Marine Renewables in the Australian Context

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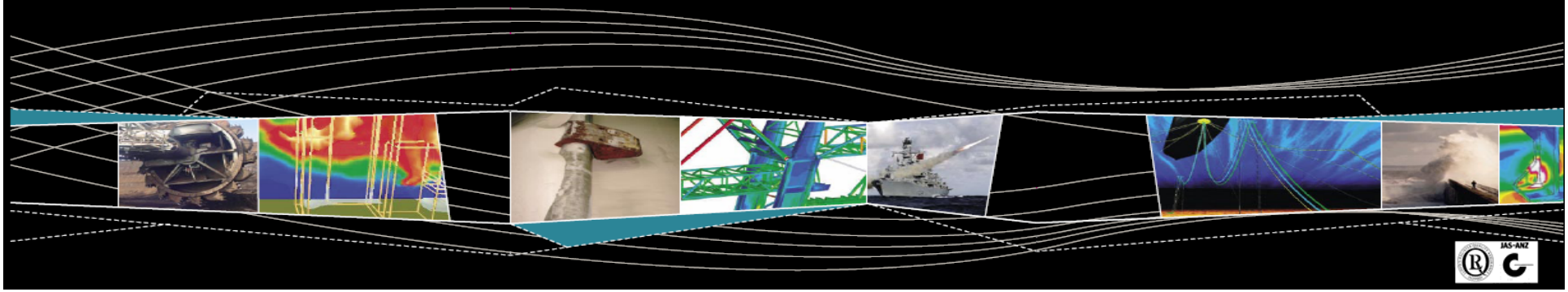
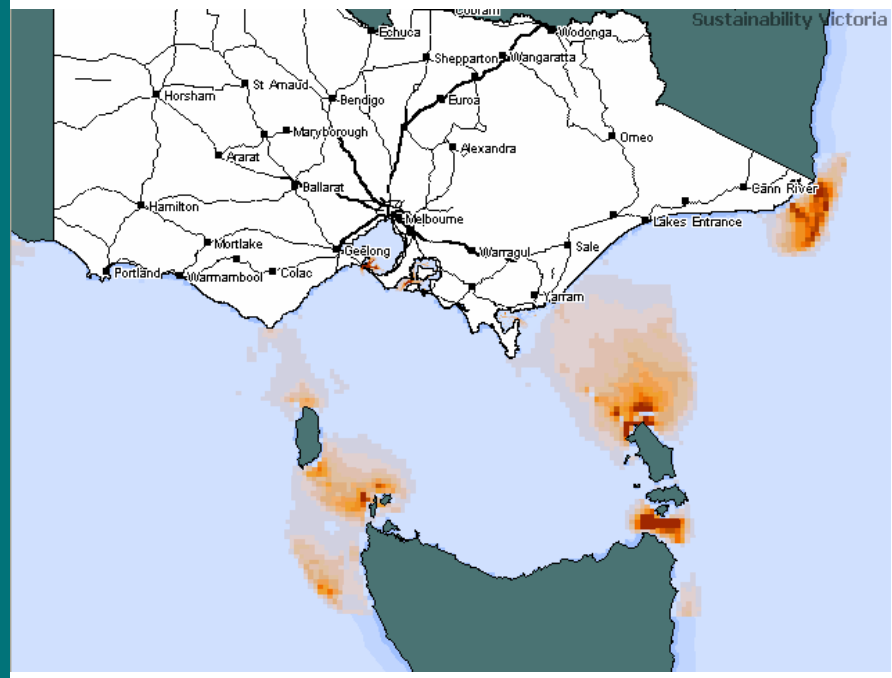


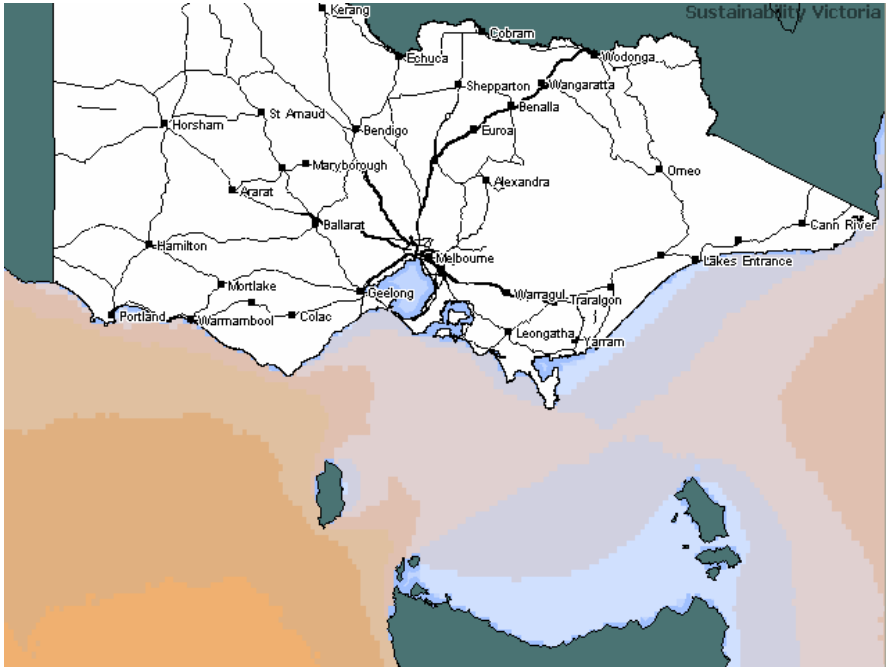
Ways Technology is Developed

International Institutions

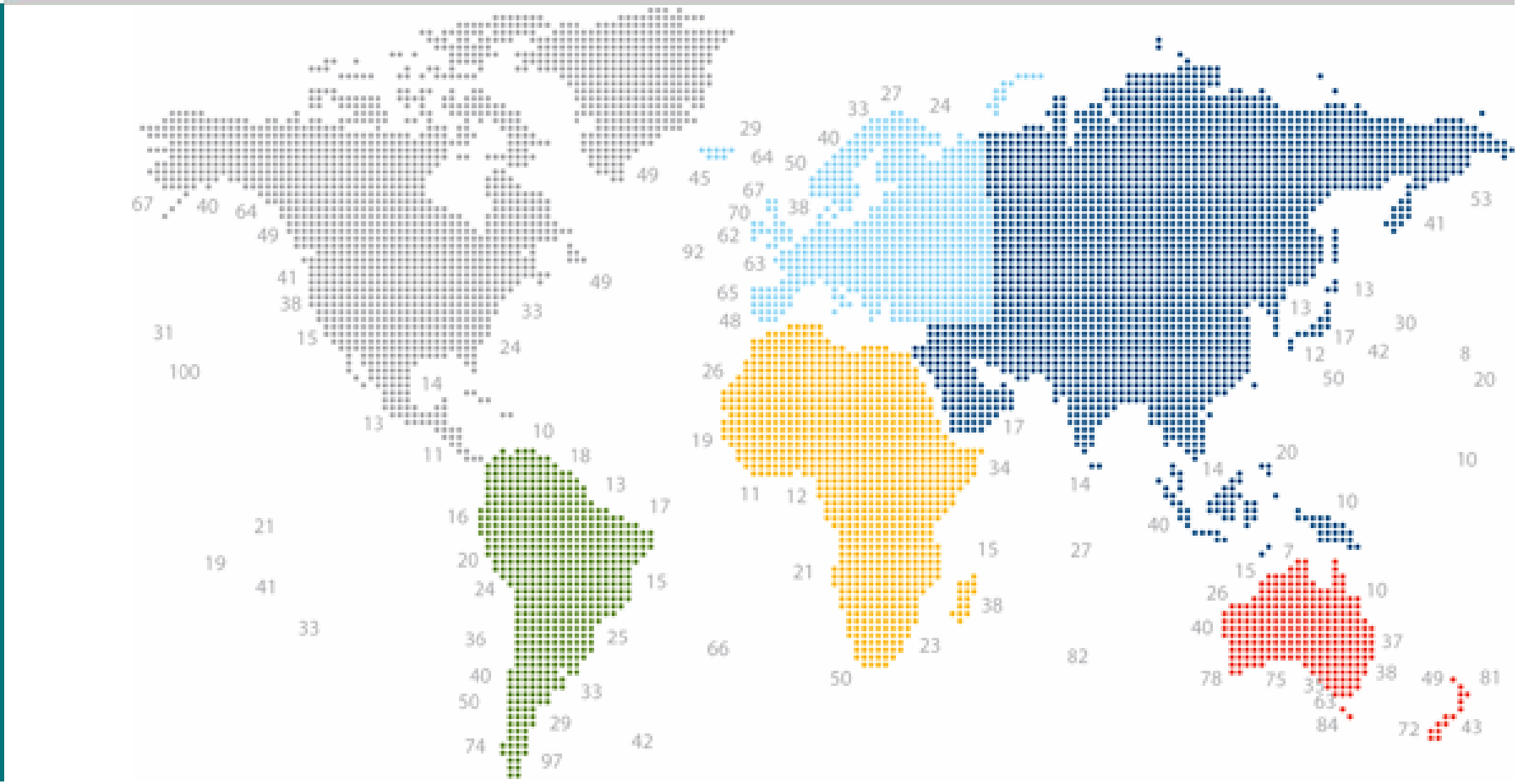
Australian Institutions

Victorian Current and Wave Map





Australian Wave Power compared to Global



Wave Period – Design for Survival in harsh small periods

- **Sea waves < 9 s**
  - **Locally generated**
  - **Monsoonal, Trade winds or local passing troughs**
- **Significant Swell waves 14 – 20 secs**
  - **Originate from Southern Ocean Storms up to 7000km away**
  - **More present in winter (~20% of time) than summer (<10% of time)**
  - **Larger in amplitude in winter as storms are closer**

Marine Renewable Companies in Australia

● = prototype

★ = planned

oceanlinx

Marine Renewable Companies in Australia

● = prototype
★ = planned

Carnegie

Marine Renewable Companies in Australia

● = prototype

★ = planned

BioPower Systems

Cross Fertilization for Solutions

Deploying into the Ocean is *complex* and *costly*

Good news:

- **The oil industry has already solved most of the problems!**

Bad news:

- **The solutions are costly.**
- **Sourcing the solutions can be in competition with the oil industry.**

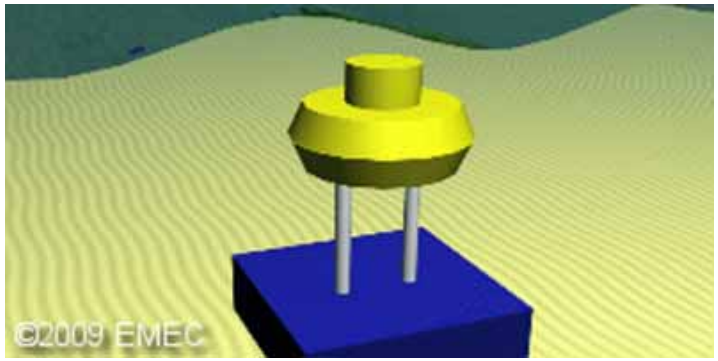
The Marine Renewable Industry needs to:

- **Borrow ideas and solutions through Cross-Fertilization with the Oil industry**

but

- **Spend its precious capital $ carefully through innovative and novel solutions.**
- **This will require an industry constantly challenging the norms**

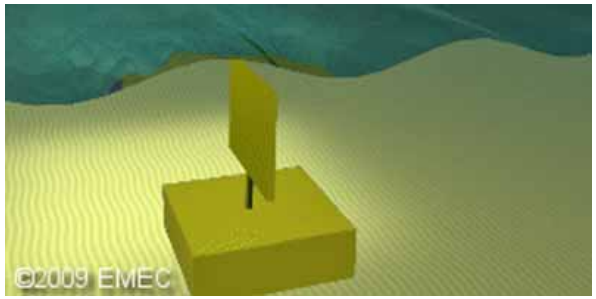
Cross Fertilization for Solutions

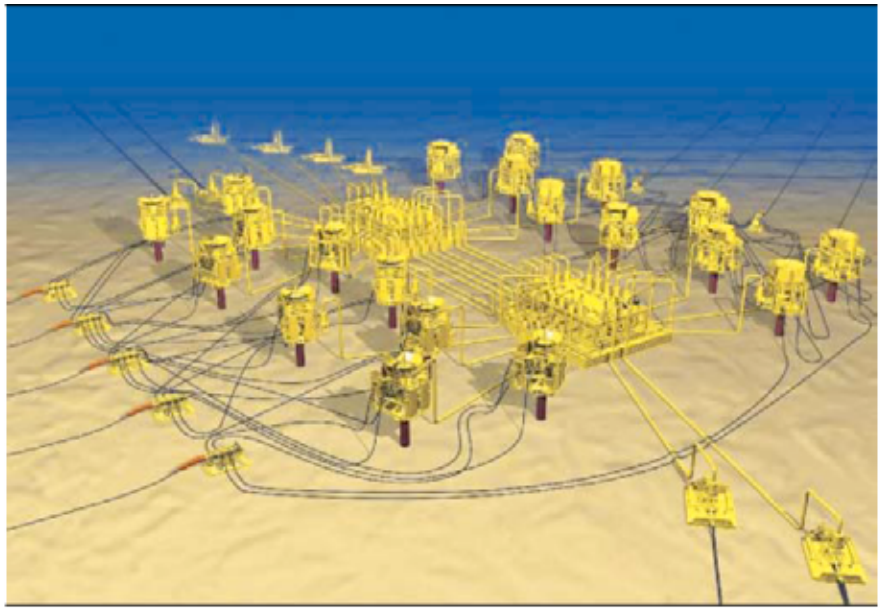


Marine Renewable Industry

Oil Industry

Cross Fertilization for Solutions



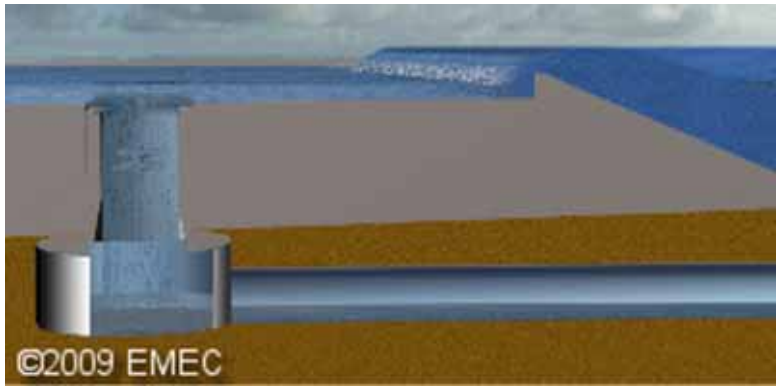


Source: FMC Technologies

Marine Renewable Industry

Oil Industry

Cross Fertilization for Solutions



Marine Renewable Industry

Oil Industry

Complexity and Cost Issues

- **Foundation**
- **Installation**
- **Proximity to ports / slipways / fabrication infrastructure**
- **Access to electrical grid**
- **Shore crossing issues**
- **Maintenance strategy – Access to local support vessels for Divers / ROVs (Underwater Remote Operated Vehicles)**

Foundation Options

Dependent On:

- **Type of Device**
- **Size of Device**
- **Water Depth**
- **Design Life (Ultimate Capacity & Fatigue)**
- **Seabed Conditions**
- **Installation strategy**

Large Power Generation = Large Environmental Loads

Large Environmental Loads = Large Foundations

Foundation Options

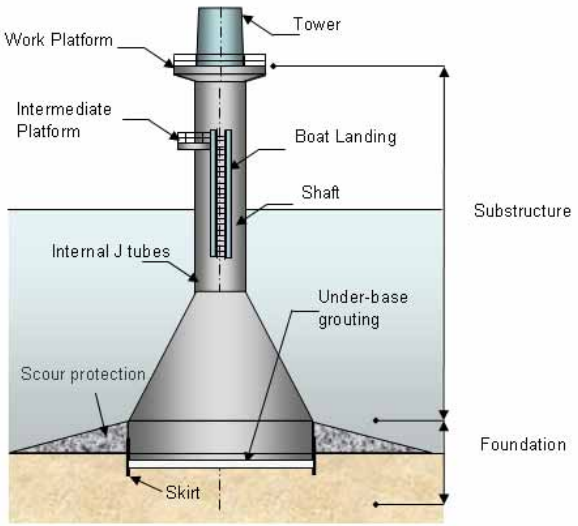
Gravity Base

Pros

- Simple
- Minimal expensive geotech investigations required

Cons

- Heavy
- Requires novel installation methods
- Expensive if device is extremely large



Geotech barge not req'd →

Foundation Options

Piled Structures

Pros

- Can provide an efficient holding capacity
- Can be relatively light structures locally fabricated and require minimal transportation costs

Cons

- Require expensive Geotech site drilling/coring from vessel & detailed laboratory analysis
- Requires a vessel to drive piles (probably a large vessel to work in relatively rough conditions)
- Australia has vast offshore regions with Calcaraneous Soils with no shear holding strength.

Foundation Options

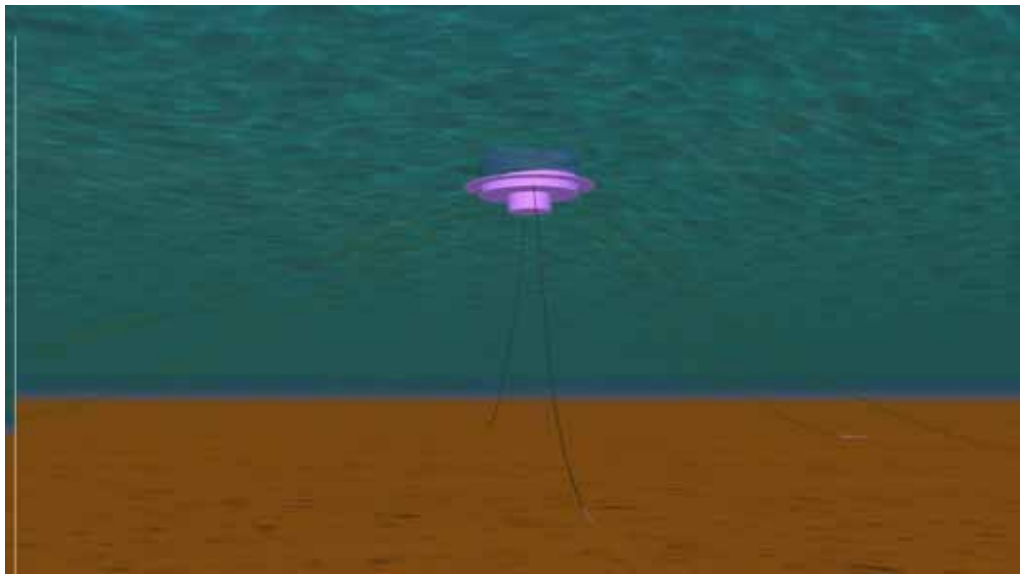
Catenary Moorings

Pros

- Can provide an efficient holding capacity
- Can utlise cheap high holding capacity drag anchors
- Installation of moorings relatively easy (cross tensioning)

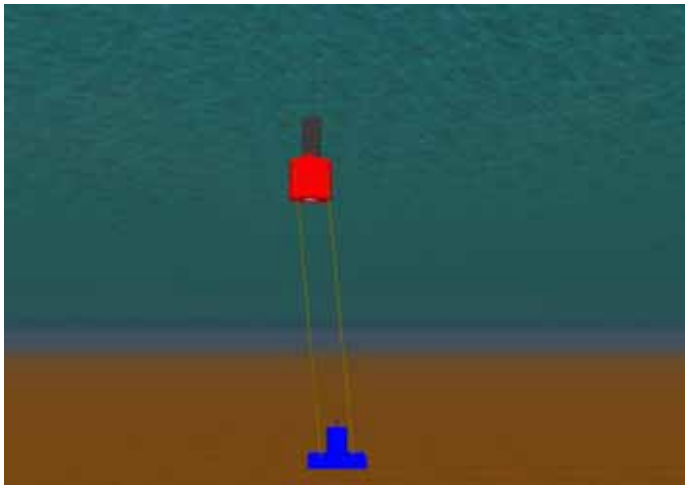
Cons

- Requires that device is allowed to respond (freely) to 1st order wave motion



Foundation Options

Tensioned Leg Moorings



Pros

- Ideal for supplying stable device platform, especially in deepwater.
- Can be relatively light structures locally fabricated and require minimal transportation costs

Cons

- Requires buoyancy and counteracting the tension
- Difficult in a lot of Calcarenous Soils – requires gravity base

Installation

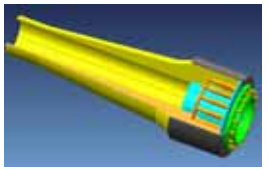
- **Good wave energy sites do not have flat water!!**
- **Use of locally available marine resources saves costs**
- **Innovative design of installation**

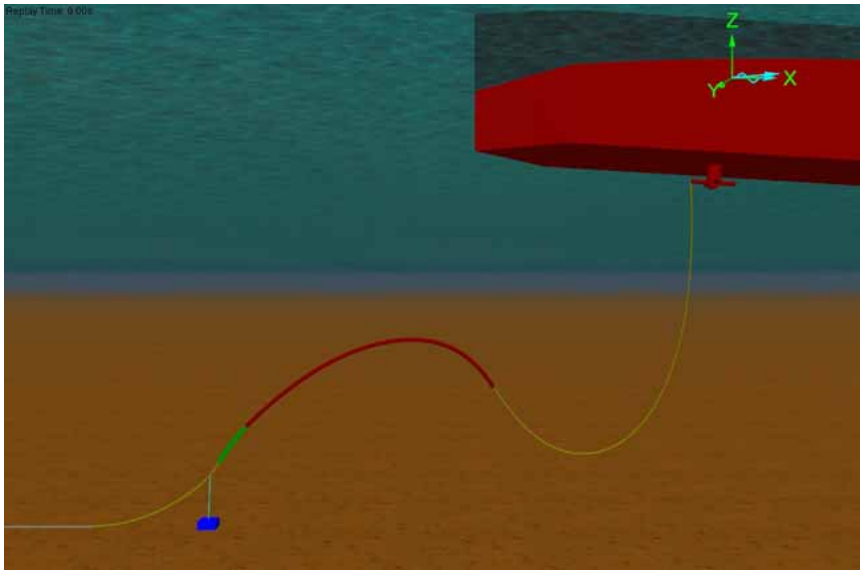
Installation

- **Cheaper if components are smaller and modular**
- **Assemble onshore and tow assembly to site**
  - Fatigue life consumed during towing

- **Proximity to ports / slipways**
- **Access**
- **Australia is remote – Mob. costs**
- **Design for All Installation Cases**
  - Abnormal fatigue loading conditions

Power Connection Issues – Dynamic Umbilicals





Power Connection Issues

DC Subsea Cables 25-550MW

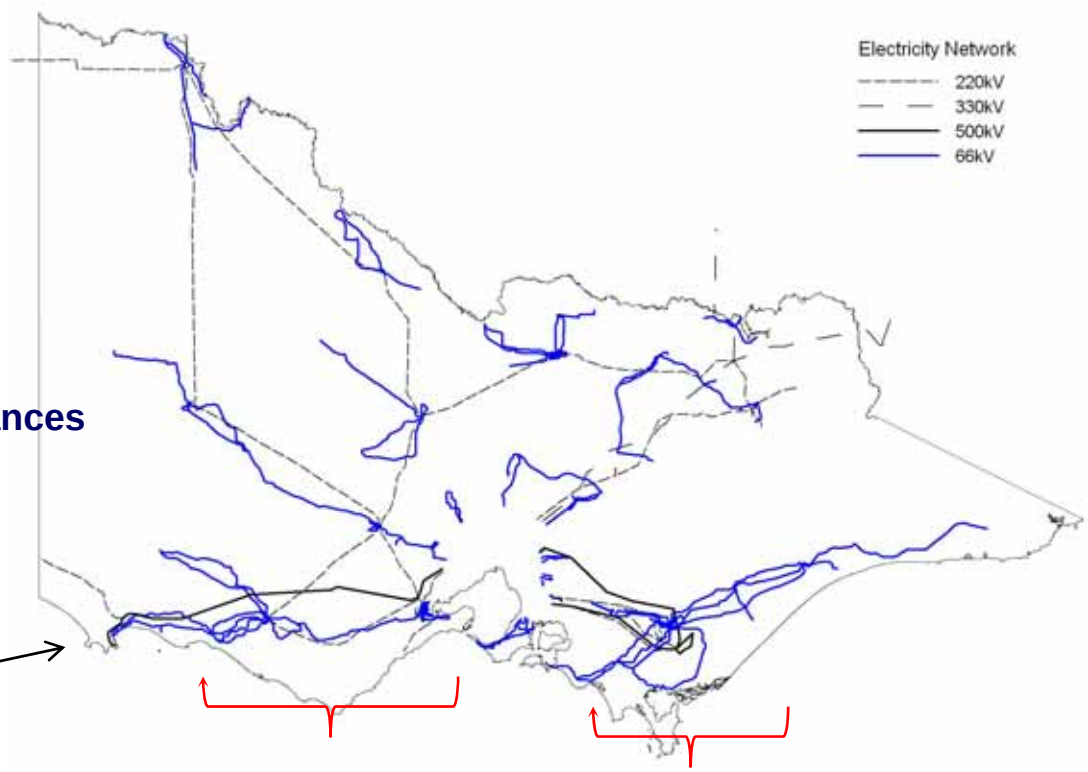
Synchronisation easier with DC

AC Subsea Cables for shorter distances

Step up transformers required

Wet mateable connectors

Courtesy: SUS DEV VIC



Good Site:
Hungry Aluminum Industry

No coastal connections @ large voltages

Maintenance

- **Shallow diving is relatively cheap**
- **Lifting heavy objects is very costly**

- **A small unit can require a crane (construction vessel)**
  - US$100k /day
  - PLUS MOBILISATION from Singapore (10 days each way)
  - Proper planning and sharing mobilsation

Summary

- **Deploying into the Ocean is *complex* and *costly***
- **Innovative Solutions are required to reduce costs**
- **Cross fertilization from other industries**
- **Foundations designs best suited to application**
- **Installation with locally available resources**
- **Subsea cable selection to suit site**
- **Grid connection needs to be considered**
- **If we are smart, Australia has an abundance of useable power !!**

THANKS