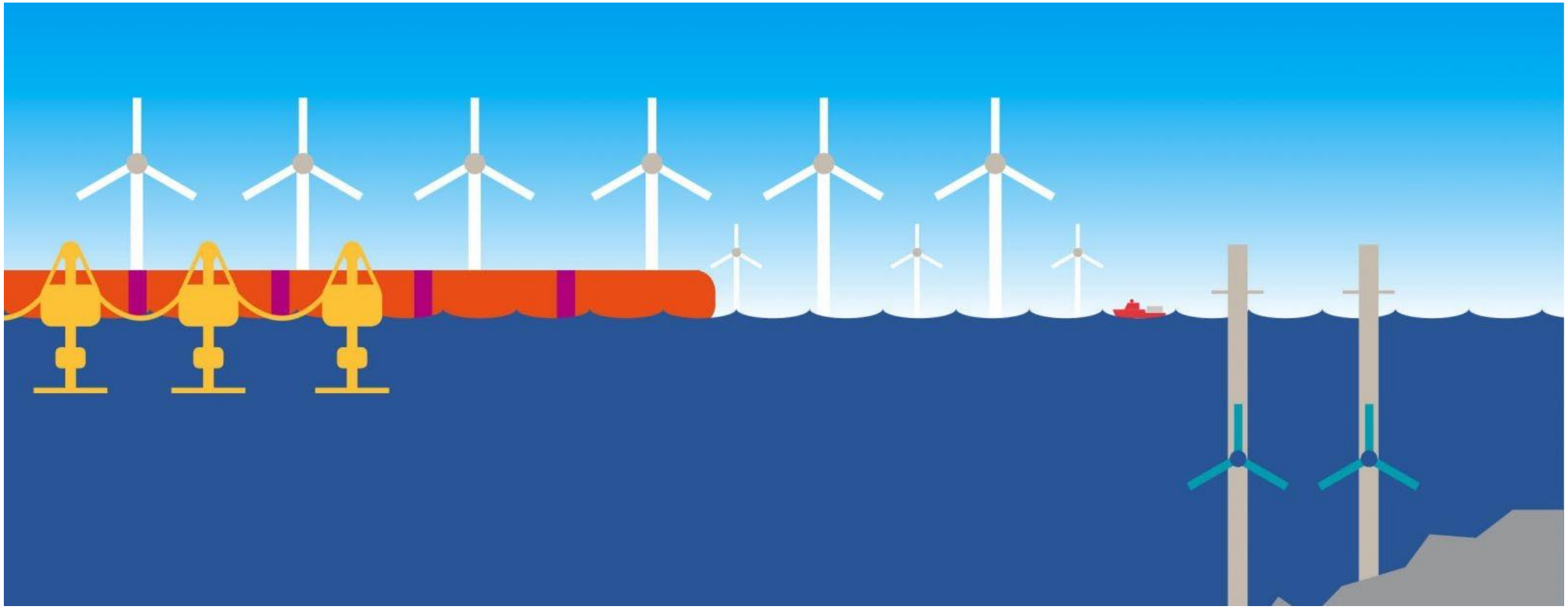


Offshore Renewable Energy: How Far the Technology in Indonesia?

Dr. Nu Rhahida Arini

Postgraduate School
PENS

Why Renewable Energy is important?

The fact of Fossil Fuel:

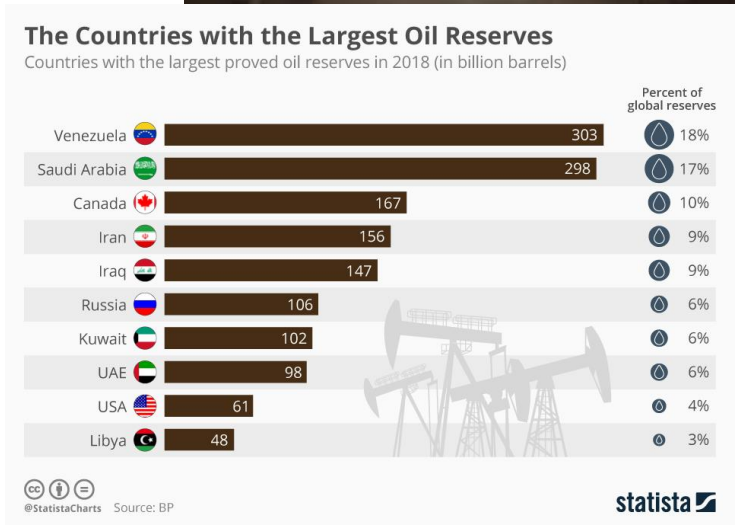
- Pollute the earth.

People use 35 million barrels of oil every year, produces CO2 and other greenhouse gases which impact on climate change, human health, global warming, etc.

- It won't last forever

It cannot be replenished. We have already used 40% of fossil fuel. Estimated reservation: 50 years of oil and gas, 100 years of coal.

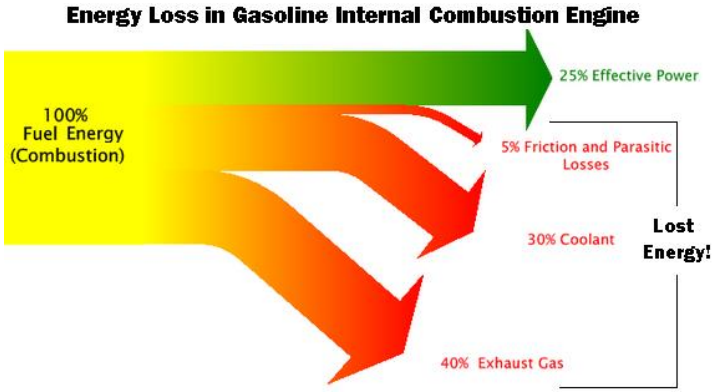
- Take a process to convert into energy (some are not straight forward (system/cycle) and needs devices). A thermal process has efficiency (i.e superheated steam power plant efficiency roughly 40-45%, distribution loss 8%)

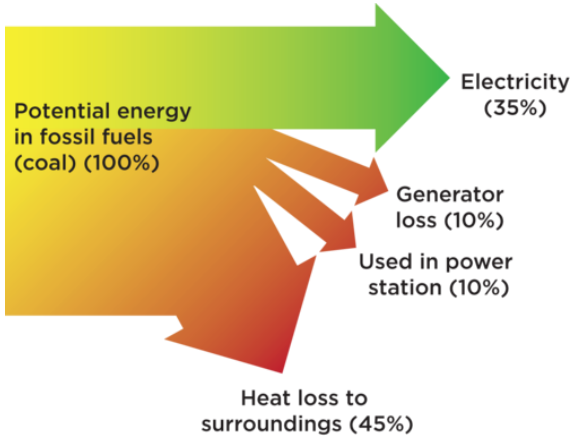


Thus we need to think on the use of

Renewable Energy:

- Greener and cleaner
- Renewed





Marine Renewable Energy:

1. Wave energy
2. Tidal energy
3. Wind energy
4. Temperature driving power
5. Salinity/osmotic power
6. Hybrid

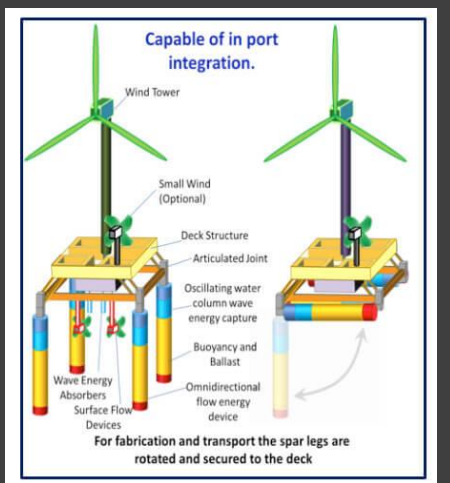
Tidal/wave energy:

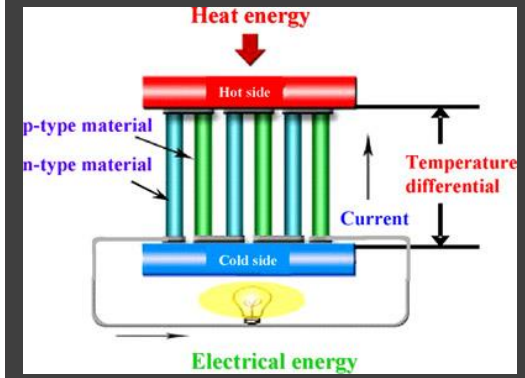
Advantages

- No waste, no pollution
- Renewable resource
- More predictable
- Minimal environmental impacts

Disadvantages

- High cost investment: expensive to build and maintain
- Requires to build grid connection
- Technology is not yet fully developed

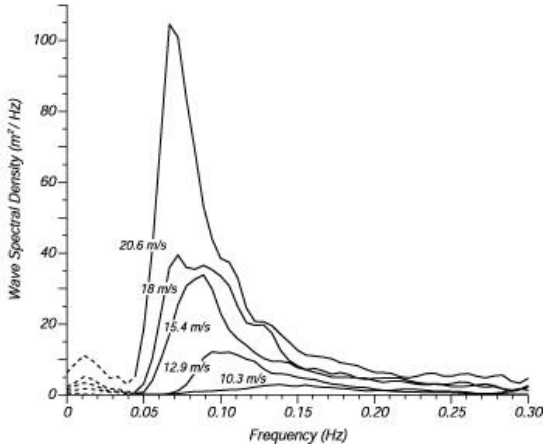


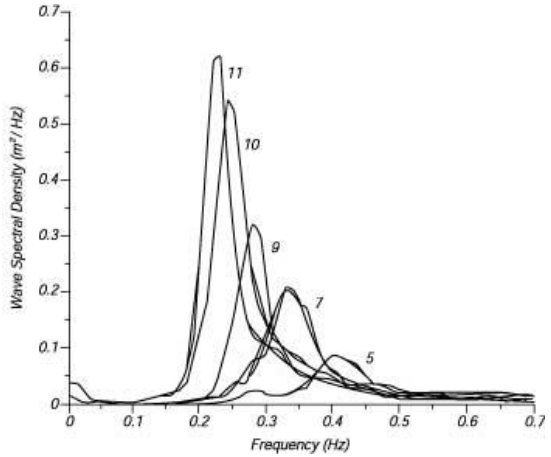


Wave energy

Ocean-Wave Spectra.

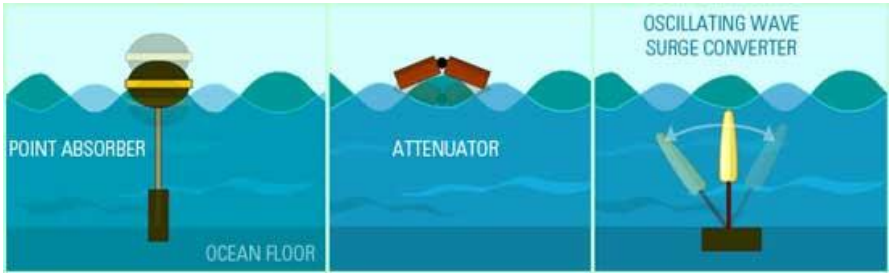
Various idealized spectra are used to answer the question in oceanography and ocean engineering, spectra which are wide-spread used: Pierson-Moskowitz Spectrum and Jonswap Spectrum.





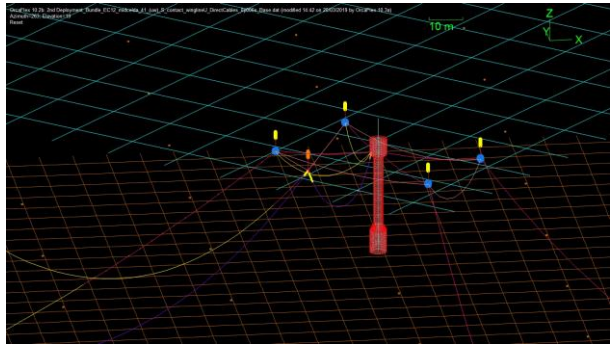
How does it work?

1. Point absorber
2. Attenuator
3. OWC



How to design

1. Fluid dynamic point of view
2. Structural analysis (i.e using Orcaflex)
3. Integration of all components



Why is the Ocean-Wave Spectra important?

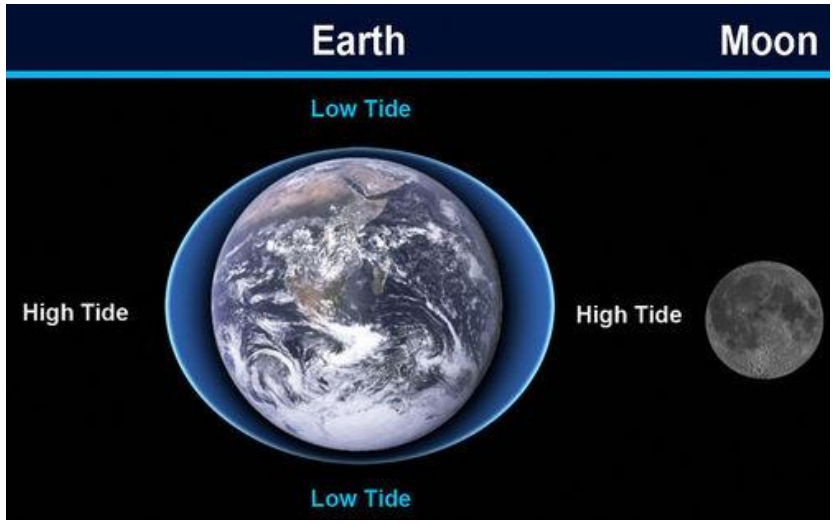
In designing ships or offshore structures we wish to know the biggest waves produced by a given wind speed to predict the fluid loading and weather.

Tidal Energy

What are tides and how are tides formed?

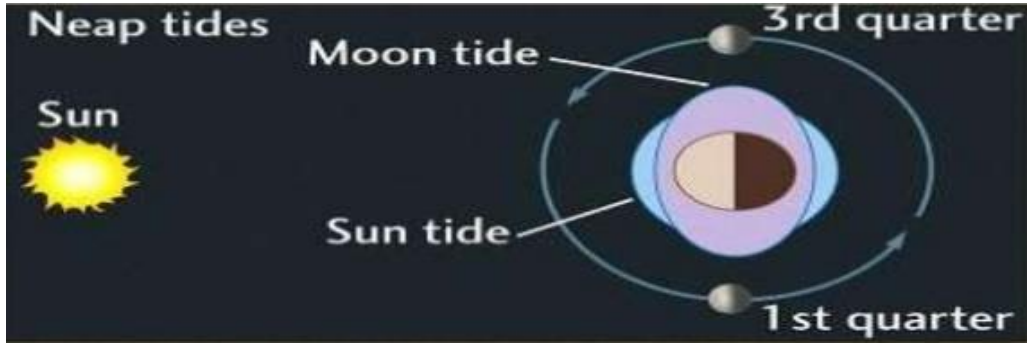
- Tides are rising and falling of earth's ocean surface.
- The gravitational force of the moon causes the oceans to bulge along an axis pointing directly at the moon.
- There are two tides formed: Spring tide and Neap tide

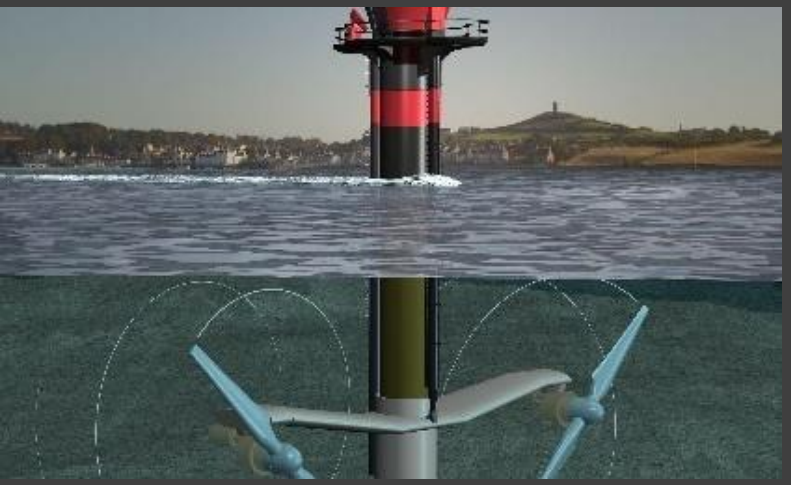
Tidal energy is a form of hydropower that converts the energy of tides into useful other forms of power (i.e electricity)

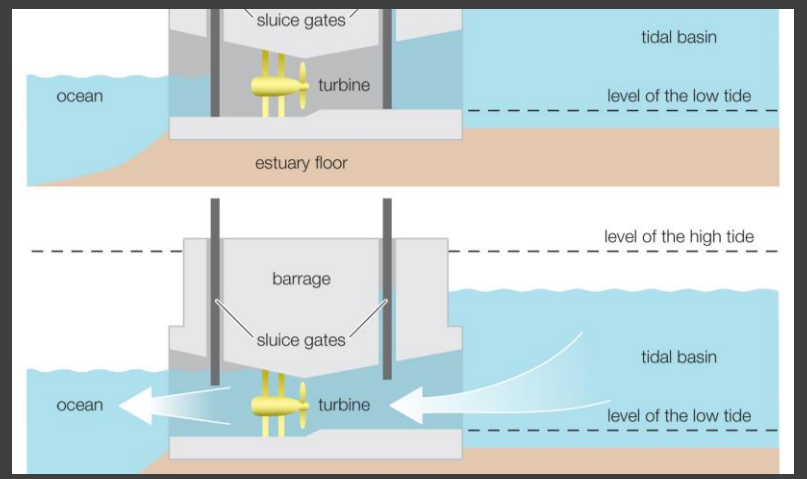


Spring tide	Neap tide
Greatest difference between low and high tide	Least difference between low and high tide
Sun and moon gravity pull in the same direction	Moon is at right angle to sun
Occur at new moon and full moon	Occur at first and last quarter

Advantage	Disadvantage
More predictable than solar and wind	Not development yet
Clean and compact	High cost
Longer life time of equipment than wind and solar farms	The impact of electro-magnetic emission







Two types of tidal energy can be harnessed or extracted to produce electricity:

1. Kinetic energy of tides
2. Potential energy of tides.

1. Kinetic Energy of Tides : energy from moving tides to power turbines in similar way to wind turbines that use wind to power turbines.

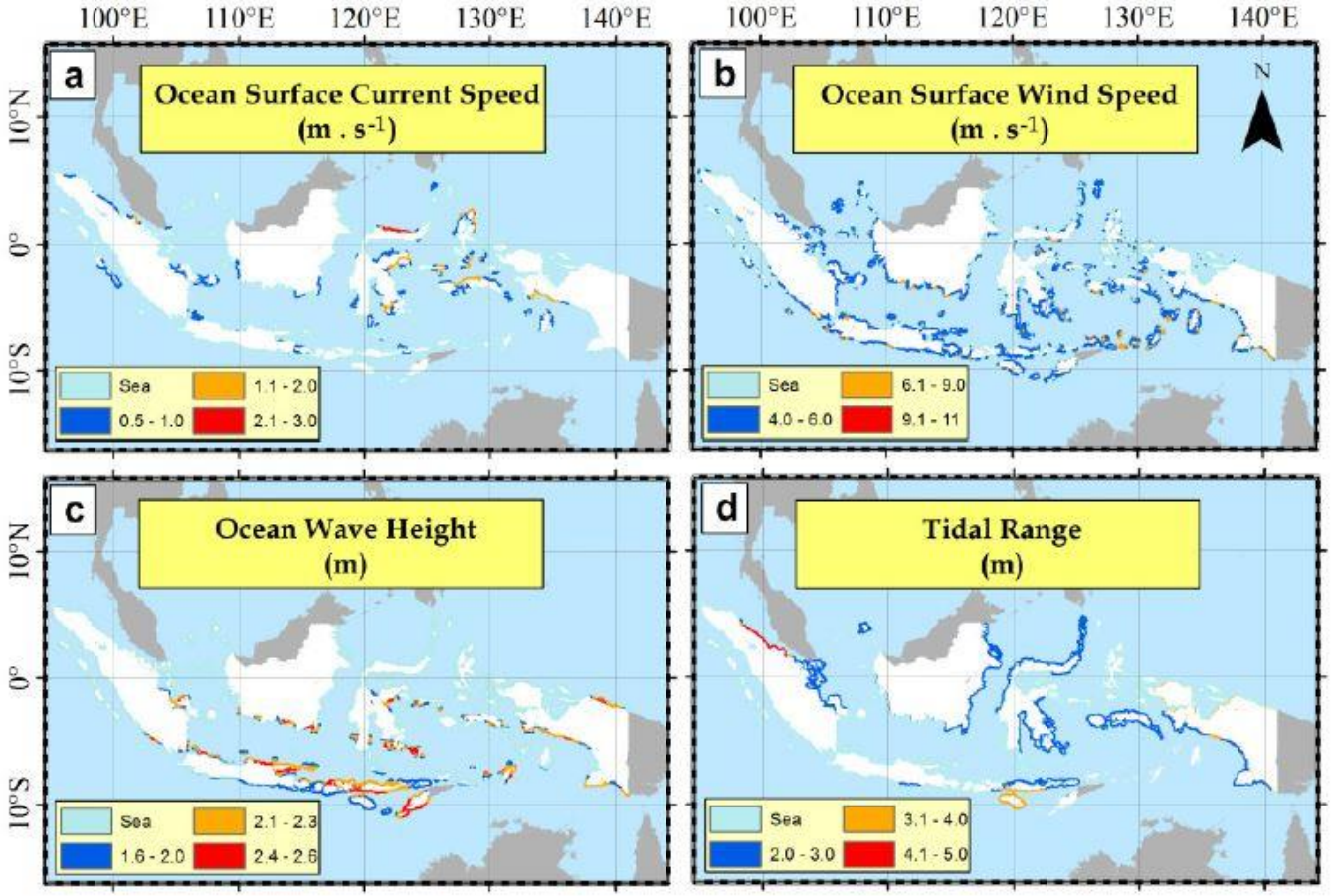
Example: Tidal current turbine (from how it is constructed: horizontal and vertical axis tidal turbines)

2. Potential Energy of Tides: tidal energy from the difference in height of high and low tides.

Example: Tidal Barage

Renewable Energy Potensial in Indonesia

1. Geothermal 29 GW (4-5% is used)
2. Tidal/Hydro 75,7 GW (5% is used)
3. Wind 9,3 GW
4. Solar



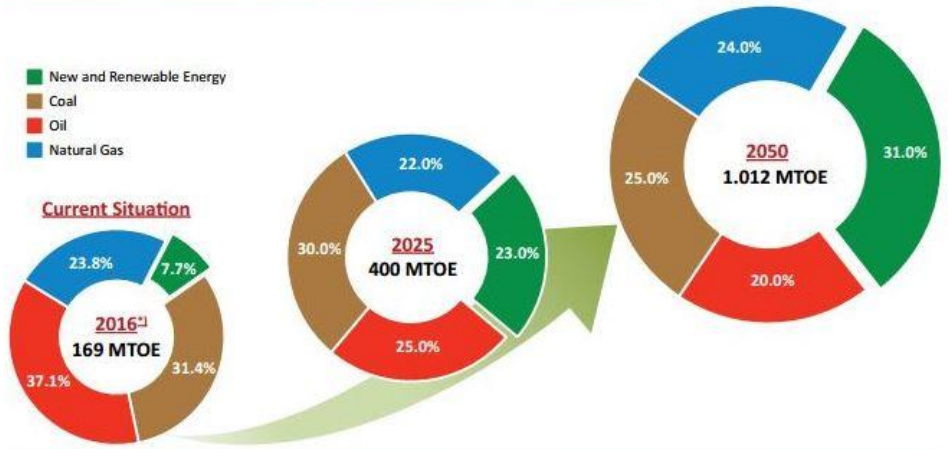
Map of current off-shore wind, wave height and tidal range in Indonesia

INDONESIA POTENTIAL OF NRE DEVELOPMENT

New and Renewable Energy Sources Type	Capacity Power Plants (GW)		
	Committed	2025 Target	2050 Target
Geothermal	7.242 GW	7.242 GW	17.5 GW (59% of 29.5 GW Potential)
Hydro Power	15.559 GW	20.987 GW	45 GW (60% of 75 GW Potential)
Bioenergy	2.006 GW	5.500 GW	26.1 GW (80% of 32 GW Potential)
Solar	0.540 GW	6.500 GW	45 GW (8.5% of 532 GW Potential)
Wind	0.913 GW	1.800 GW	28.6 GW (25% of 113.5 GW Potential)
Other Energy	0.372 GW	3.125 GW	6.4 GW
TOTAL	26.631 GW	45.153 GW	168.6 GW

Sources: MEMR, 2017

INDONESIA'S NEW & RENEWABLE ENERGY TARGET

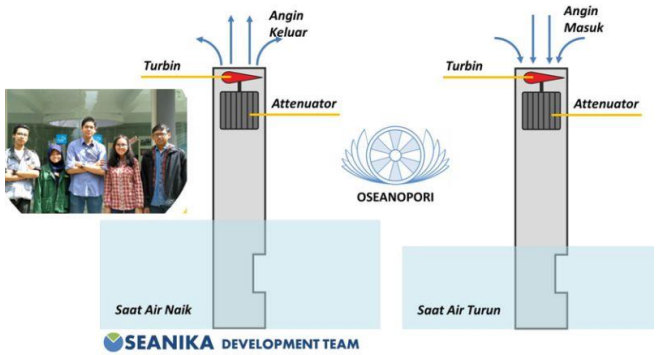


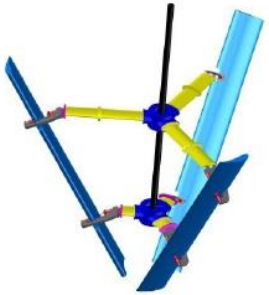
	2016	2025	2050
NRE Mix	7.7 %	23%	31%
Energy Supply	169 MTOE	400 MTOE	1.012 MTOE
Generation Capacity	59 GW (NRE 8 GW)	136 GW (NRE > 45 GW)	443 GW (NRE > 167 GW)
Electricity/Capita	956 kWh	2.500 kWh	7.000 kWh
Electrification Rate	91%	~100%	~100%

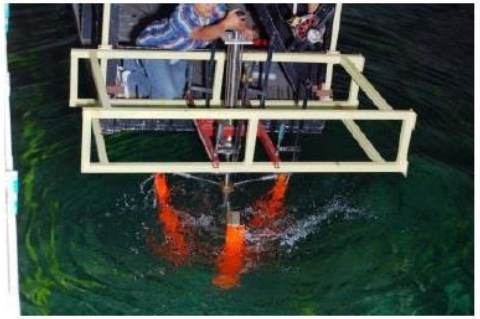
Offshore Renewable Energy Technology in Indonesia

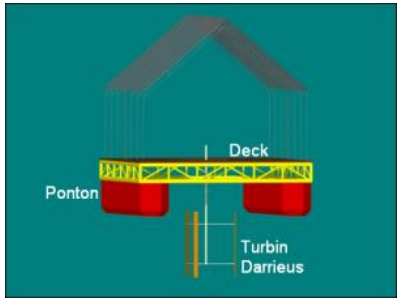
- **Fact**: No commercial offshore renewable energy device has been installed in Indonesia
- **Plan**: the Ministry (ESDM) installed the first tidal energy converter in Larantuka Straits (2016/2017)
- **Lab-scale and Real-Scale Device**:

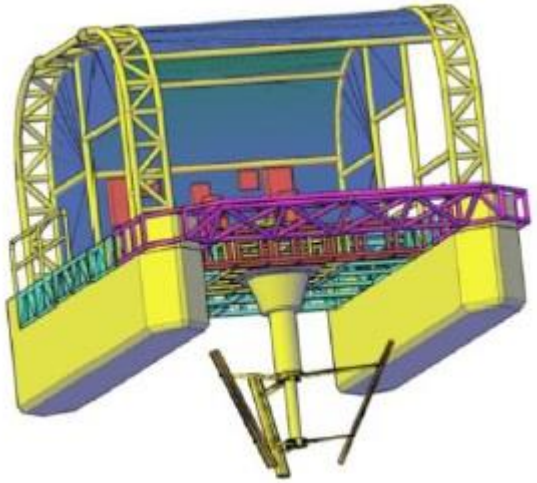
1. ITB wave energy column (2015)
2. ITS Indonesian Tidal Power (INTIP) (2017)
3. BPPT: a. Tidal energy in Larantuka Straits
   b. Wave-tidal energy in Madura Straits



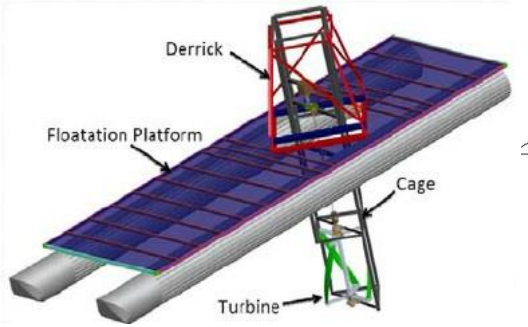


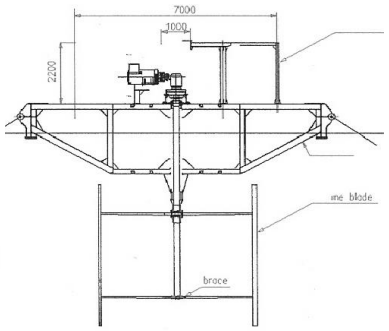






Offshore Renewable Energy Research in PENS





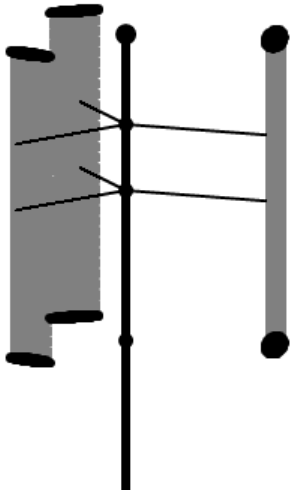
Background:

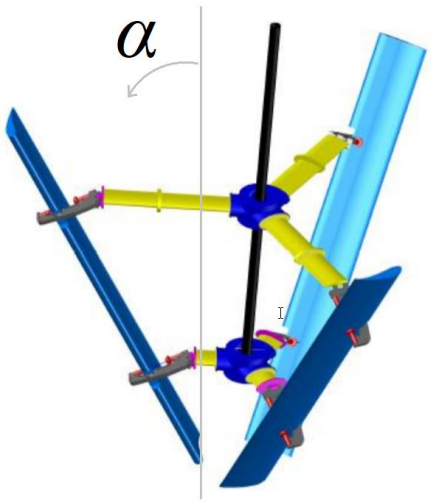
1. Electrification in east java province is low
2. Indonesia has long coast-line, an archipelago country, 2/3 Indonesian area is ocean

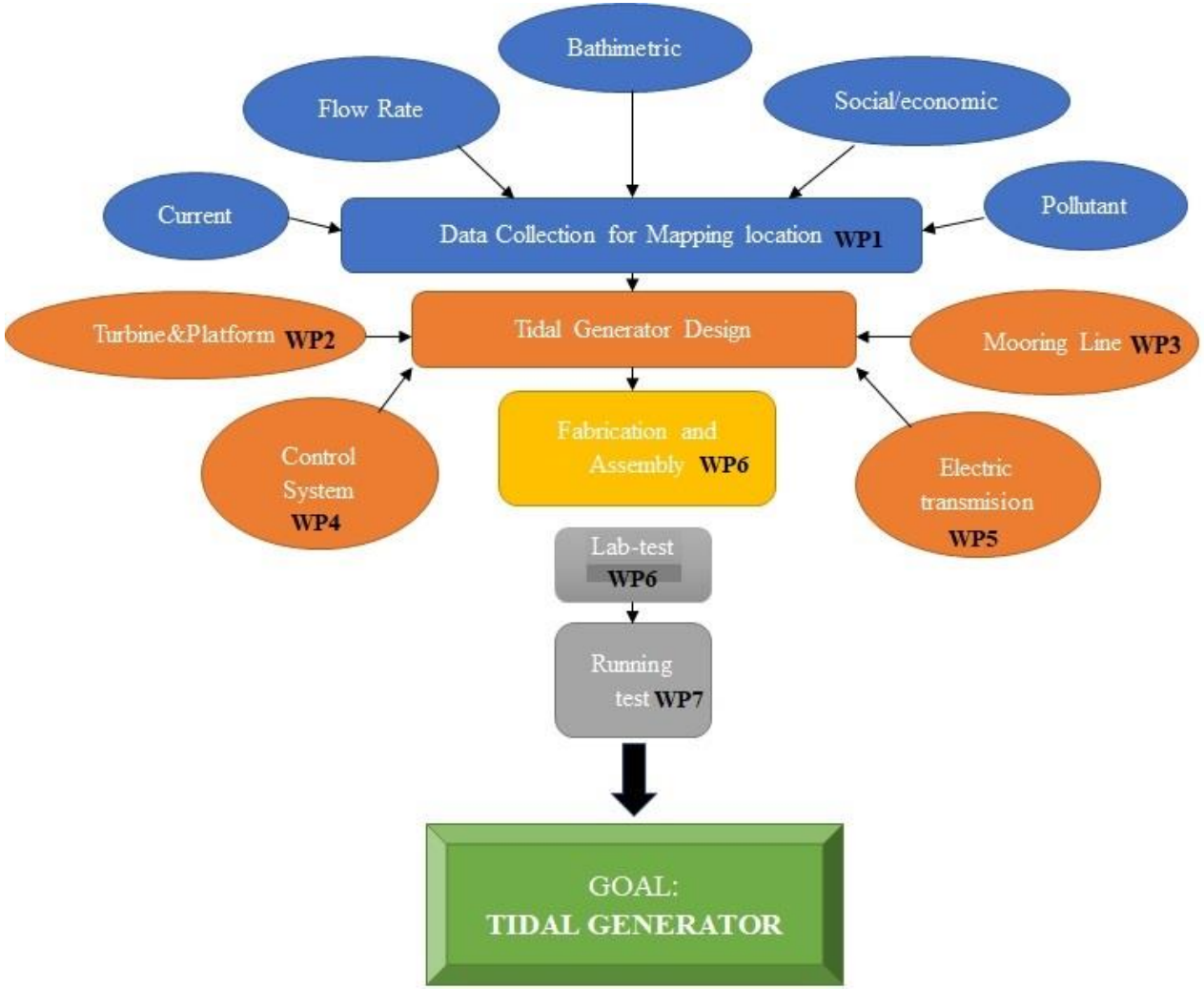
Propose:

1. Design tidal turbine
2. Design wave-tidal energy converter

Work package/Stages:







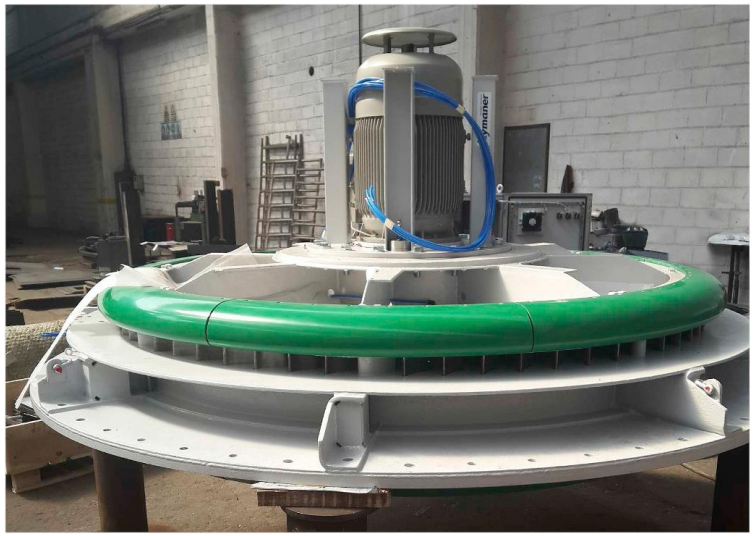
Design of Wave Energy Converter:
OPERA (Open Sea Operating Experience to Reduce Wave Energy Cost)

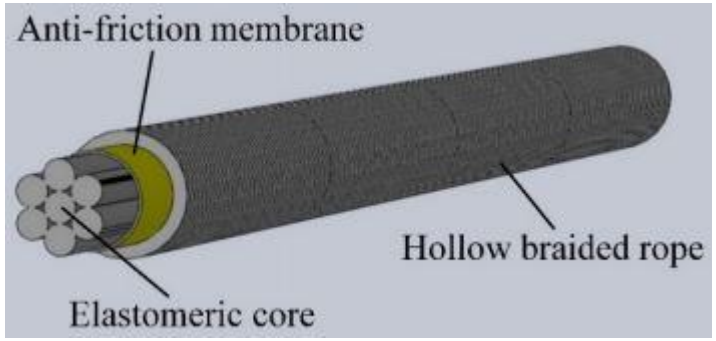
Aim:

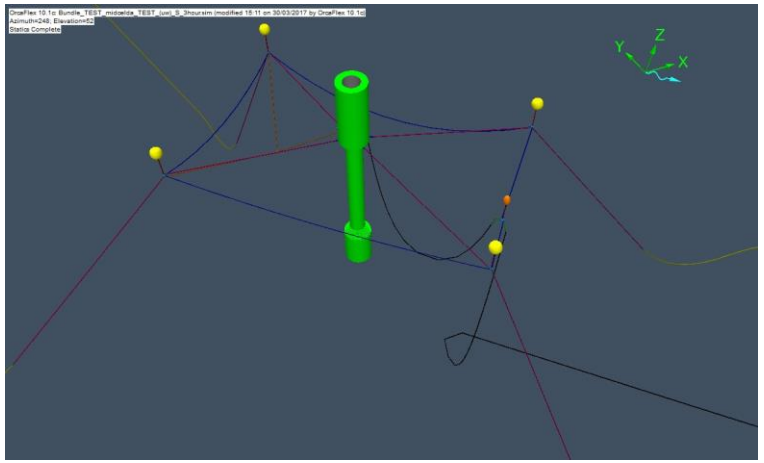
1. Reduce cost of energy
2. Improve overall performance
3. Lower risk (increase reliability)

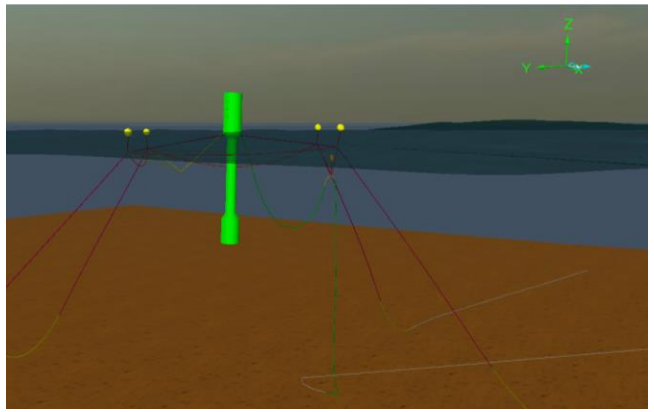
Innovations

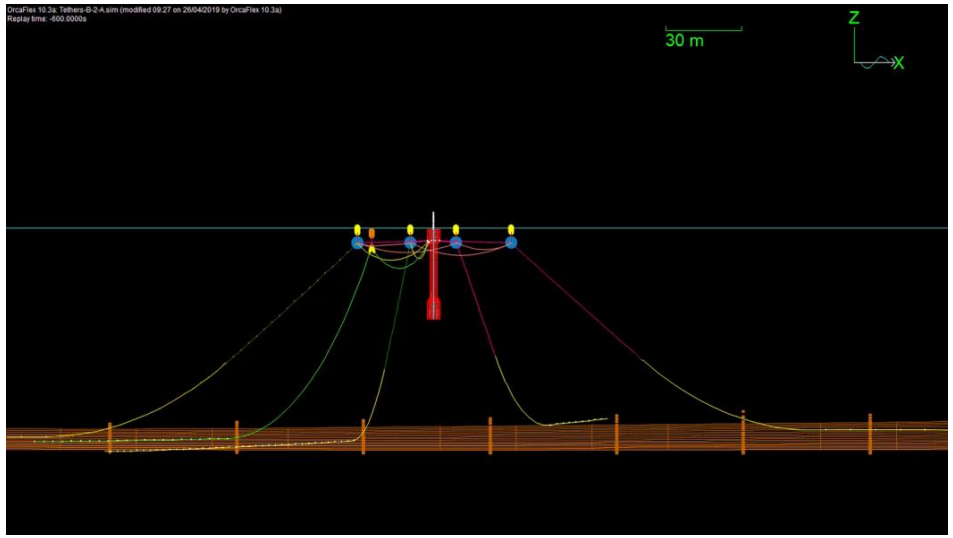
1. Novel biradial air turbine
2. Advanced control strategies
3. Elastomeric mooring tether
4. Shared mooring configuration











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Thank you