UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Ocean wave energy conversion

James Joubert

Stellenbosch University

Wave Energy Forum

15 October 2010

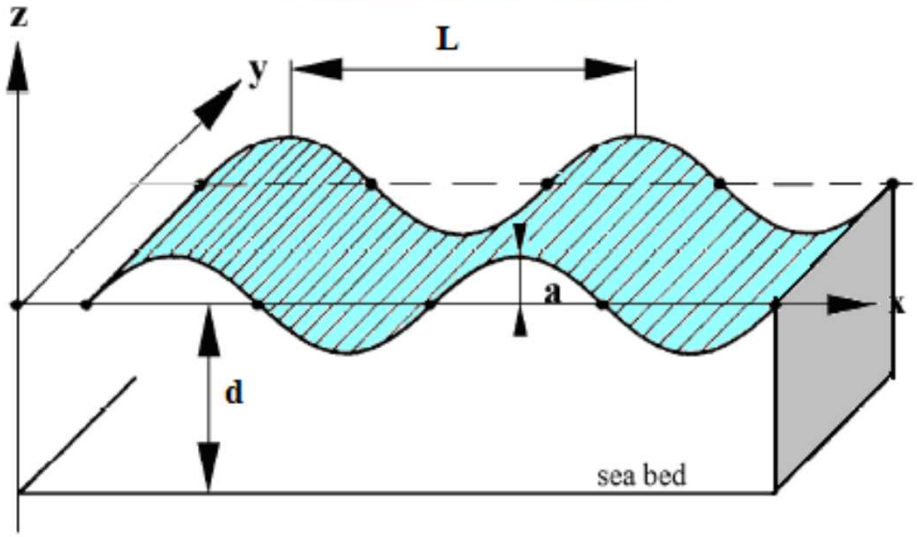
Study motivation

RENEWABLE & SUSTAINABLE ENERGY STUDIES

Wave power

RENEWABLE & SUSTAINABLE ENERGY STUDIES

Rate at which energy is transmitted in the direction of wave propagation across a vertical plane perpendicular to the direction of wave advance

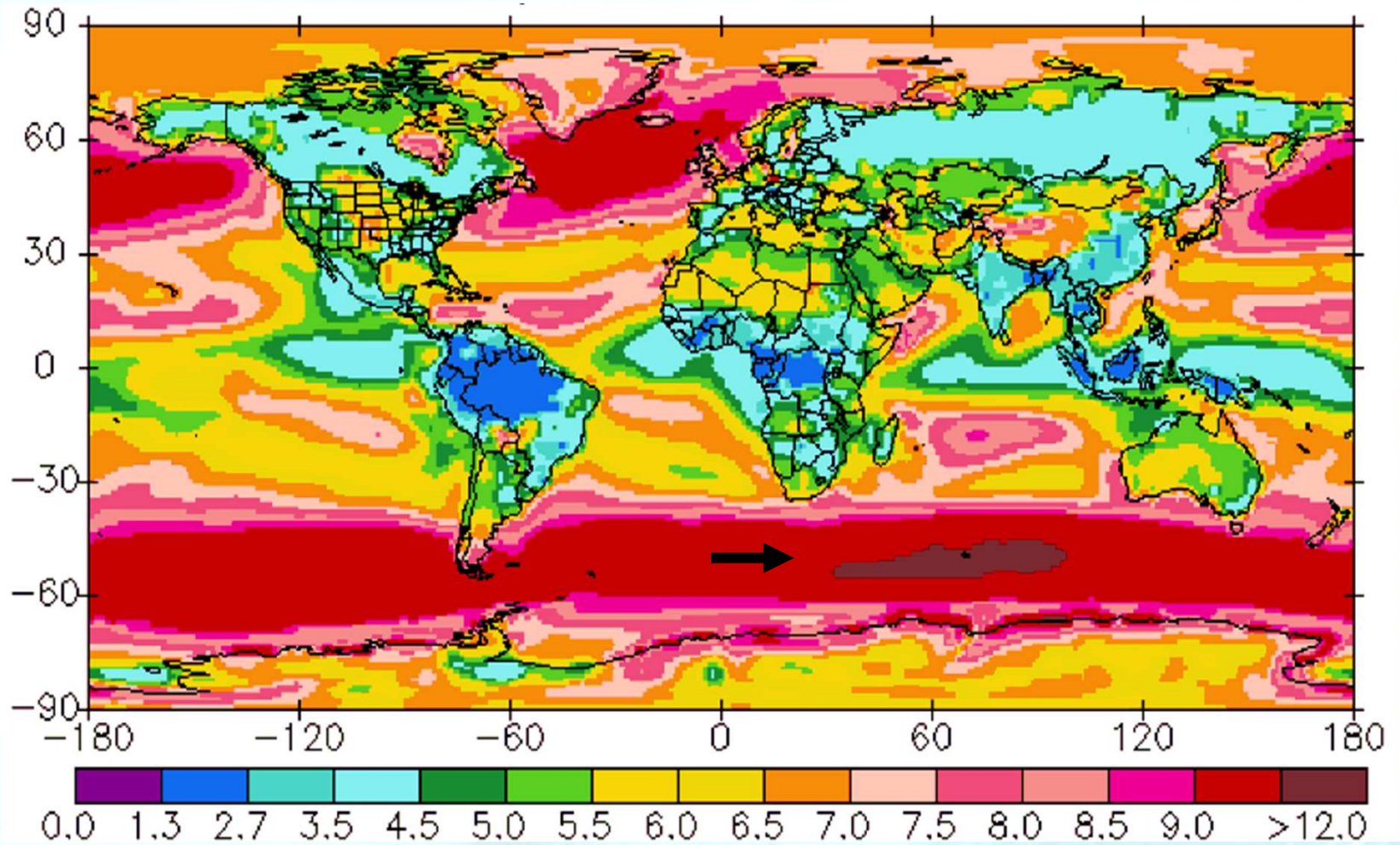


Waves are generated by wind

Wave height and period is a function of wind speed, duration and generation length (fetch)

World wind map

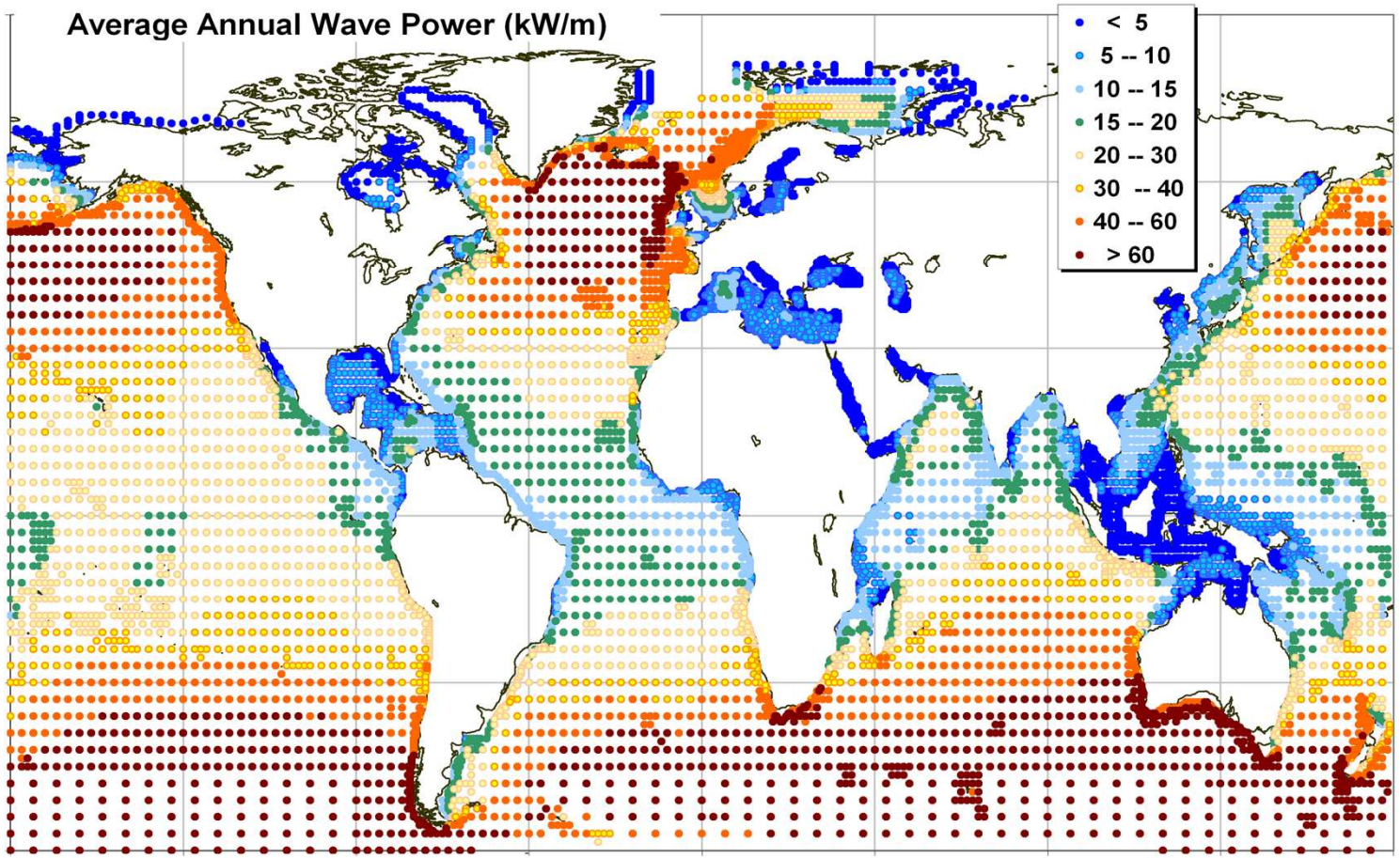
RENEWABLE & SUSTAINABLE ENERGY STUDIES



Slide courtesy of Deon Retief

Global wave power resource

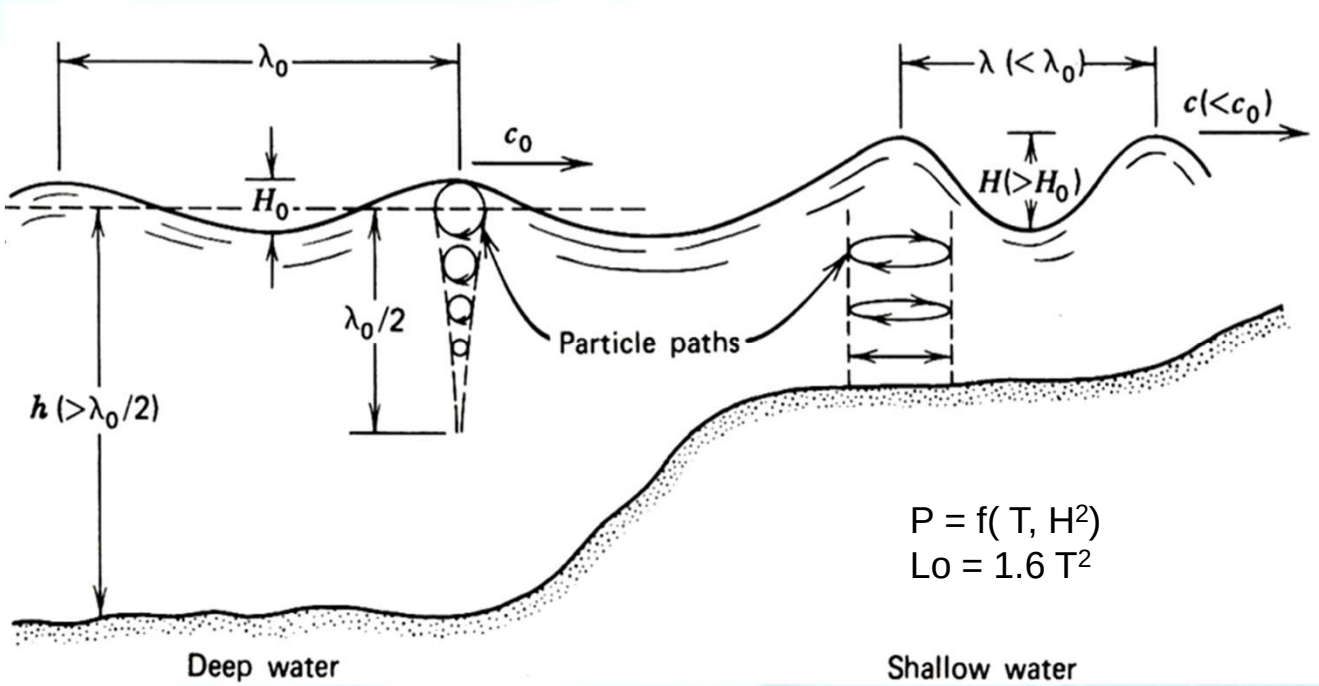
RENEWABLE & SUSTAINABLE ENERGY STUDIES



World Waves data/OCEANOR/ECMWF

Converter design

RENEWABLE & SUSTAINABLE ENERGY STUDIES



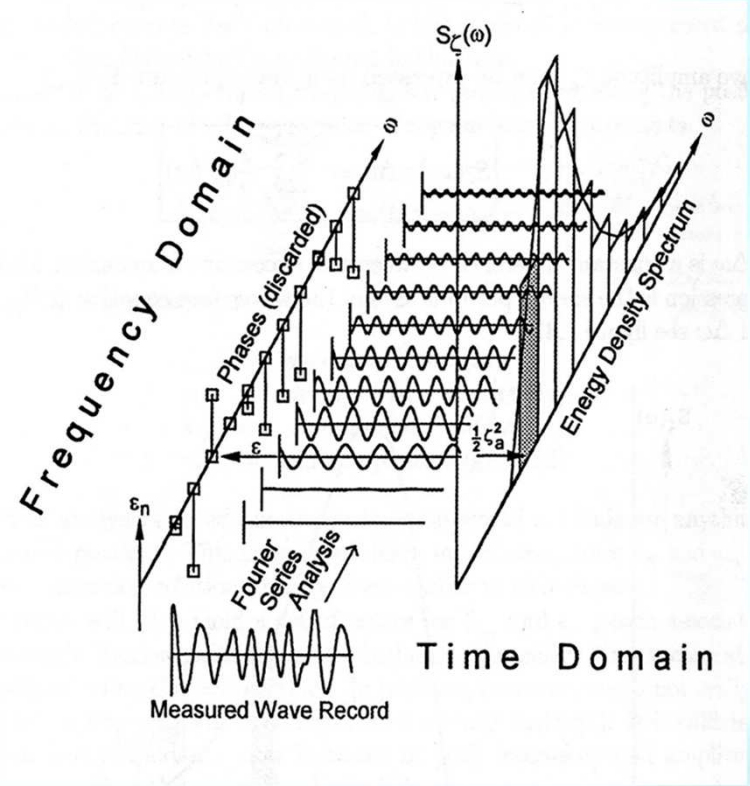
Inshore Wave Heights from 2.5m average up to 20m maximum

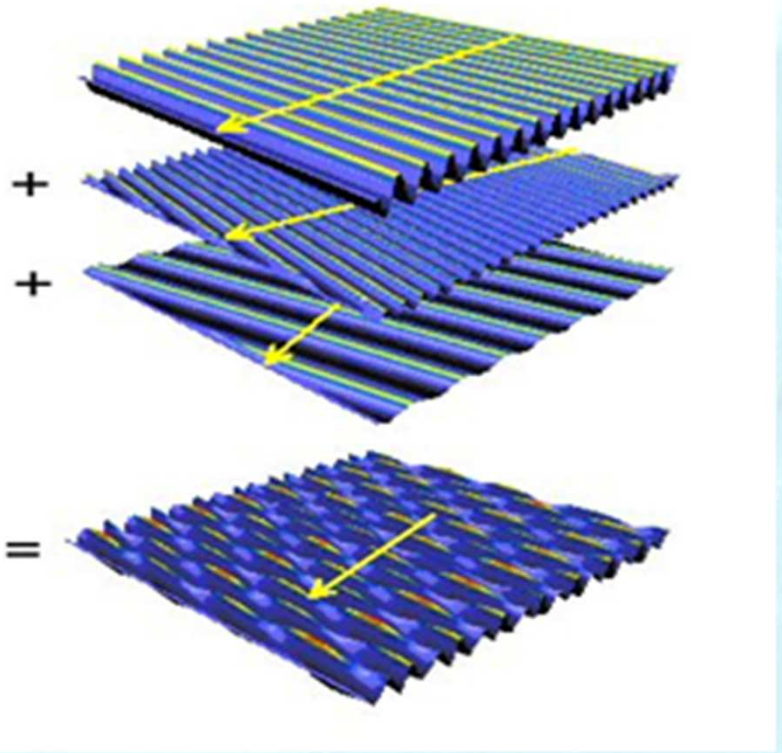
Wave Lengths from 75m (7sec period) to 500m (18sec period) and average of 225m (12 sec period), even within one data set

Slide courtesy of Deon Retief

Wave energy density spectrum

RENEWABLE & SUSTAINABLE ENERGY STUDIES

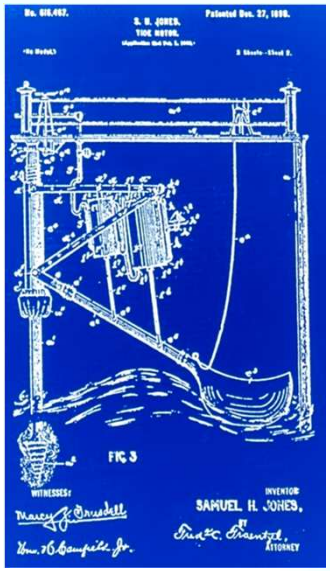




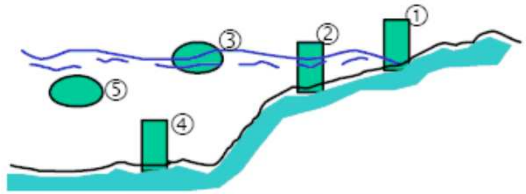
Device types

RENEWABLE & SUSTAINABLE ENERGY STUDIES

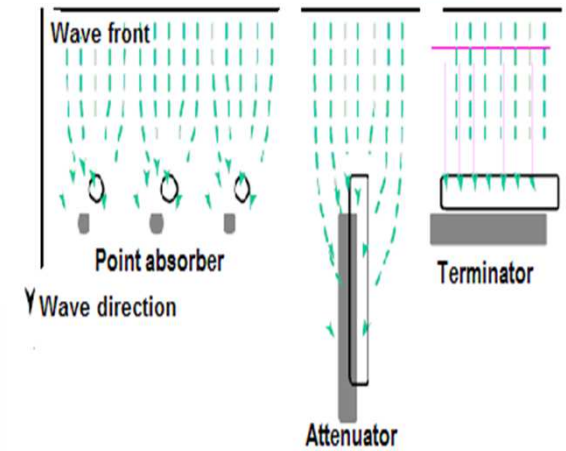
1898 Patent



- ① Shore-based
- ② Near-shore bottom-standing
- ③ Floating; near-shore or offshore
- ④ Bottom-standing or submerged on not too deep water.
- ⑤ Submerged not far from a water surface
- ⑥ Hybrid; units of types 2-5 combined with an energy storage (such as a pressure tank or water reservoir) and conversion machinery on land.



Deployment location

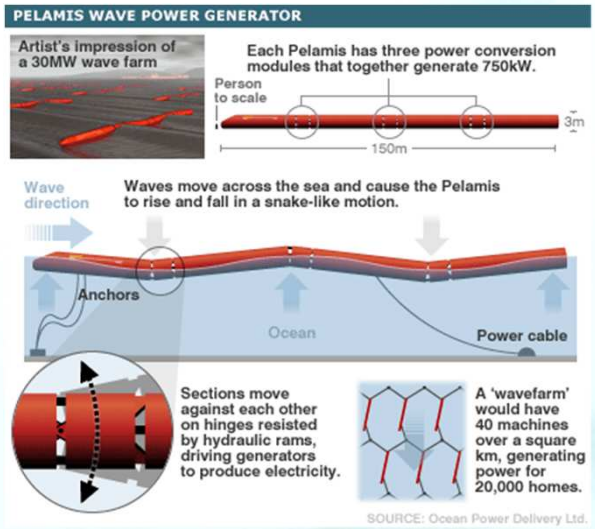


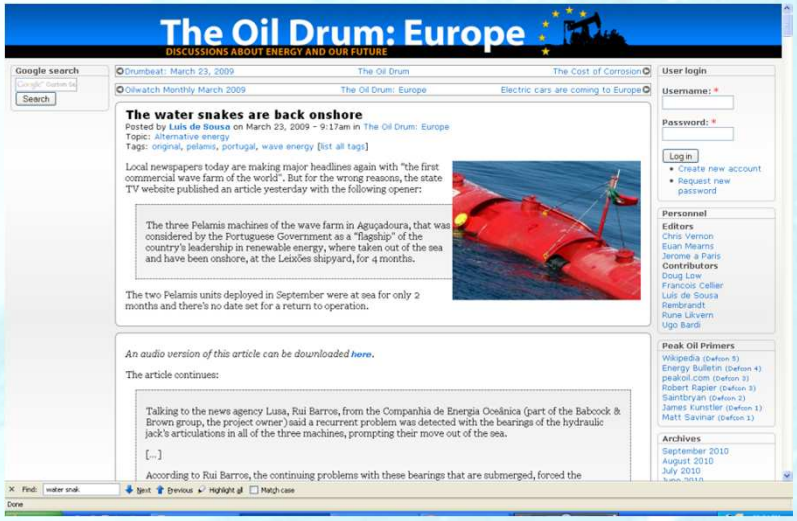
Size and orientation

Power take-off: hydraulic ram, elastomeric hose pump, pump-to-shore, hydroelectric turbine, air turbine and linear electrical generator

Challenges

RENEWABLE & SUSTAINABLE ENERGY STUDIES





Challenges

RENEWABLE & SUSTAINABLE ENERGY STUDIES

GREEN ENERGY DREAM SUNK

Generator vanishes under waves

PORT Kembla's revolutionary wave energy system today lies at the bottom of the sea, a victim of the wave power it is meant to harness.

The 170-tonne structure, which had been moored 150m offshore, broke free of its pylons on Friday afternoon. Developers Oceanlinx rushed to try to save it while it was lodged on rocks, but high seas prevented any recovery effort. Overnight the platform sank.

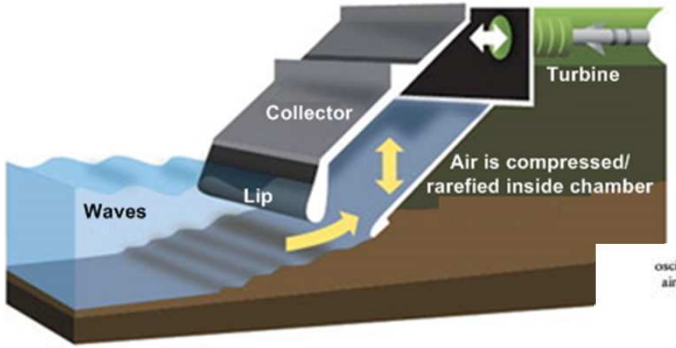
Port Kembla Port Corporation CEO Dom Figliomeni said that at this stage the structure was not posing a threat to shipping.

However, port and Oceanlinx representatives would meet today to discuss salvage options.

■ REPORTS PAGE 3

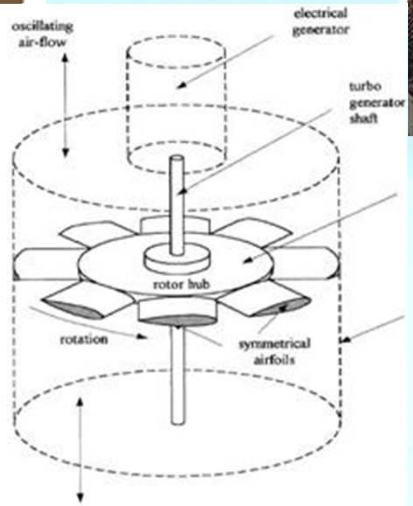
LIMPET

RENEWABLE & SUSTAINABLE ENERGY STUDIES



Area = 20x7m

Capacity: 500kW = 2x250kW
Cost = R10.4million
R20 800/kW



Wells turbine
Overall efficiency = 25%

Breakwater WEC's

RENEWABLE & SUSTAINABLE ENERGY STUDIES

60 kW
Sakata, Japan (1987 – 1991)

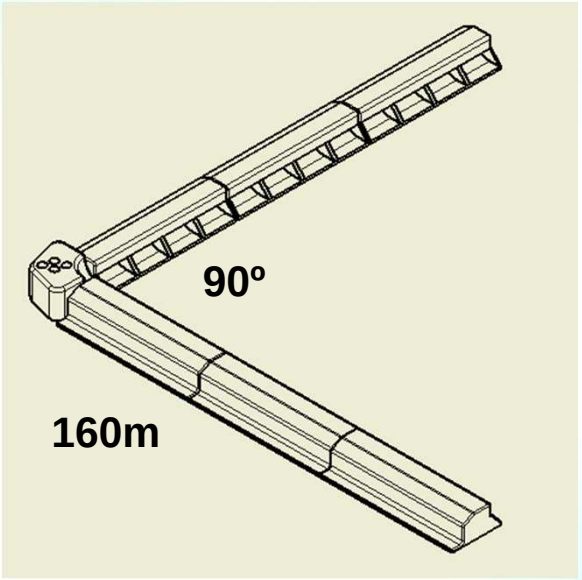
150 kW
Vizhinjam, India (1991 -)

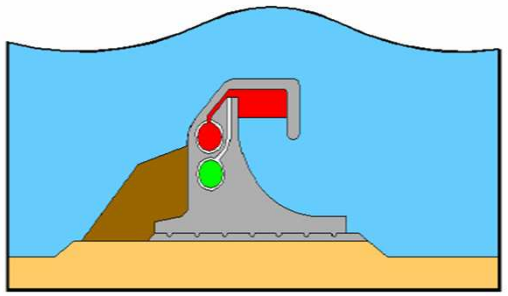
40 kW SDE

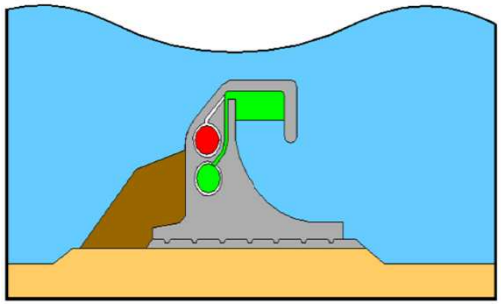
300 kW = 16x18.5kW

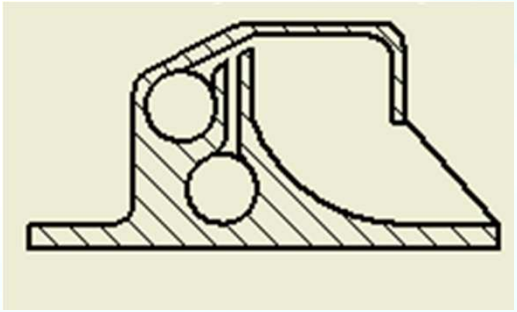
Stellenbosch wave energy converter (SWEC)

RENEWABLE & SUSTAINABLE ENERGY STUDIES

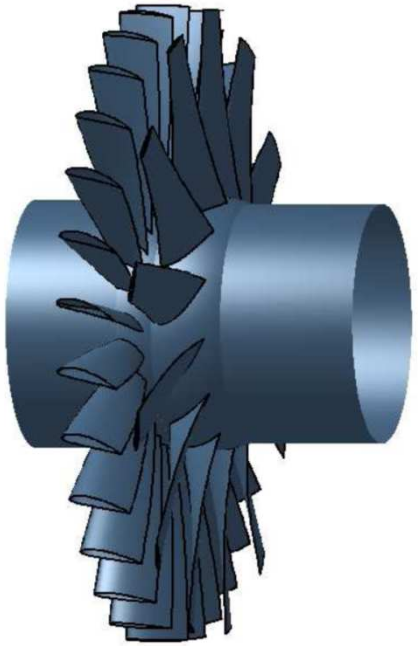


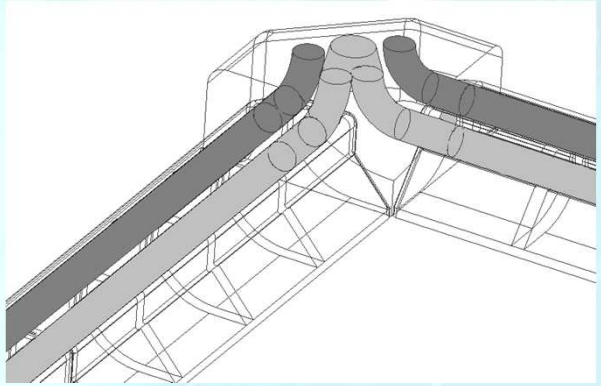






12m x 6m x 3.5m





SWEC (cont)

RENEWABLE & SUSTAINABLE ENERGY STUDIES

Barriers for full scale deployment

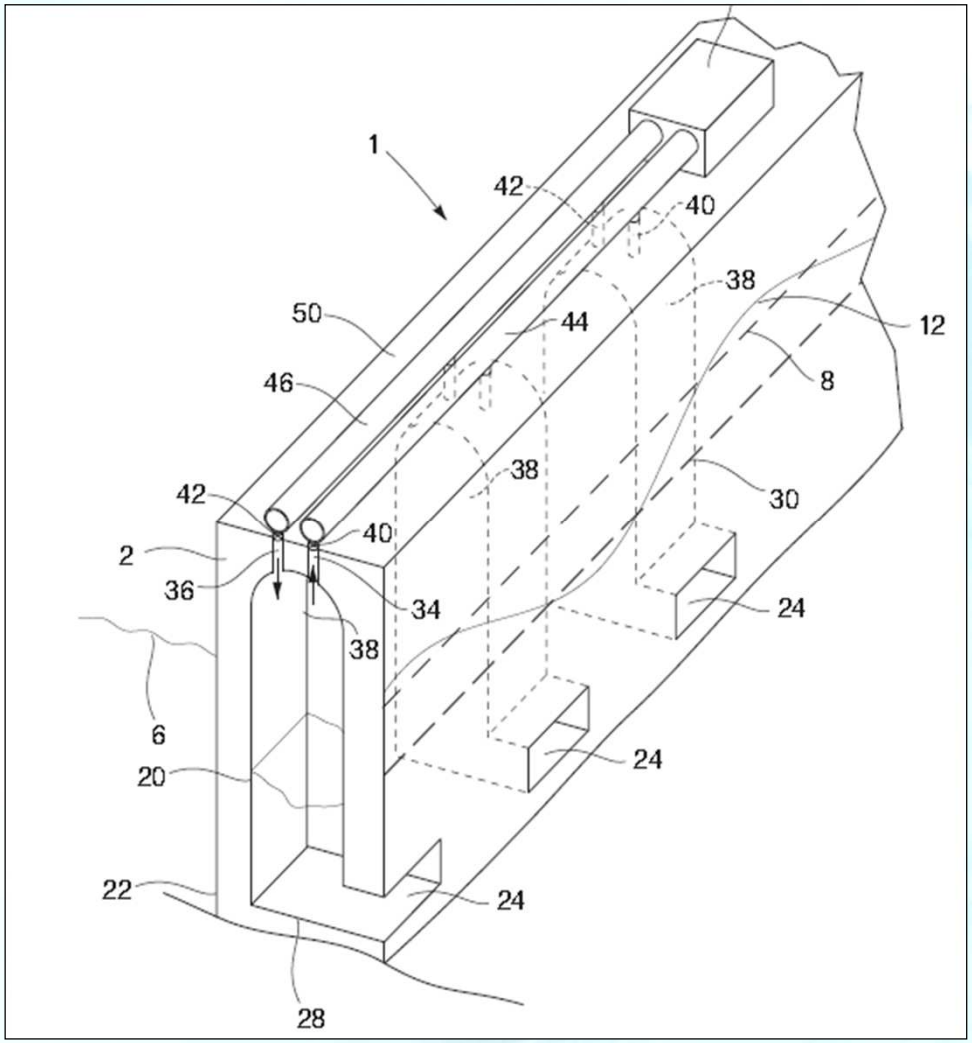
- Oil price stabilised
- High capital cost
- Complex licensing & permit requirements

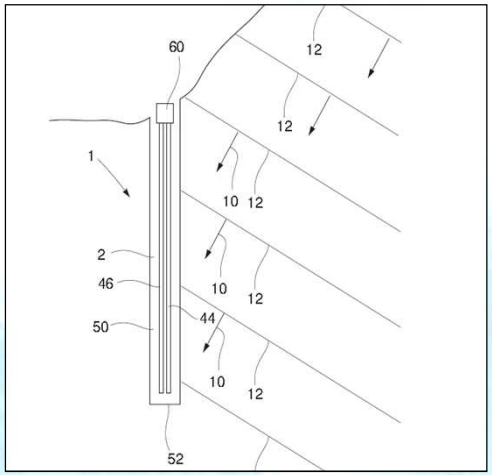
Incorporate SWEC principle into breakwater structure for existing/new port development

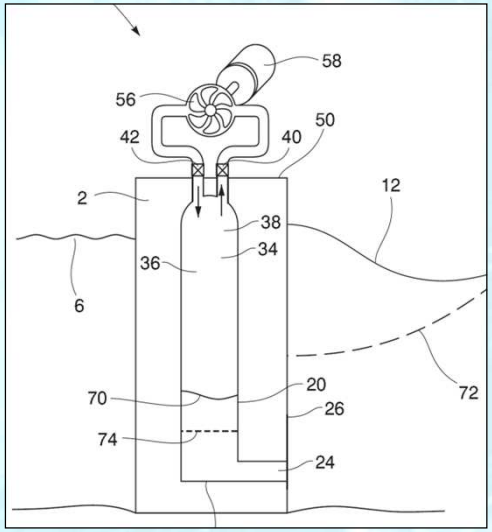
- Cost sharing between breakwater & WEC
- Reduced loadings on breakwater
- Simplifies EIA
- Supply clean, free energy to development

ShoreSWEC

RENEWABLE & SUSTAINABLE ENERGY STUDIES







Site selection

RENEWABLE & SUSTAINABLE ENERGY STUDIES

Granger Bay

Table Bay wave energy resource (cont)

RENEWABLE & SUSTAINABLE ENERGY STUDIES

Mean annual average wave power distribution of Table Bay based on 10 years of hindcast wave data

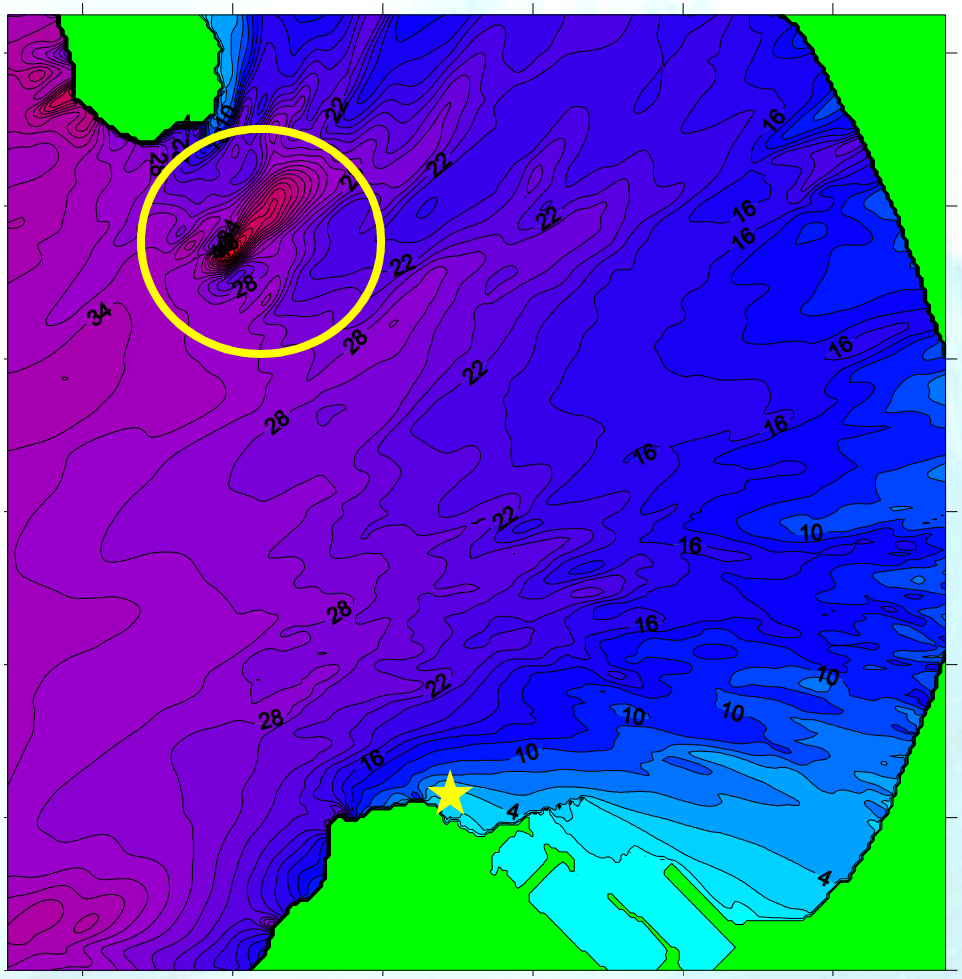
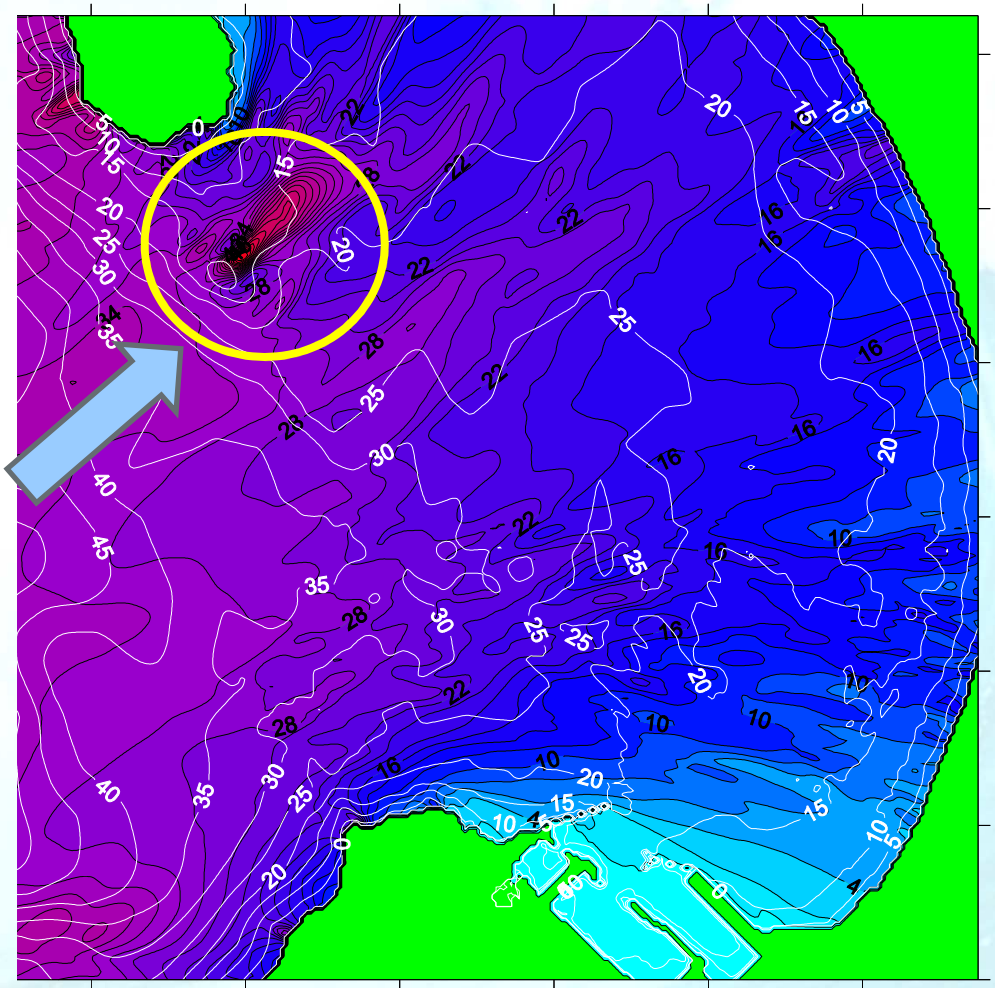


Table Bay wave energy resource (cont)

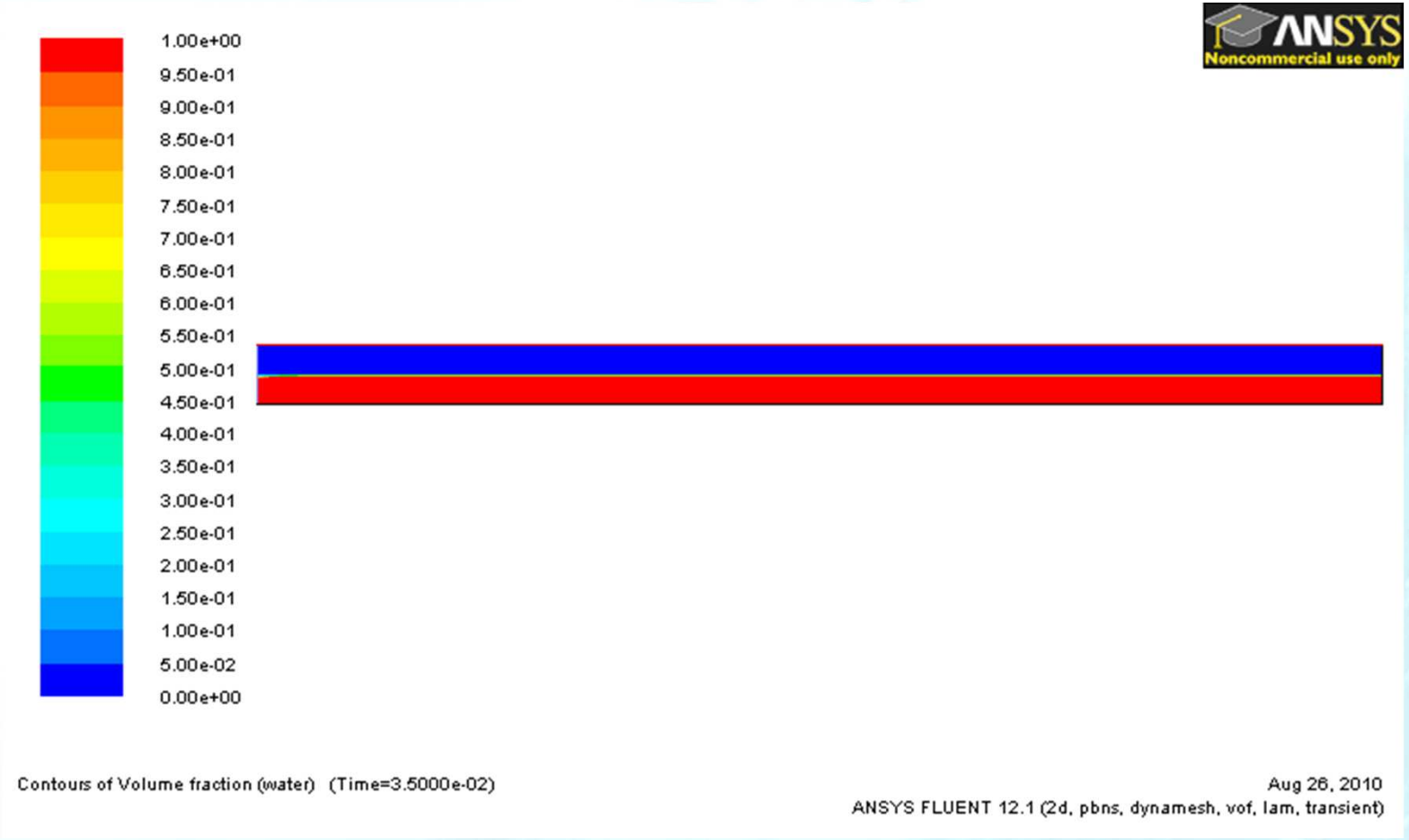
RENEWABLE & SUSTAINABLE ENERGY STUDIES

Mean annual average wave power distribution of Table Bay based on 10 years of hindcast wave data

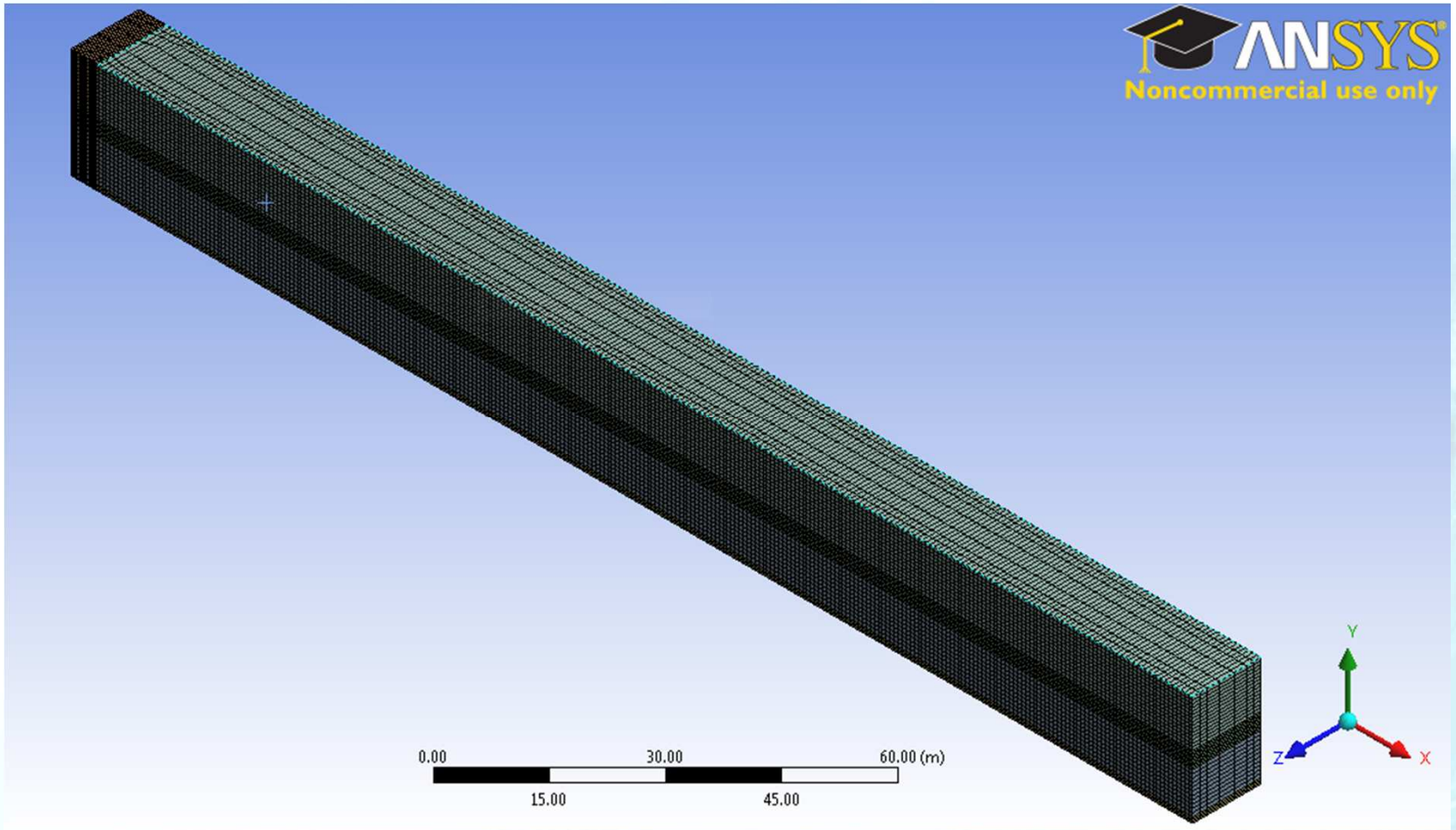


Numerical model: 2D Fluent wavemaker

RENEWABLE & SUSTAINABLE ENERGY STUDIES



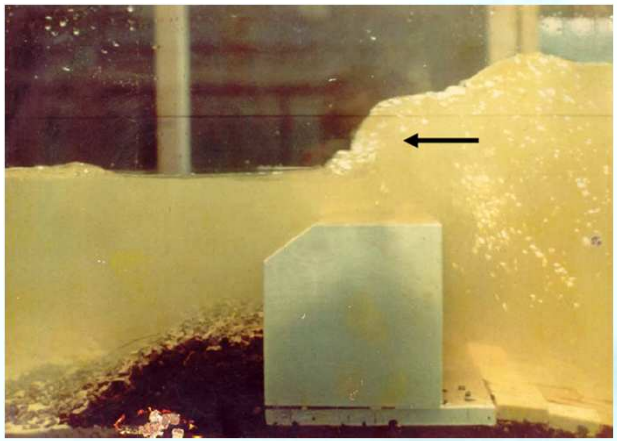
Numerical model: 3D Fluent wavemaker



What lies ahead…

RENEWABLE & SUSTAINABLE ENERGY STUDIES

- Complete numerical model to optimise design parameters: chamber dimension, orientation, length etc.
- Physical model tests to verify numerical model and determine generation capacity
- Develop economic model



Conclusions

- Great opportunities for wave energy development in SA, but also barriers
- SA has a world class wave energy resource
- SA has an indigenous WEC designed for local conditions
- Opportunity to demonstrate SWEC conversion principle in port development
- Wave power focal zone exist in Table Bay


Thank you for your attention
Any questions?

Stellenbosch Wave Energy Converter(SWEC)

RENEWABLE & SUSTAINABLE ENERGY STUDIES