

ASIA CLEAN ENERGY FORUM 2025

Empowering the Future: Clean Energy
Innovations, Regional Cooperation and
Integration, and Financing Solutions

2-6 June | ADB Headquarters



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Regional Cooperation and Integration, and Financing Solutions

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Untapped Alternatives - Other Marine Renewable Energy (e.g. Tidal In-Stream Energy and more)

06 June 2025 | 9–10:30 a.m. (GMT+8)

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Marine Renewable Energy (MRE)

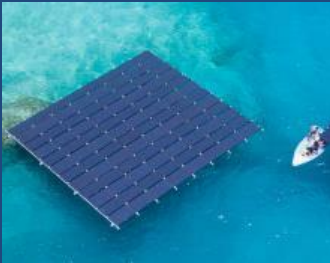
“MRE = Renewable energy production which makes use of marine **resources** or marine **space**.”*

Marine Renewable Energy (MRE)



- Offshore Wind

- Marine Solar



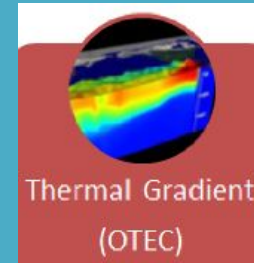
- Marine biomass
(micro- and macro-algae)



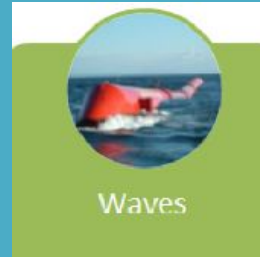
Ocean Renewable Energy (ORE) – subset of MRE

- Currents (Ocean Current, Tidal Currents/In-Stream)

- Thermal Gradient (via OTEC**)



- Waves



- Salinity / Osmotic Gradient



- Tides (Tidal Range)



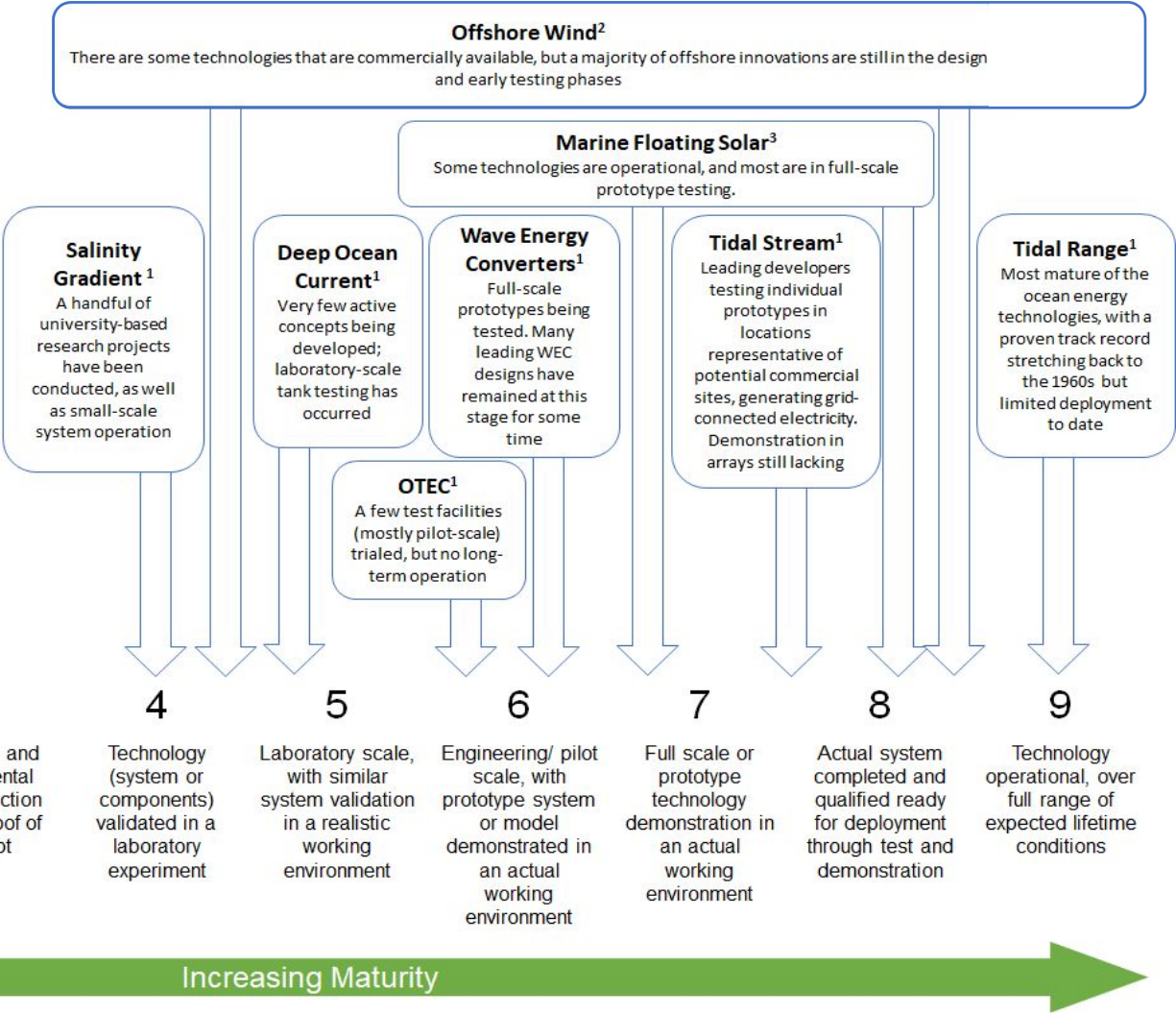
Tidal In-Stream Energy Converters (TISEC)

Technology Readiness

¹IRENA (2014)

²Dvorak et al. (2016)

³estimation from 2021 data

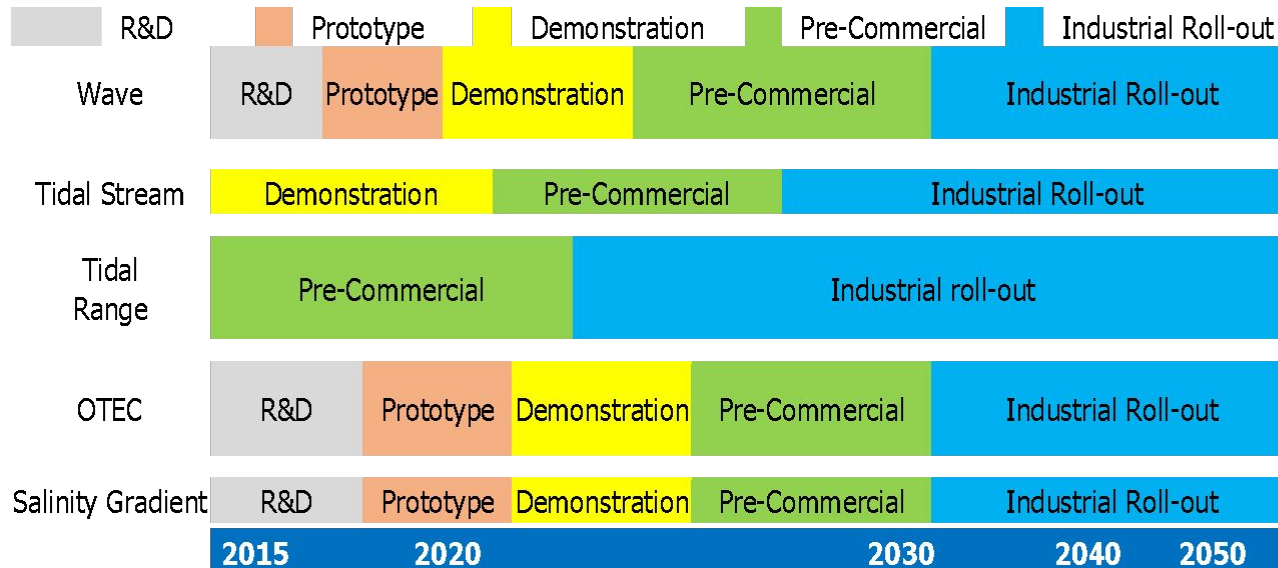


Technology	Typical Plant Capacity Factors*
Solar PV	16.1% to 20.8%
Offshore Wind	30% to 50%
Tidal Range (e.g. Barrage)	Typically 25%
Tidal Stream	25% to 40%
Ocean Current (e.g. Gulf Current in Florida Strait)	Up to 70%
Wave	32% to 40%
OTEC	90% to 95%

***Note:** these are dependent on other factors such as: site, resource, technology, and other project parameters

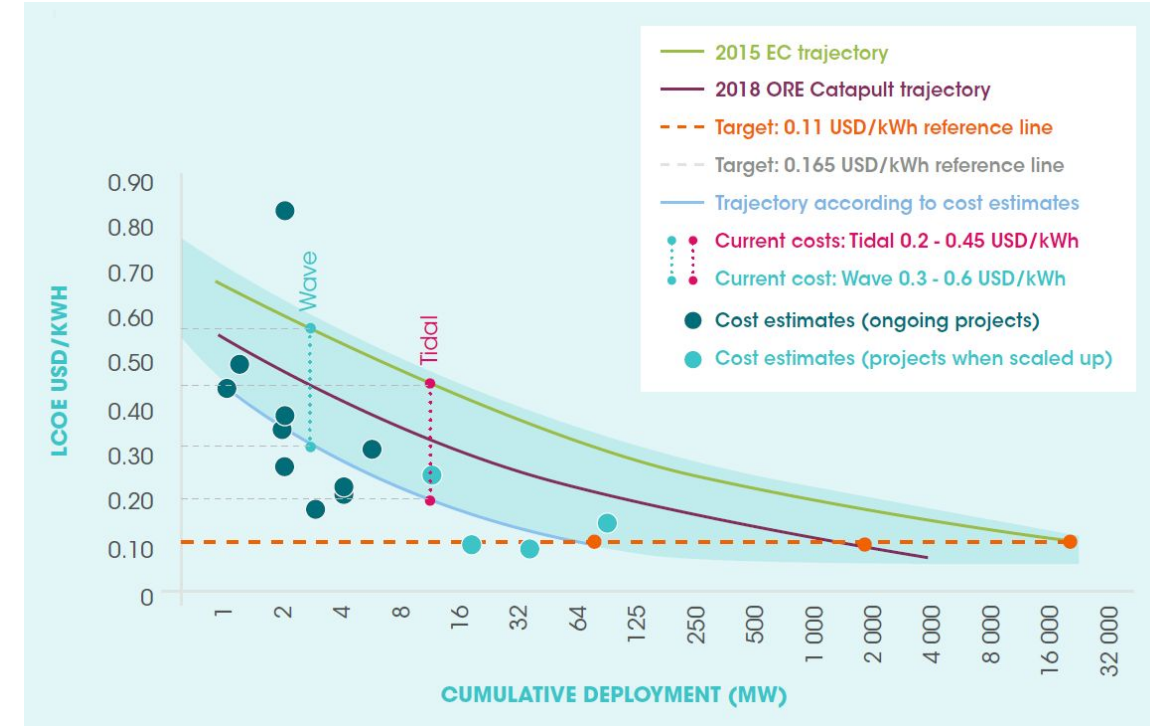
Ocean Energy Technologies: Commercialization, Levelized Cost of Energy

Timeline for the Development Phase of Ocean Energy Technologies

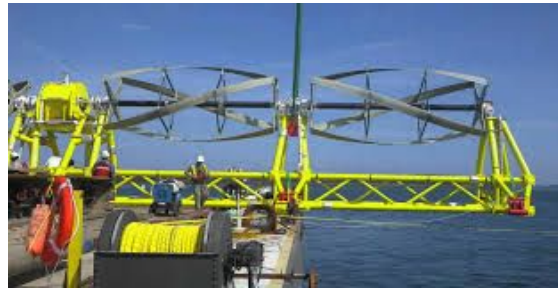


Ocean Energy Forum. (2016). *Ocean Energy Strategic Roadmap 2016, building ocean energy for Europe*. Maritime Forum. European Commission.

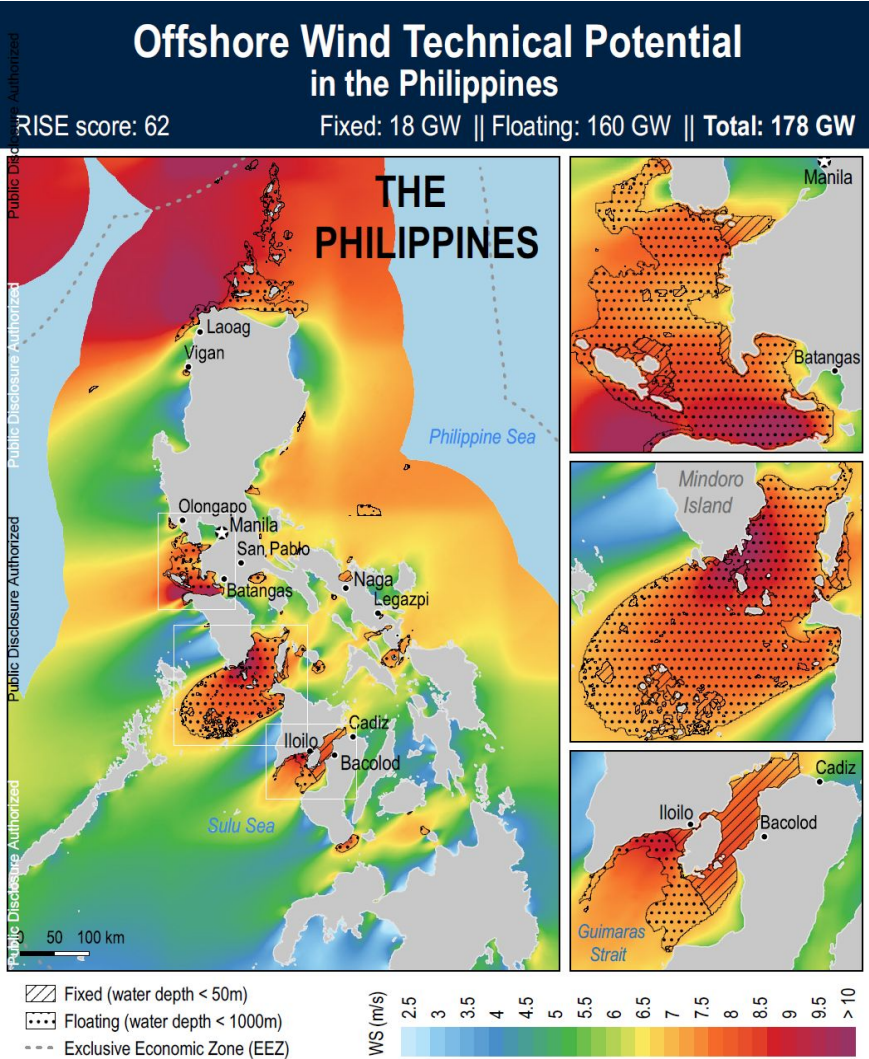
Target Cost Reduction Curve and Recent Wave & Tidal LCOE



IRENA. (2020). *Innovation outlook: Ocean energy technologies*. International Renewable Energy Agency. International Renewable Energy Agency.



Philippines Marine Renewable Energy (MRE) Resource Potential

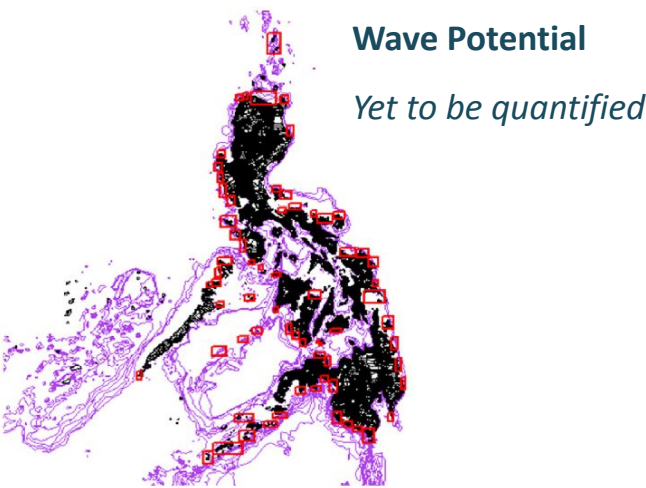
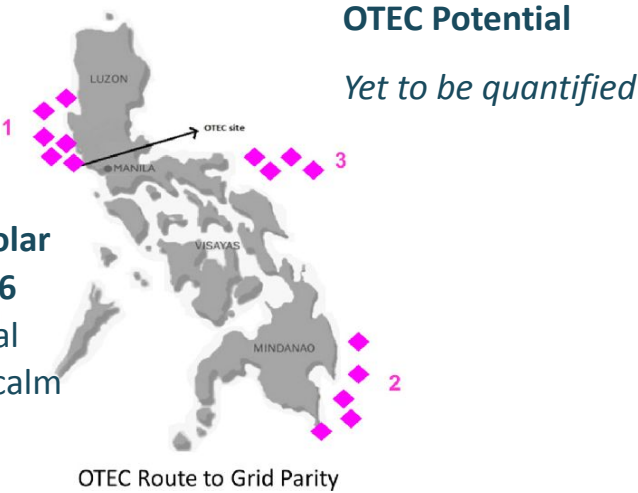


Ocean Renewable Energy Potential: 170GW Estimated

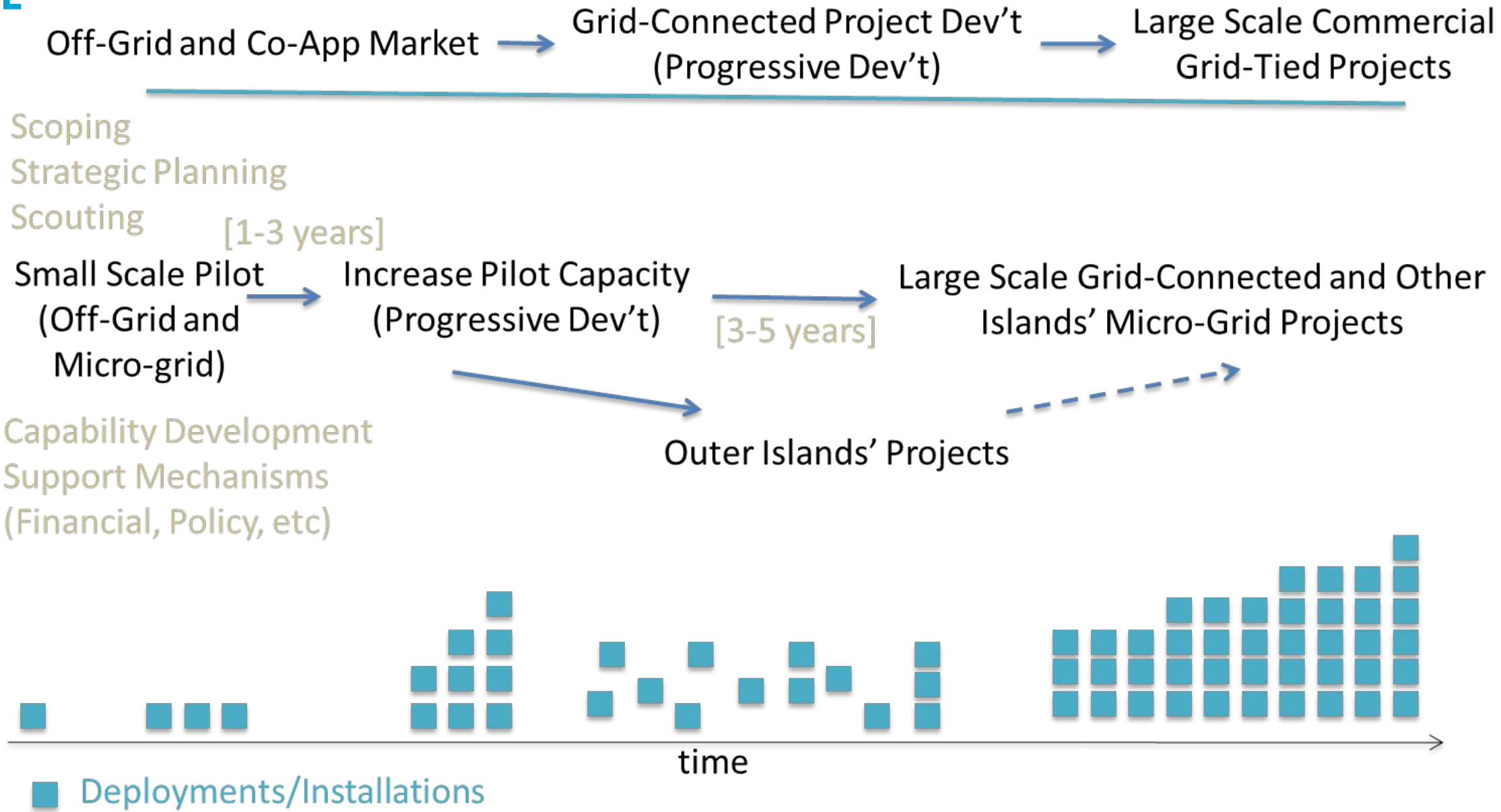


Tidal In-Stream (Current)
At least ~40 to 60GW of practically extractable resource

Marine/Offshore Solar
Estimated to be 266 GWp. Huge potential for near-shore and calm bay areas.



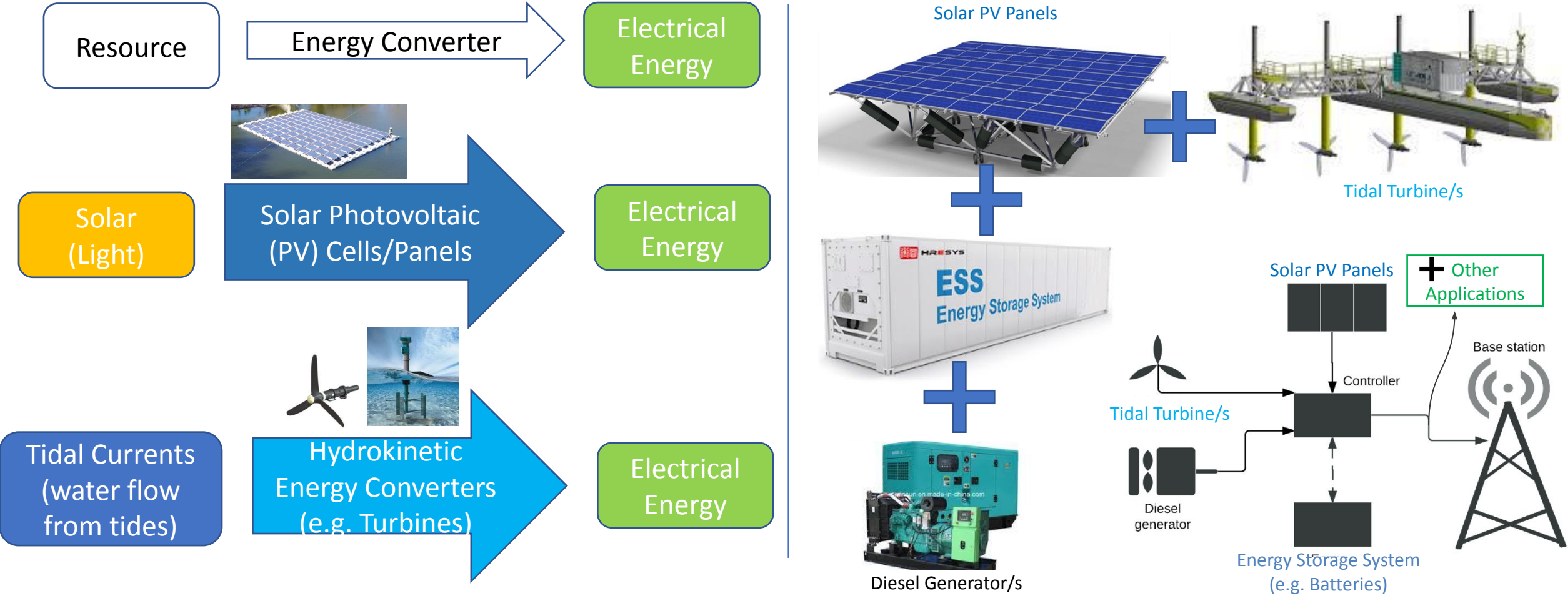
Progressive Development Pathway for Tidal Energy and Other Emerging MRE



Harness Untapped Energy Resources – Marine Solar + Tidal Energy + more?

Hybrid Marine Renewable Energy System

Harnessing Energy from Tidal Currents and Solar (on land and at sea)



Example for 10kW* Load – Some Technology Options



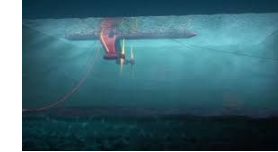
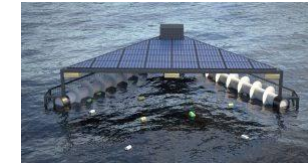
Marine Floating Solar

- Resource Availability:
~ 17% of the time
- Size: ~20 kWp
- Surface Space:
~140 sqm
- Costs**:
- Project Dev't + CapEx
~S\$150k to S\$200k
- Annual OpEx
~S\$10k to S\$20k



Tidal Current Turbine/s

- Resource Availability:
~30% to 40% of the time (in a month)
- Size: ~ 40 to 100 kWp
- Surface Space:
~35 to 70 sqm
- Costs**:
- Project Dev't + CapEx
~S\$200k to S\$350k
- Annual OpEx
~S\$10k to S\$25k



Hybrid Floating Solar + Tidal

- Size (Solar): ~10 kW
- Size (Tidal): ~20 to 60 kWp
- Surface Space:
~70 sqm
- Costs**:
- Project Dev't + CapEx
~S\$175k to S\$300k
- Annual OpEx
~S\$10k to S\$20k

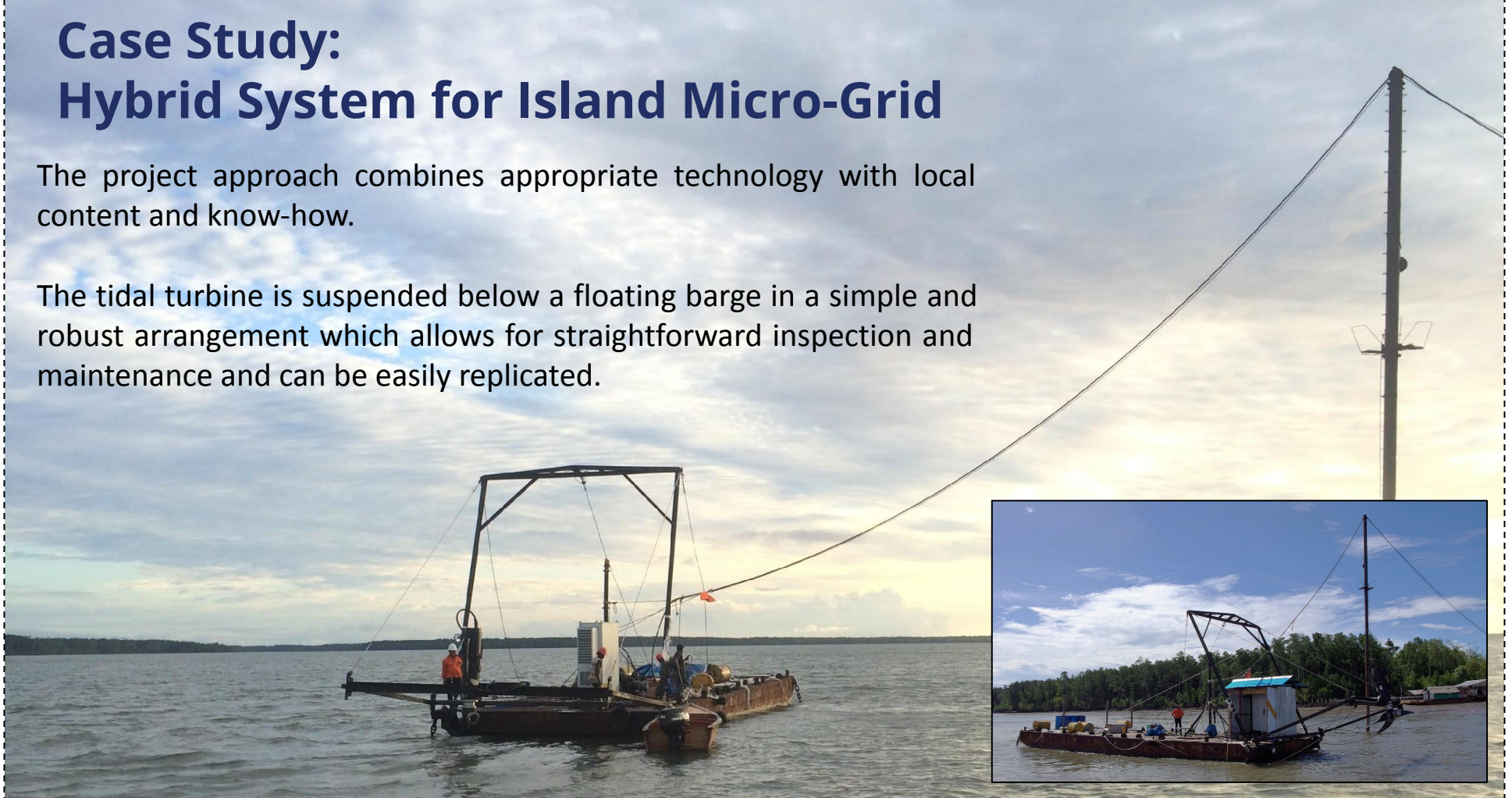
*Electrical Load: 10kW Power with 8 hours per day operation,
assumed daily load energy requirement = 80kWh/d

** May include a feasibly-sized energy storage system (e.g. battery)

Case Study: Hybrid System for Island Micro-Grid

The project approach combines appropriate technology with local content and know-how.

The tidal turbine is suspended below a floating barge in a simple and robust arrangement which allows for straightforward inspection and maintenance and can be easily replicated.

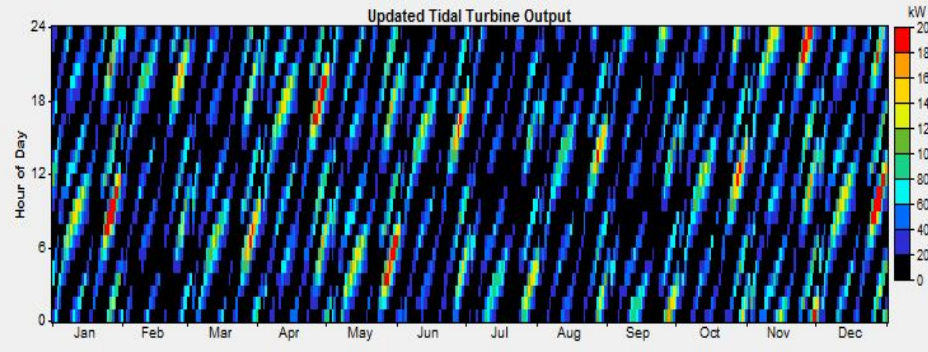
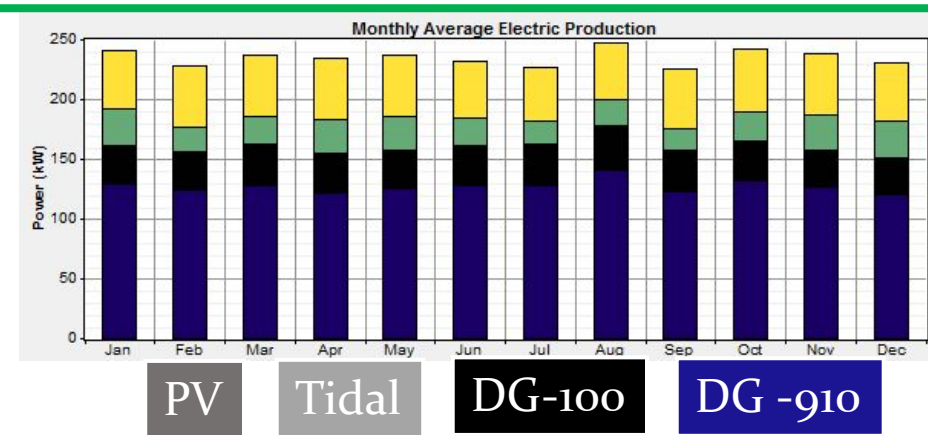
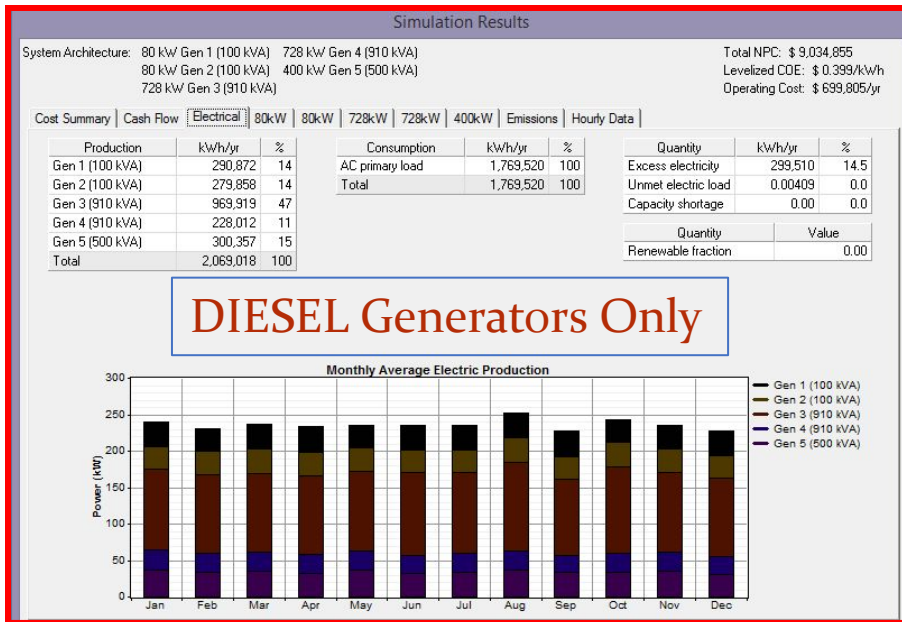


The project has proven the capability of a multi-company team to develop, implement and successfully deploy a tidal turbine in one of the most remote and areas of Indonesia.

The installation of Schottel Hydro's 50kW turbine in West Papua is a significant step on the journey to use marine renewables to de-carbonise energy supplies across the region.



Case Study: Hybrid System for Island Micro-Grids



Power System Config.	RE Fraction	Excess Electricity	LCOE (USD/kWh)
Diesel GenSets (910, 100 kVA) + Batt (576kWh) + Solar (300kWp) + Tidal (200kWp)	31.6%	12.6%	0.368
Diesel GenSets (910kVA, 100 kVA) + Batt (720kWh) + Solar (600kWp)	38.6%	20.1%	0.386
Diesel GenSets (910kVA, 100 kVA)+Batt.(1440kWh)	0.0 %	2.47%	0.456
Diesel GenSets (2x 910, 500, 100 kVA)	0.0 %	14.5%	0.50



Example: Reference Rates and Costs of Tidal In-Stream Energy Projects

fluid . energy . intelligence

Project/s Size and Location	Technology	Feed-in Tariff (FIT) / Power Purchase Agreement (PPA) Rate or LCOE and term	Notes/Remarks
22MW, Canada [2]	Tidal In-Stream	a. FIT: CAD530/MWh (~PhP19.63/kWh), 15 years b. FIT: CAD420/MWh (~PhP15.56/kWh), 15 years	FIT rates are developmental rates called “COMFIT” or Community FIT. Lower rate for projects producing >16,640 MWh
9MW, Canada [3]	Tidal In-Stream	CAD530/MWh (~PhP19.63/kWh), 15 years	Project Cost: ~PhP4.34B
~1-2MW, Indonesia (West Papua) [1]	Hybrid Tidal In-Stream, Solar, Diesel	Diesel-only LCOE: USD0.5 to USD 1 / kWh (~PhP24.06 to PhP48.12/kWh) Hybrid (Tidal+Solar+Battery+Diesel) Case Study LCOE: USD 0.25 to USD 0.368 /kWh (~PhP12.03 to PhP 17.71/kWh), 20 years	Phase 1 (Test): Tidal + Diesel – completed in 2017
600kW to 5MW, Philippines	Hybrid Tidal In-Stream, Solar, Diesel	Diesel-Only True Cost of Generation Rate: ~PhP 13.5 to 24.83/kWh Hybrid (Tidal+Solar+Battery+Diesel) LCOE: (~PhP12.03 to PhP 17.71/kWh), 20 years	Various Off-Grid Studies – i.e. Tawi-Tawi, Dinagat, San Antonio (N. Samar) <u>Estimated/Indicative Project Costs:</u> PhP75m-100m (600kW, no OpEx) PhP125m-150m (1.2MW, no Opex) ~PhP500m (5MW, no Opex)

Potential Pilot Projects (Cross-Sector Integrated Solutions)



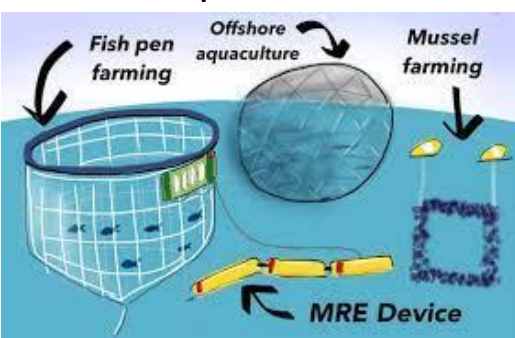
Ocean/Marine Renewable Energy: Marine Solar, Offshore Wind, Tidal In-Stream, Wave

Systems and Eco-Systems' Integration

Transportation

Ice

Aquaculture



Energy Storage

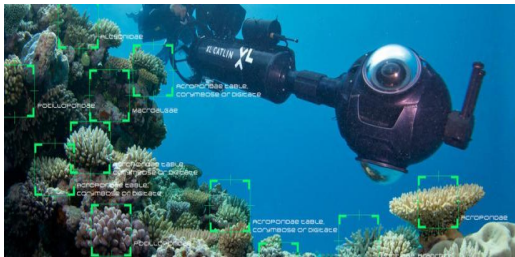
Testbedding
Other Innovations
Technologies
Business Models
“Learn by Doing”



Ports/Marinas/Bays



Water Production



Reef Restoration, Marine Area Monitoring

Harness Untapped Energy Resources – Marine Solar + Tidal Energy +



Summary, Conclusions, & Recommendations

- ▶ **Marine Renewable Energy Options Exist (Huge, yet to be tapped Potential)**
 - ▶ Offshore Wind, Marine Solar, (Commercial), and Tidal Currents (Pre-Commercial)
 - ▶ Other Emerging Marine RE: Waves, OTEC, Salinity Gradient, Marine Biomass
 - ▶ Need for a Resource Inventory Review and Suitability Studies for Pilot Projects
- ▶ **Identified Key Needs / Next Steps**
 - ▶ Resource Inventory
 - ▶ MRE Development Roadmapping
 - ▶ Tools, e.g. Marine Spatial Planning
 - ▶ Market Mechanisms
 - ▶ Feed-In Tariff Rate Setting
 - ▶ Access to Subsidies for True Cost of Generation (e.g. from (UCME))
 - ▶ Enabling / Opening Up Access to Funding and Financing
 - ▶ Enhancing Research, Development, and Demonstration
 - ▶ For Early Stage Projects and Other Stages
- ▶ **“Greening” the Marine and Maritime Ecosystem/s**
 - ▶ Sustainable Integrated Development for Islands and Coasts
- ▶ **Progressive Development Approach Towards a Blue Economy**
 - ▶ Capability Development - Local Supply Chain (especially Services)
 - ▶ Hybrid Systems and Co-Application will be key to success
- ▶ **Support Needed from Partners and the wider Stakeholders**

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