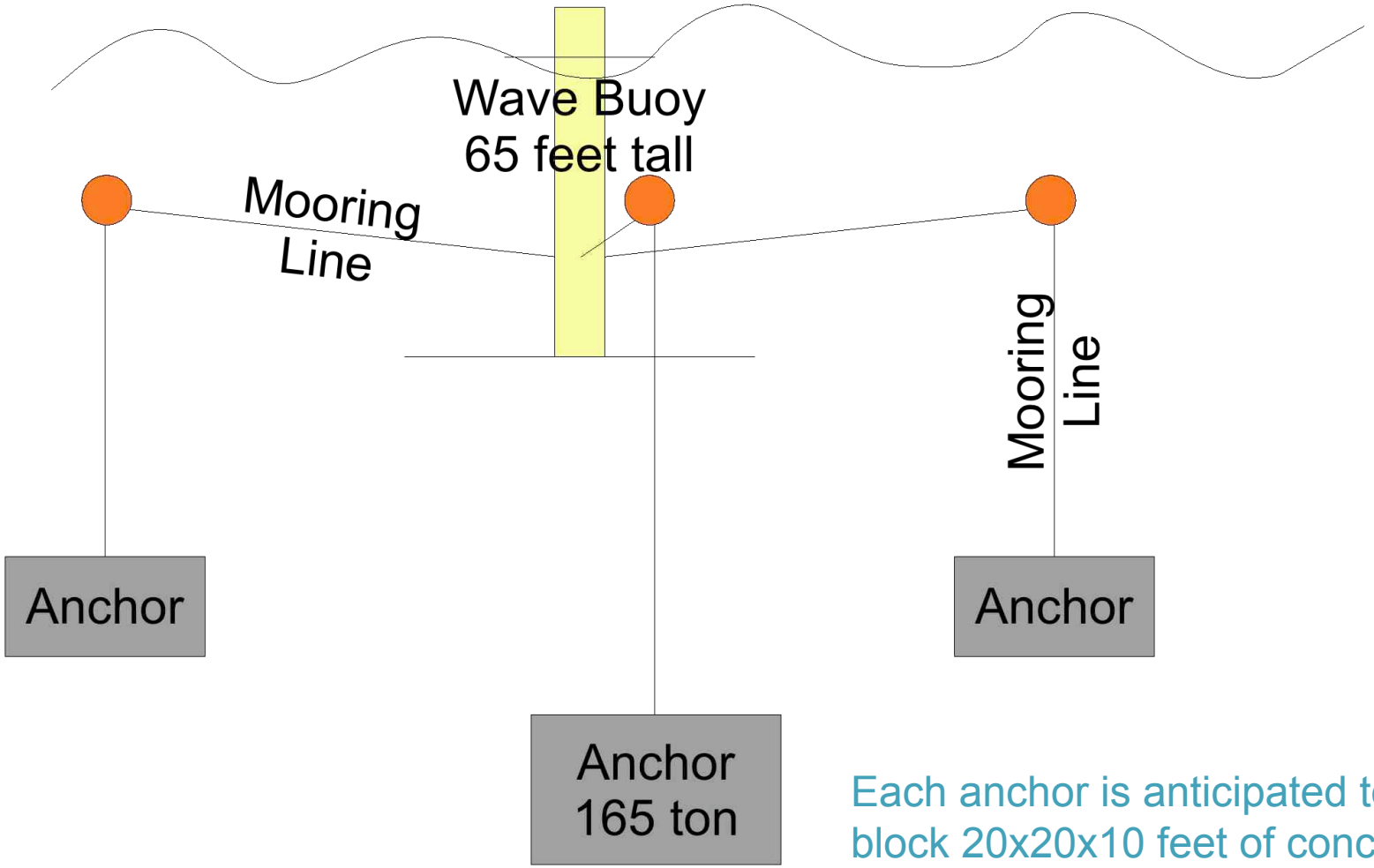
Pressure to increase device size to harness more wave energy. This increases structural demands and greatly influences costs due to fabrication and deployment expenses.

Many device developers have no idea yet of maintenance requirements or full-time employment opportunities.

Holding On

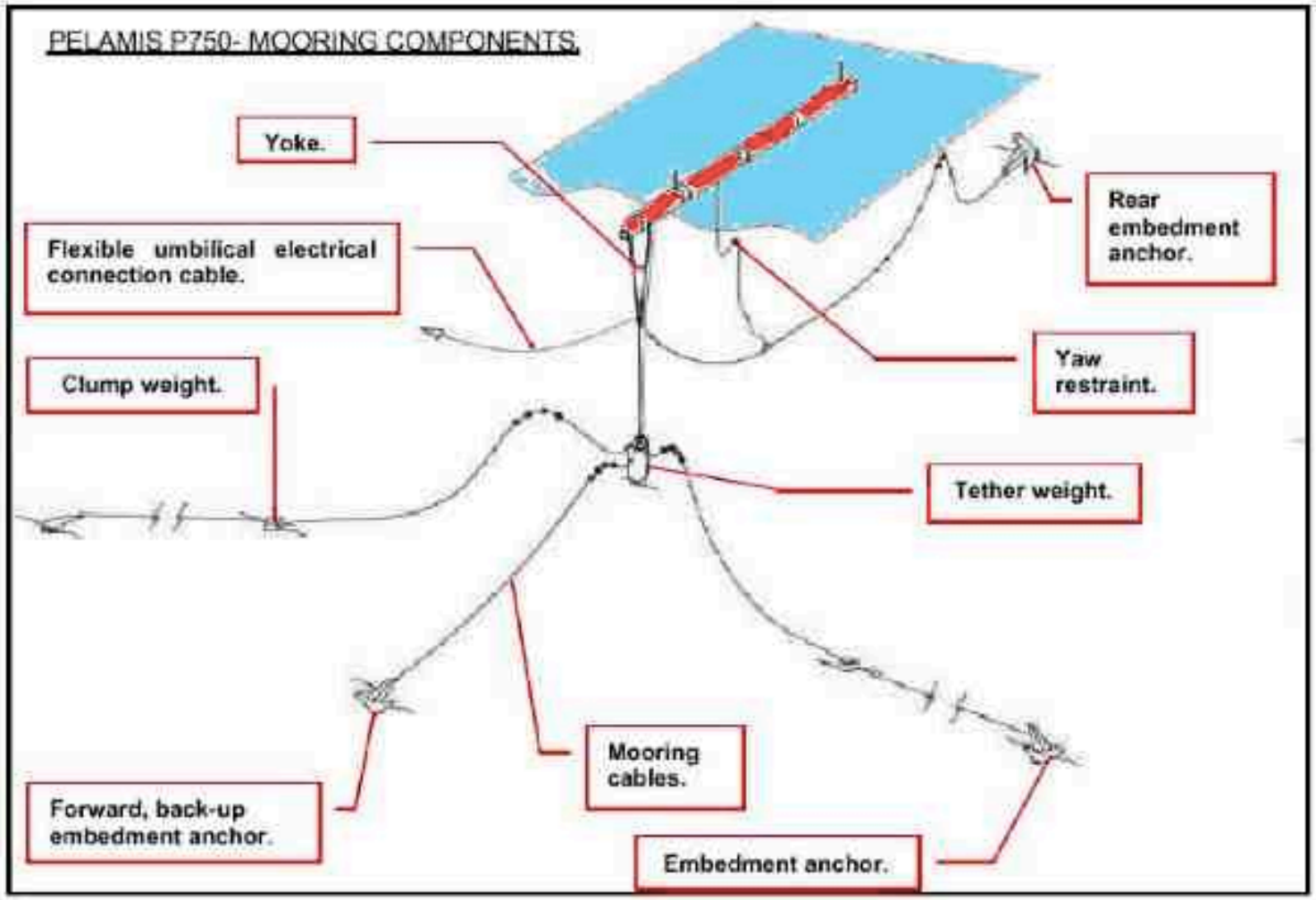
Anchoring and Mooring

OPT Mooring System



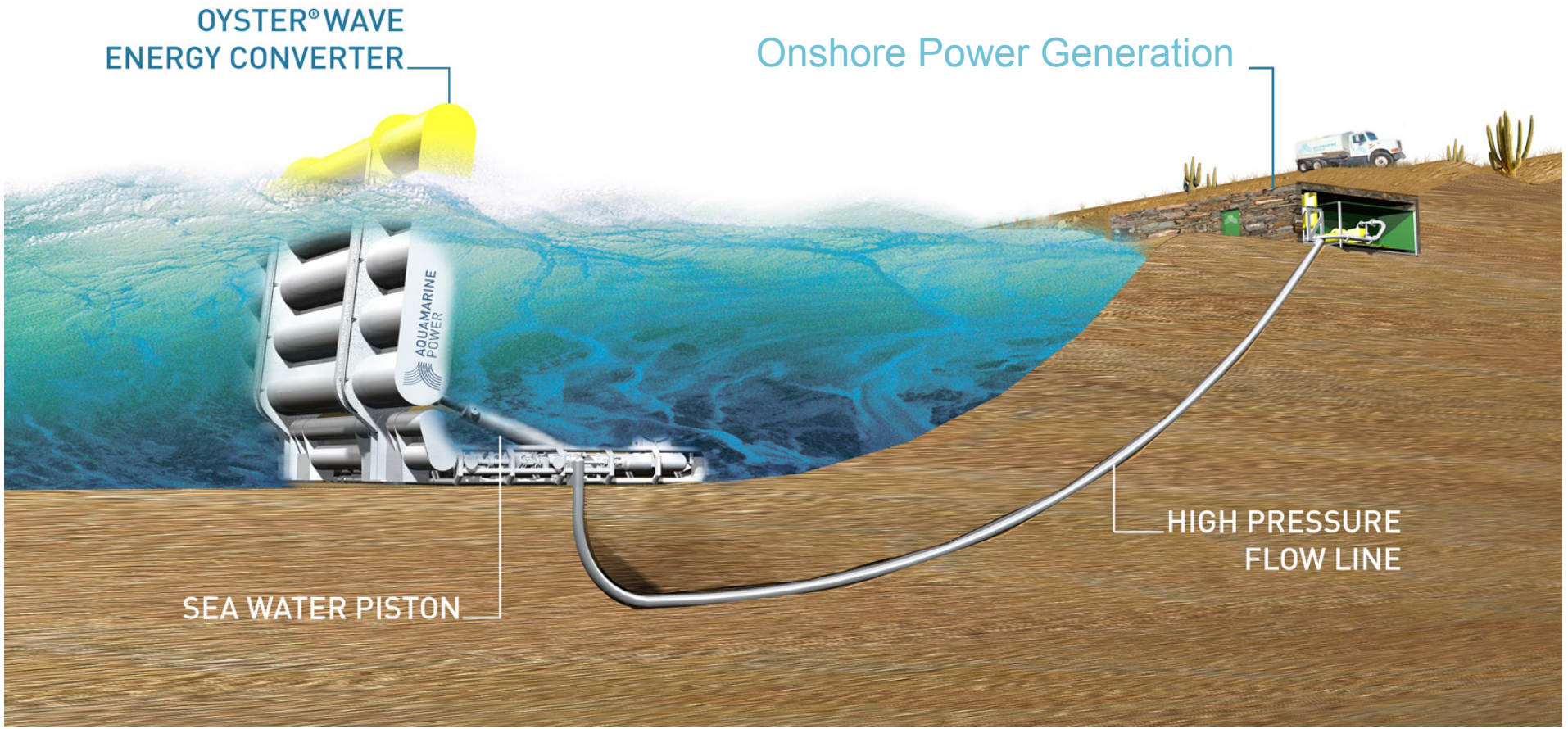
Each anchor is anticipated to be a block 20x20x10 feet of concrete

Pelamis Mooring System



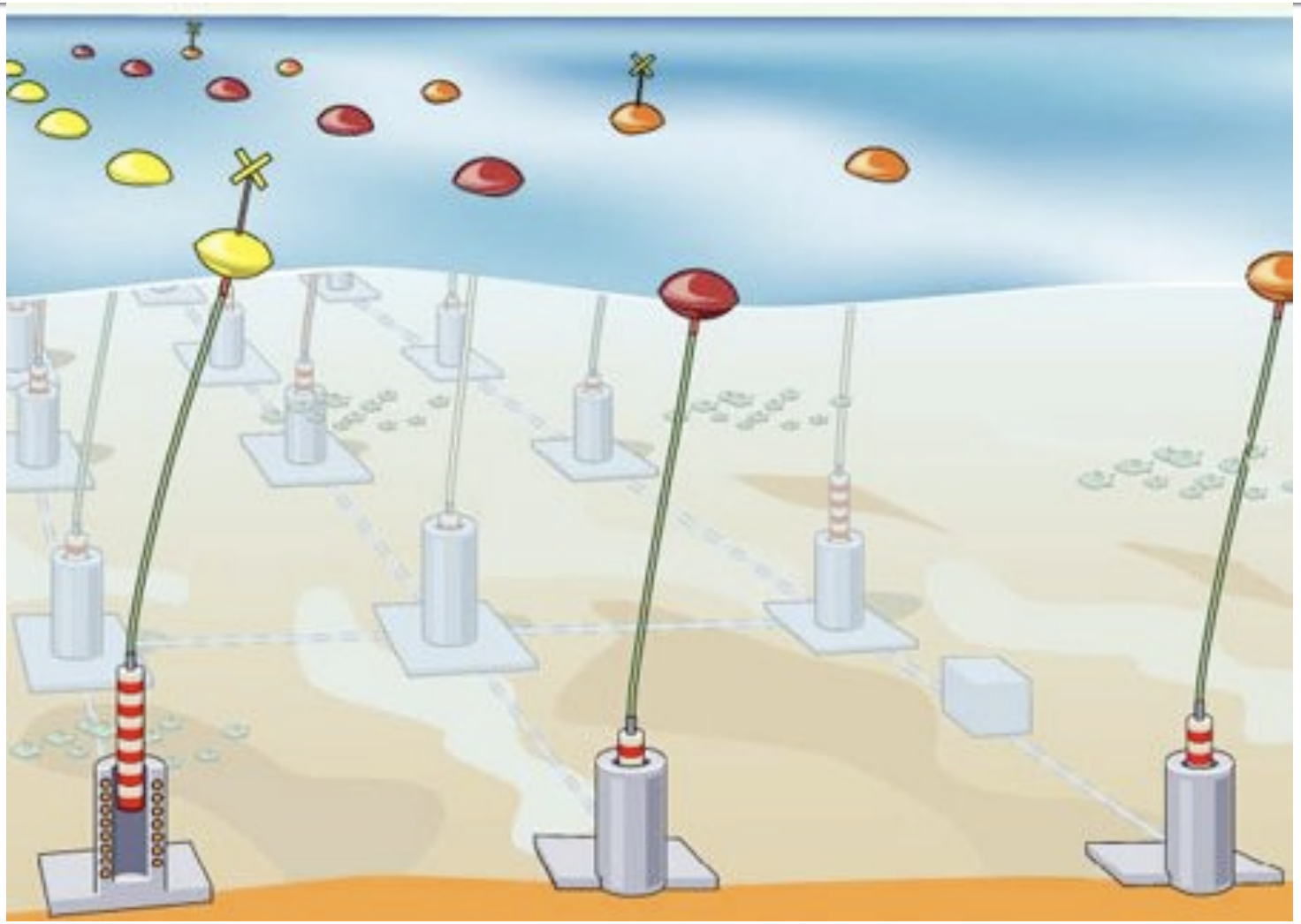
Source: EPRI – Offshore Wave Power Feasibility Demonstration Project 2005

Oyster Mooring System



Source: Aquamarine Power website, 2010

Seabased AB mooring system



Source: http://www.treehugger.com/WaveEnergyBuoys.jpg 2010

Wrapping It Up

Designing a mooring system that works is a challenge. Doing it cheaply is nearly impossible.

Every technology developer thinks they have a unique and practical solution that will work.

Take developer claims with a grain of salt, the industry is still in its infancy.