Blue Horizons:
On Blue Economy Development for the Philippines

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OceanPixel

Enabling Sustainability through Data Intelligence

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Supporting Sustainable Transformations

www.oceanpixel.org

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Enabling Sustainability through Data Intelligence

Supporting Sustainable Transformations

fluid . energy . intelligence

NANYANG TECHNOLOGICAL UNIVERSITY
Energy Research Institute @ NTU

OceanPixel is a Singapore start-up that was incorporated in 2014, having spun-off from the Energy Research Institute at NTU.

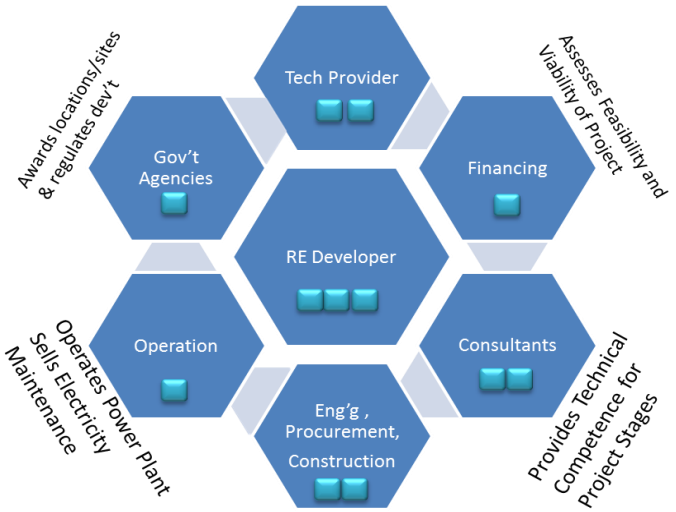
The core team has combined expertise in sustainable energy research, development, demonstration, project development and experience in the relevant industry ecosystem, business, finance, policy and education.

OceanPixel believes in the development of **Sustainable Ecosystems**, and supports these efforts by offering **Data Management** technologies and services coupled with **Suitability Analytics**, data catalogues, report products and technical services. OceanPixel has various global involvements, but is currently focused in South East Asia, handling projects in Singapore, Philippines and Indonesia.

OceanPixel

Provides intelligence to the sustainability ecosystem

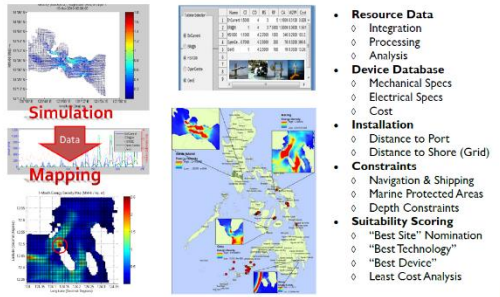
Develops tech, sells, and facilitates installation



Builds Power Plant

- 'Oceans' of Data.
- Multiple 'Ecosystems'.
- Visualized and Understood.

With OceanPixel's capabilities, we provide *Multi-Site, Multi-Device, Multi-Criteria GIS Decision Approach* to project development.



- **Resource Data**
  - Integration
  - Processing
  - Analysis
- **Device Database**
  - Mechanical Specs
  - Electrical Specs
  - Cost
- **Installation**
  - Distance to Port
  - Distance to Shore (Grid)
- **Constraints**
  - Navigation & Shipping
  - Marine Protected Areas
  - Depth Constraints
- **Suitability Scoring**
  - "Best Site" Nomination
  - "Best Technology"
  - "Best Device"
  - Least Cost Analysis

BLUE ECONOMY

Traction in Focus Industry Sectors:
>100 Engagements for 50+ Clients worldwide

Marine & Offshore

Oil & Gas

Telecommunications

Renewable Energy

Disaster & Defence

(Surveillance, Resilience)

Food

(Farming, Aquaculture)

Transportation

(Land, Sea, and Air)

Habitable Environments

(Cities/Urban, Rural, Islands, & Coasts)

Water

(Production, Desalination, Sanitation, Wastewater

*Future

OceanPixel – Our Journey so far…

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2014

Spin-Off from NTU

UK Study Visit

2015

- NTU Pre-Seed Funding
- Presence in PH
- Key presence in Asian Wave and Tidal Energy Conference

2016

- JV w/ Aquatera (UK) for Project Development in South East Asia
- Pioneering Tidal Energy Hybrid Project in Indonesia

2017

- SPRING SG Grant Support for Technology and Market Dev't
- Singapore Floating Tidal Energy Demo with Envirotek

2018

- Selected (top 5) for the Oracle Startup Cloud Accelerator

2019

- Joint Venture with DAEEUN (Korea) and LIVES (PH) for Solar RE Projects in Philippines

2020

- Australia Blue Economy Cooperative Research Centre Industry Partner
- SLNG Innovation Project Collaboration

2021

2023

$2M to $5M

2025

OceanPixel

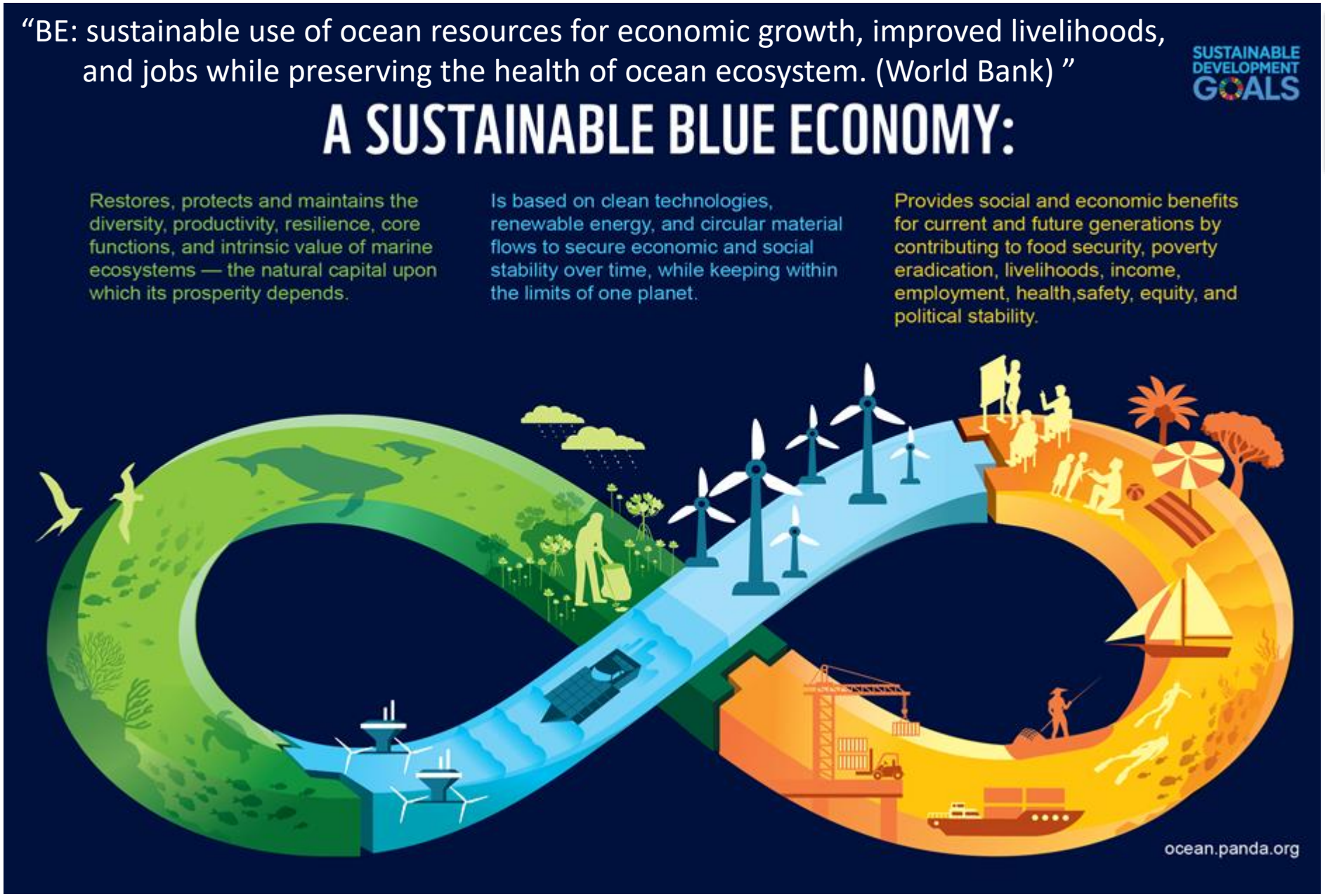
(Data Mgt & Intelligence, Consultancy)

3 Core IP
(5+ in R&D)

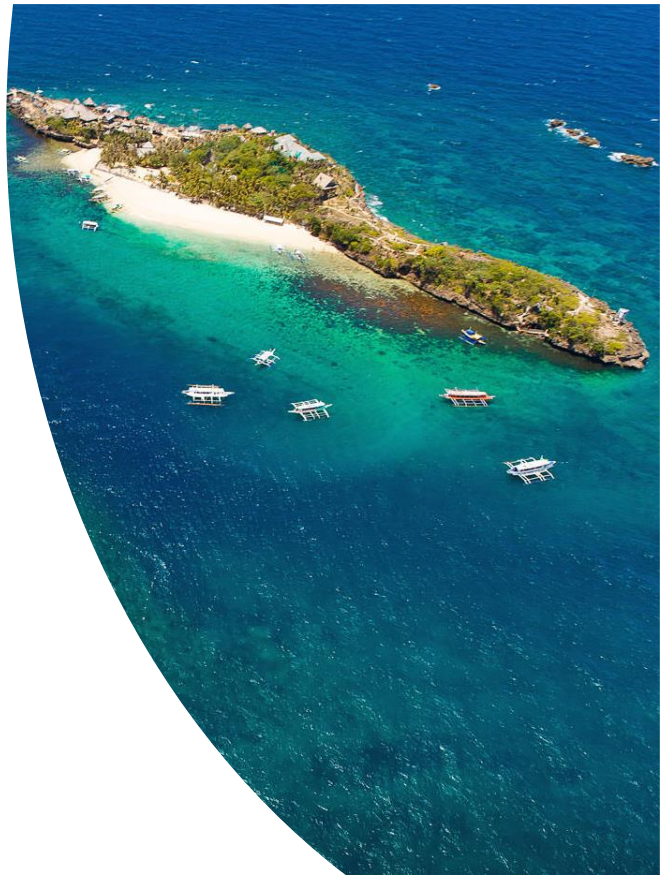
(Project Development)

Strategic Partnerships
(e.g. DHI, Elcee, VOS, Aquatera, Orcades, Brimes Wave Energy, etc)

"BE: sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem. (World Bank) "



Example: ADB MARES Project: Marine Aquaculture, Reefs, Renewable Energy, & Ecotourism for Ecosystem Services



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2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Outcomes and Challenges

The Decade is a transformative vision to deliver the 'science needed for the future we want' painted by the following outcomes:

1. A **clean ocean** where sources of pollution are identified and reduced or removed.

2. A **healthy and resilient ocean** where marine ecosystems are understood, protected, restored and managed.

3. A **productive ocean** supporting sustainable food supply and a sustainable ocean economy.

4. A **predicted ocean** where society understands and can respond to changing ocean conditions.

5. A **safe ocean** where life and livelihoods are protected from ocean-related hazards.

6. An **accessible ocean** with open and equitable access to data, information and technology and innovation.

7. An **inspiring and engaging ocean** where society understands and values the ocean in relation to human wellbeing and sustainable development.

Blue Economy Aspirations for the Philippines

Republic of the Philippines
NATIONAL INNOVATION COUNCIL

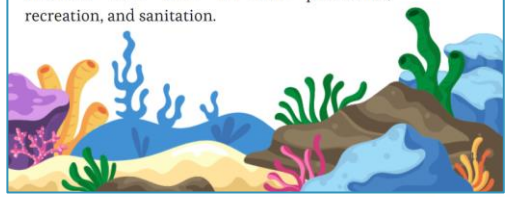
NATIONAL INNOVATION AGENDA 2032

Smart and Innovative Philippines
Patungo sa Matatag, Maginhawa,
at Panatag na Buhay para sa Lahat

Blue Economy and Water

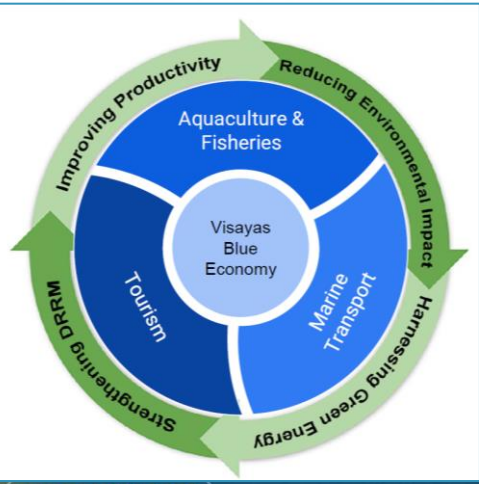
Innovations that sustainably harness coastal, marine, and inland water resources to support economic growth and generate sustainable livelihoods and jobs while preserving aquatic ecosystems.

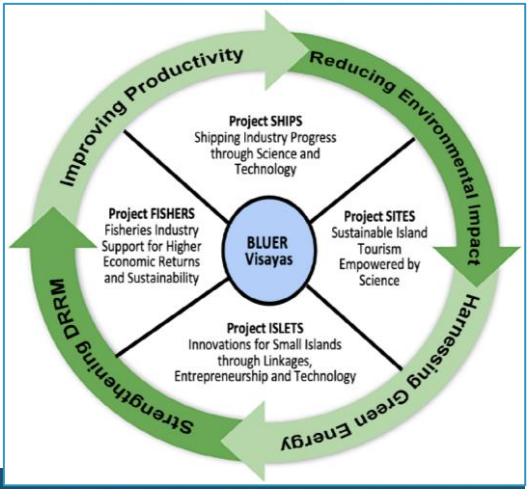
These include the sustainable fish- and marine-based industries, green maritime transport, sustainable tourism, ocean energy, sustainable management of freshwater resources, protection of marine ecosystems, marine scientific research, and improvement of water quality according to intended uses such as food production, recreation, and sanitation.



PAGTANAW 2050
THE PHILIPPINE FORESIGHT
Science • Technology • Innovation

Towards a Prosperous, Archipelagic, Maritime Nation





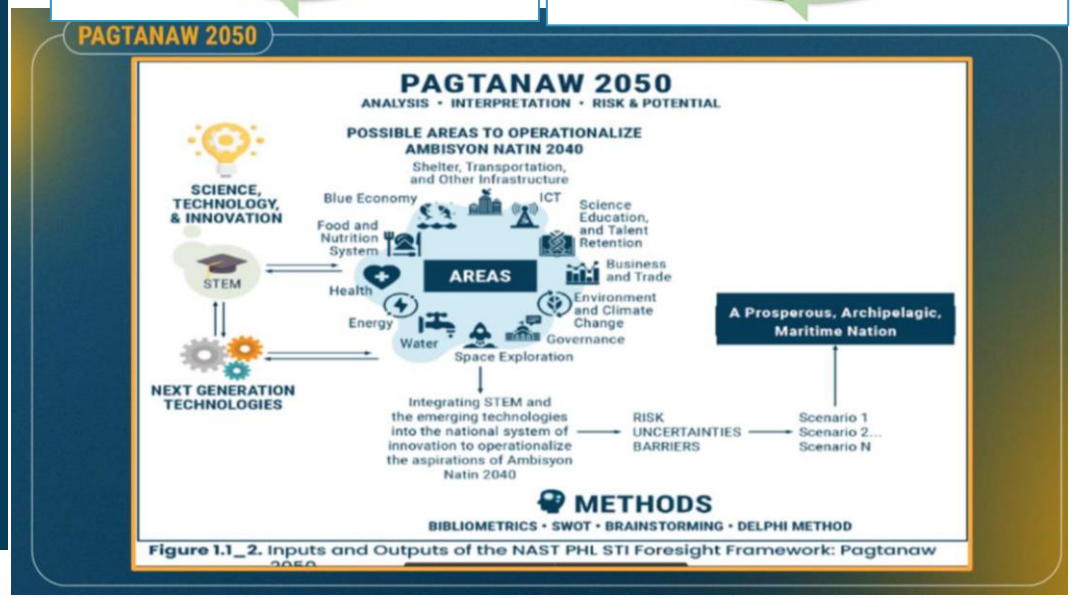
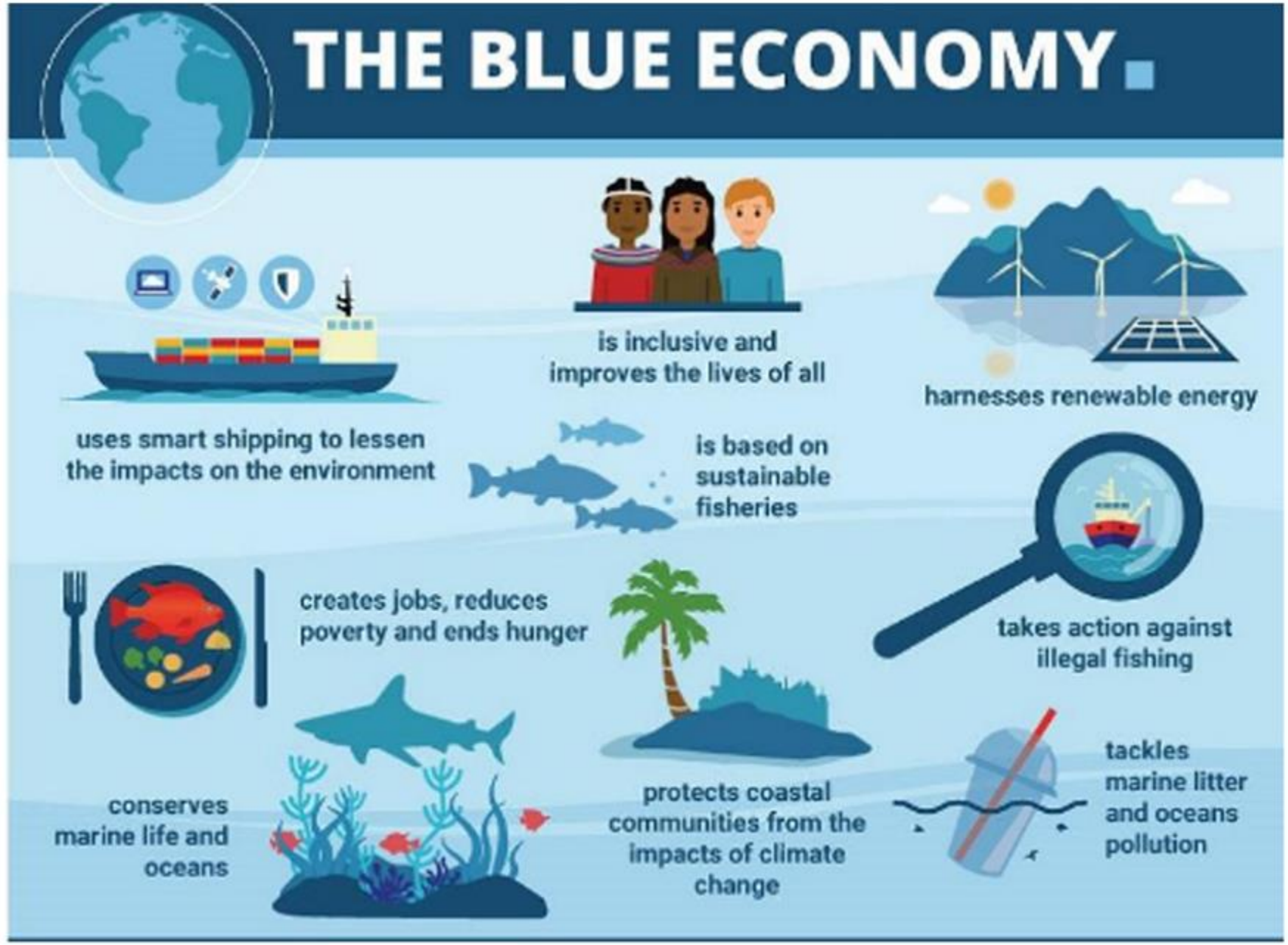


Figure 1.1_2. Inputs and Outputs of the NAST PHL STI Foresight Framework: Pagtanaw 2050

But the vision
of a real BLUE ECONOMY
entails being aware of and
working with the
ENVIRONMENT

This means using new
knowledge & technology to
lessen impact on the ocean
and sharing the bounty to
improve lives



https://escaribbean.com/blue-economy-harnessing-blue-benefits/

Blue Economy Hubs – Some Int'l Learning

- Renewable Energy and Offshore Electrification
- Fisheries and Aquaculture
- Maritime Transport

- Tourism
- Climate Change
- Waste Management

- Water Supply and Sanitation
- Reclamation
- And more!

Marine Spatial Planning (MSP) for achieving sustainable Blue Economy

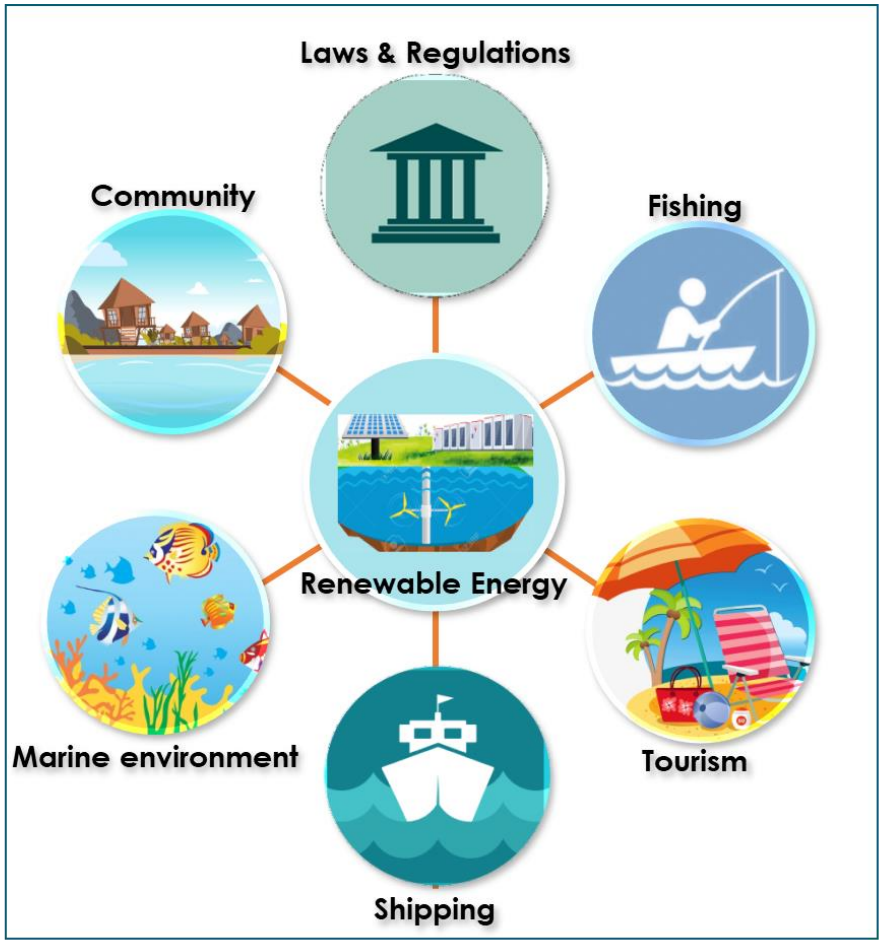
The **Blue Economy is a sustainable approach to ocean** use that seeks to balance economic growth with the protection of ocean ecosystems.

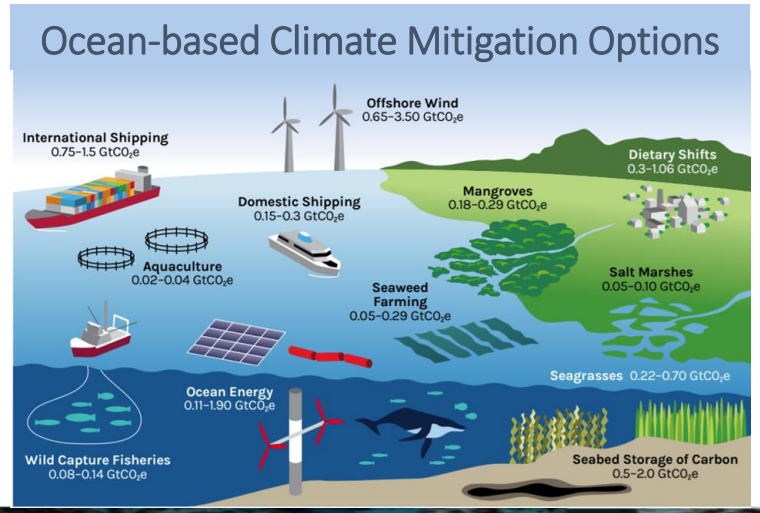
- It encompasses a wide range of activities, including fisheries, maritime transport, tourism, offshore renewable energy, aquaculture, and marine biotechnology.

FAO's BGI and the European Commission's approach are both working to promote sustainable development of the ocean.

MSP is a key tool for achieving this goal, as it can help to ensure that human activities in the ocean are managed in a way that benefits both the environment and the economy.

Ecosystems towards Blue Economy Development





Sustainable Integrated Development for Islands & Coasts

Aquaculture & Fisheries

Green Transport – Sea and Land

Green Maritime Ecosystem – Ports, Vessels, Aquaculture, Desalination, Water, Ice/Cooling ++

Renewable Energy + Green Transport
+ Aquaculture + Water Production
+ Freezing/Cooling + Local Content
+ Other Sustainable Initiatives

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NLA International's Holistic Blue Economy Development Framework (22 steps)					Continuous Activities		
1. Map and measure ocean wealth (4 steps)					**Stakeholder Engagement**	**Mobilise financial resources**	**Strategic Communication**
1.1 Map extent and condition of ocean natural assets over time	1.2 Quantify natural capital and ecosystem services from ocean resources	1.3 Collect and synthesise socio-economic information on existing ocean sectors and users	1.4 Create Ocean accounts, a holistic dashboard of ocean wealth including historic information		Establish list of key stakeholders and communication channels with / to them	Undertake review of available development bank / related sources of funding	Announce Blue Economy as a major strategic initiative
2. Assess Ocean risks and impacts (4 steps)					**Stakeholder Engagement**	**Mobilise financial resources**	**Strategic Communication**
2.1 Map flows of land-based pollution into the coastal zone and other forms of ocean pollution	2.2 Map loss and degradation of marine and coastal ecosystems and key drivers thereof such as dams, coastal development, pollution, climate change, fishing practices	2.3 Establish anticipated effects of climate change on coastal and marine resources	2.4 Quantify and prioritise risk areas under a business-as-usual scenario to inform planning		Invite submissions from stakeholders on Ocean risks and impacts	Engage Development Banks in assessing Ocean risks and discuss funding potential mitigation plans	Publicise the importance of Ocean risk mitigation for the Blue Economy, and the government's commitment to it
3. Establish a holistic and integrated Blue Economy governance framework (4 steps)					**Stakeholder Engagement**	**Mobilise financial resources**	**Strategic Communication**
3.1 Conduct review of best practice Blue Economy governance structures in comparable nations to create a menu of options for implementation	3.2 Create gender-balanced, responsive and trans-disciplinary ocean governance structures including Finance, Education and Environment Ministries	3.3 Establish accessible ocean data repositories and portals and data governance protocols	3.4 Participate in international collaborations for peer-learning, innovation and cooperation		Discuss ideal governance arrangements and principles with stakeholders	Mobilise financial resources for implementation of Blue Economy plan	Announce new governance structures, and the impact they will have on cross-cutting government priorities
4. Develop a Blue Economy plan (5 steps)					**Stakeholder Engagement**	**Mobilise financial resources**	**Strategic Communication**
4.1 Determine an overall vision for a national Blue Economy	4.2 Establish SMART objectives (specific, measurable, achievable, realistic and timebound)	4.3 Undertake consultative Marine Spatial Planning (MSP) including ambitious conservation targets, including all ocean stakeholders	4.4 Determine policies and regulations with an ecosystem and natural capital approach including activities on the high seas	4.5 Assess measures required to stem ocean pollution	Invite to all relevant stakeholders to contribute to / comment on the Blue Economy plan	Plan and secure resources to implement and enforce associated regulations, including capacity development	Announce ambition and intended outcomes of the nation's Blue Economy plan
5. Implement and monitor the Blue Economy plan (5 steps)					**Stakeholder Engagement**	**Mobilise financial resources**	**Strategic Communication**
5.1 Implement measures required to stem ocean pollution	5.2 Implement and enforce policies and regulations with an ecosystem approach including activities on the high seas	5.3 Implement monitoring, control and surveillance activities across EEZ	5.4 Promote Blue Economy entrepreneurship	5.5 Monitor activities and ocean wealth over time and adapt marine spatial planning and policy as necessary according to evidence of what works well	Develop and implement an ongoing stakeholder engagement plan grid targeted at specific sectors	Provide resources for capacity development	Develop and implement an ongoing comms grid targeted at specific audiences

Supporting Blue Economy Development

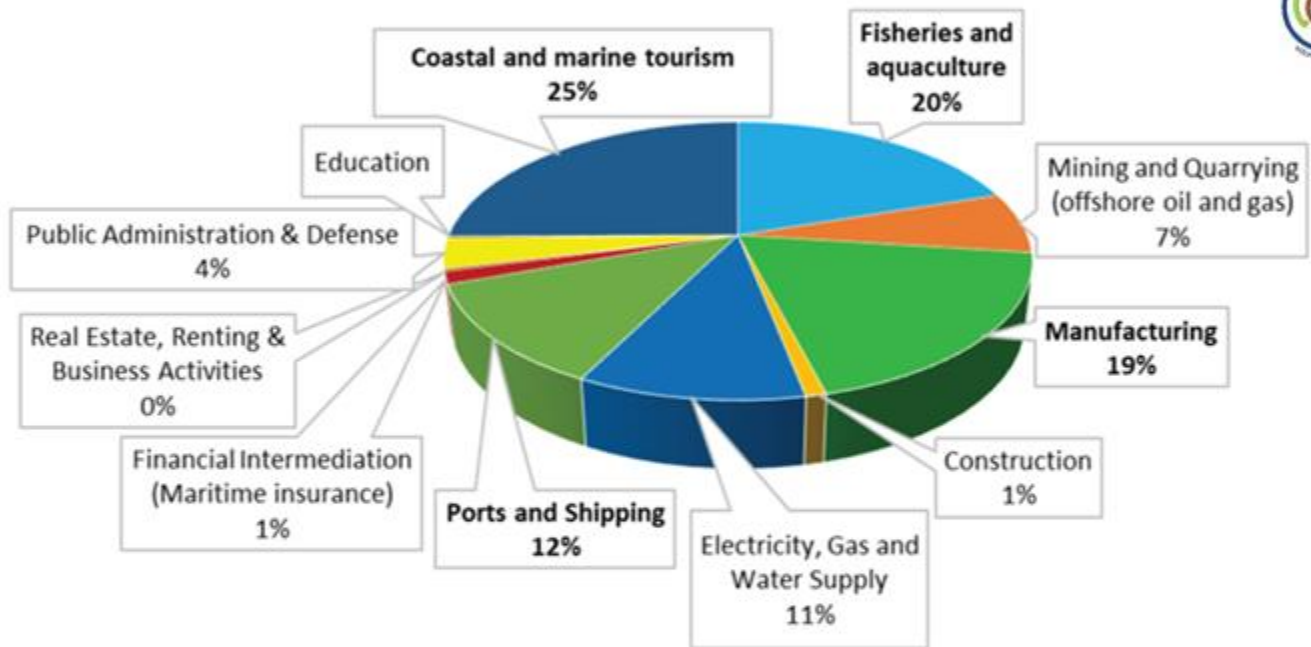
- *MoU with MinDA signed in Sept 2022 during Presidential Visit of BBM in Singapore*
- *Workshop in Oct 2022 with MinDA and Partners for Blue Economy Development Strategy*
- *Met with Cong. Kiko Benitez to support PH Blue Economy Bill*
- *Advocating the Establishment of Blue Economy Consortia and Knowledge Hubs in PH*
- *Exploring ADB Support / Technical Assistance for developing a Philippine Blue Economy Framework (with NEDA) and formulating an over-arching strategic plan*
- *Information, Education, and Communication efforts, e.g. Visayas Blue Economy Forum (April 2023)*
- *Incorporation of Blue Economy Development Mindset & Principles in various sectors, agencies, etc for all stakeholders (industry, government, academe, communities, NGOs, general public)*

Philippine BLUE by the numbers

Laura T. David, Ph.D. , Rhodora Azanza, Ph.D.

We can think of **blue economy** as being composed of all industries associated with the marine environment

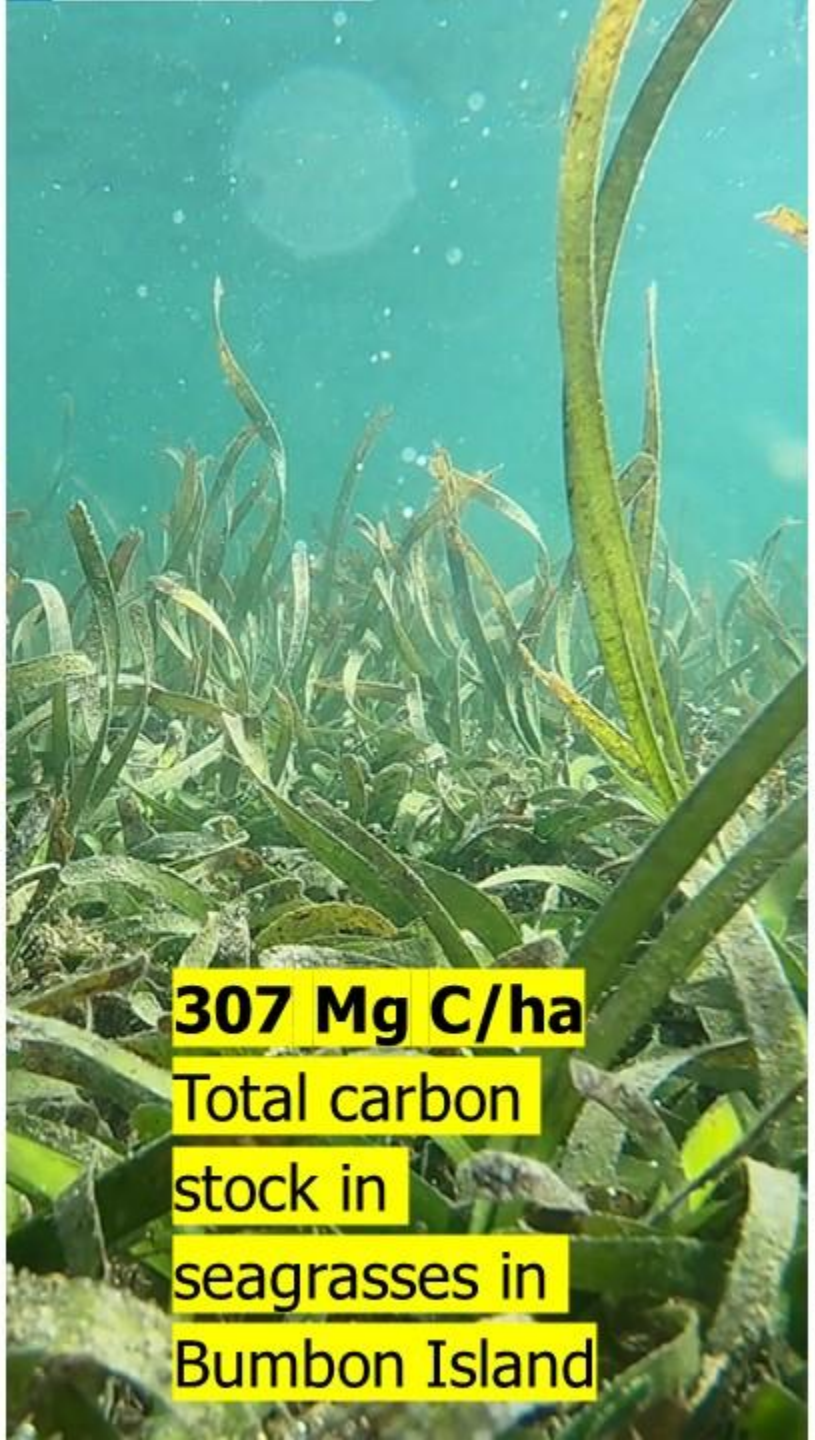
1. Tourism, Resorts, and Coastal Development
2. Fisheries and Aquaculture
3. Coastal Manufacturing
4. Ports, Shipping, and Marine Transport
5. Energy
6. Seabed Mining Oil and Gas
7. Defence
8. Marine Biotechnology and Medicine
9. Marine Technology and Environmental Services



% Contribution to the BLUE economy
PEMSEA 2016

510-780Mg C/ha

Total carbon stock in Carretunan Mangroves



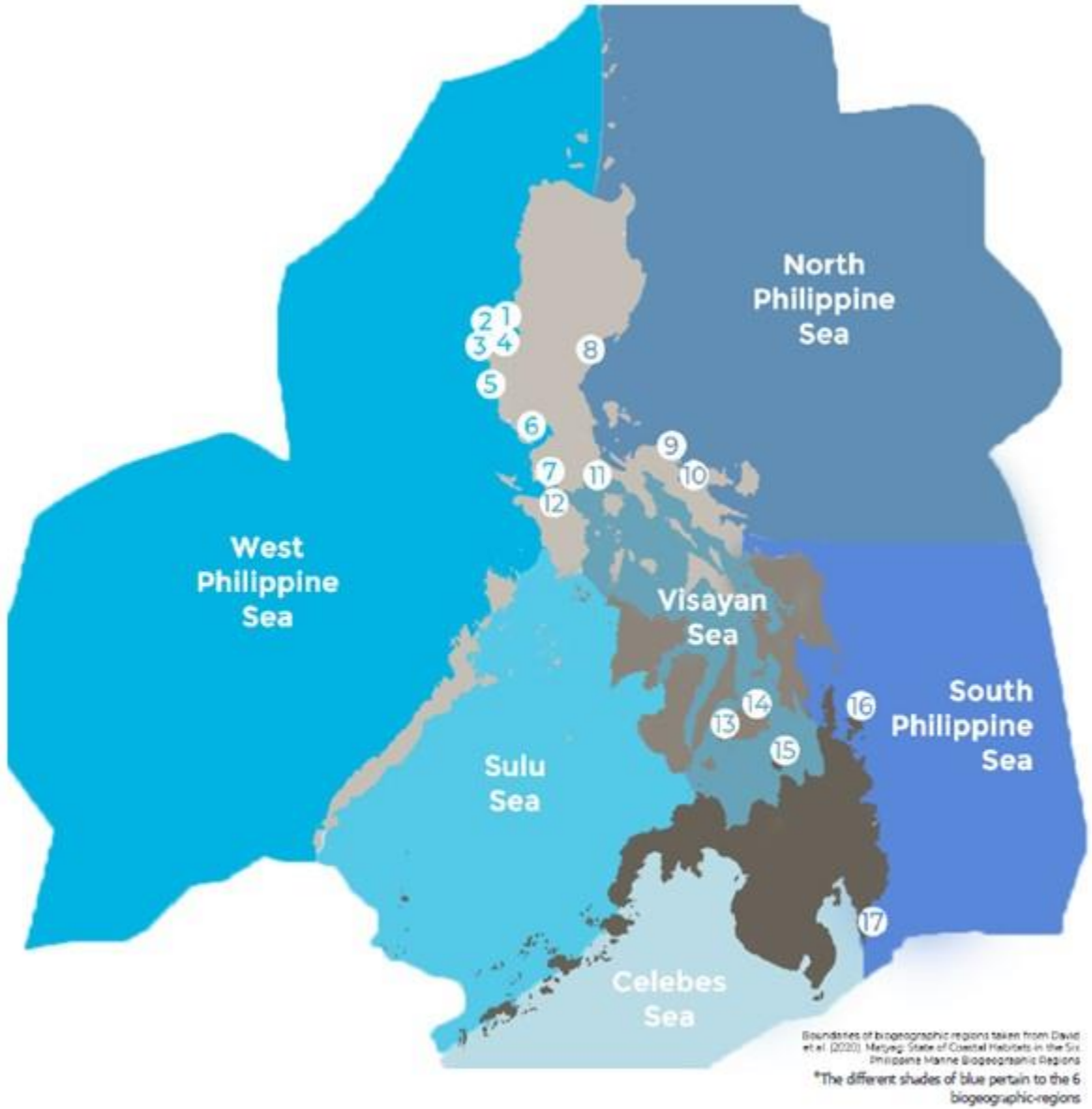
307 Mg C/ha

Total carbon stock in seagrasses in Bumbon Island

278 Mg C/ha

Total carbon stock in the unvegetated area

LTDavid et al., UPMSI



Boundaries of biogeographic regions taken from David et al. (2020) Martyeg: State of Coastal Habitats in the Six Philippine Marine Biogeographic Regions

*The different shades of blue pertain to the 6 biogeographic-regions

Standing Stock (Tons CO_2)

2.7 Million Total

Additional CO_2 Sequestered by Seagrass beds Per Year (Minimum Tons CO_2)	Additional CO_2 Sequestered by Seagrass beds Per Year (Maximum Tons CO_2)

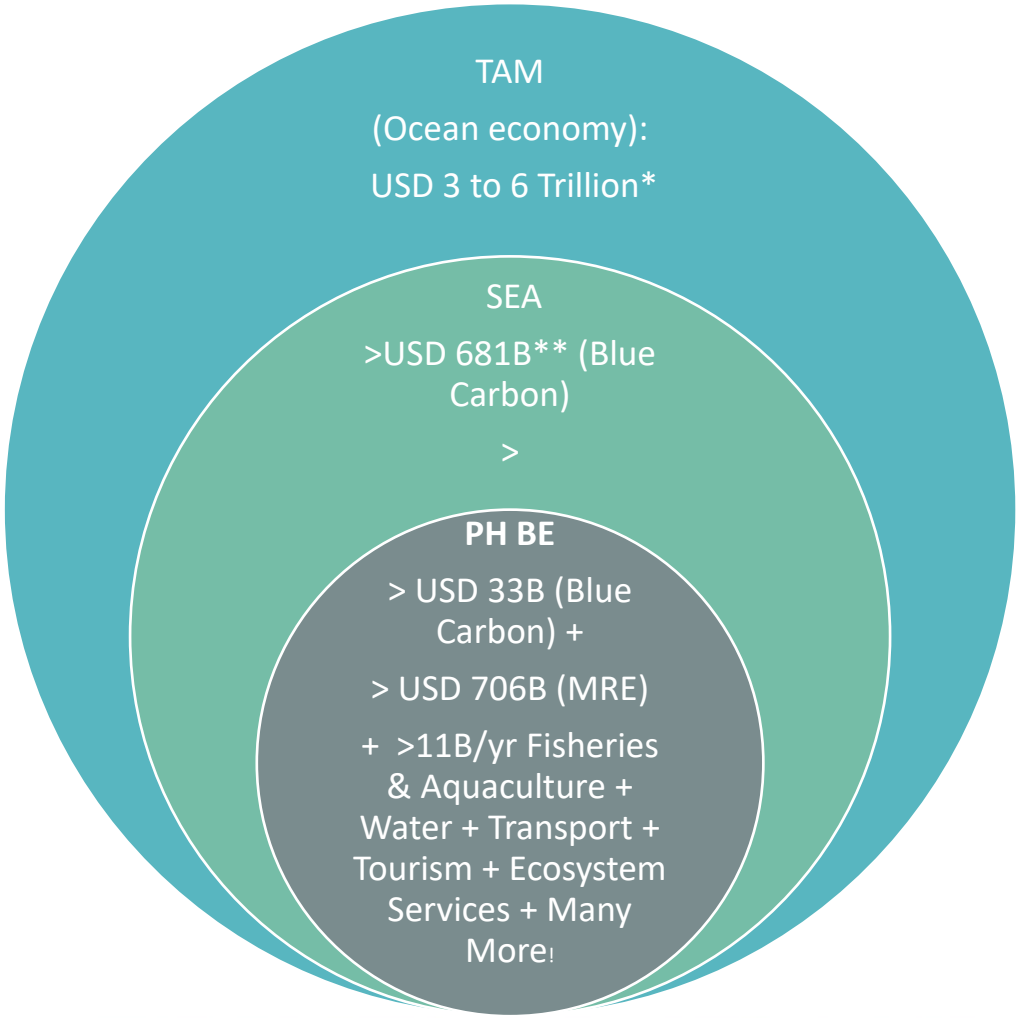
1.7 – 3.4 Thousand Total

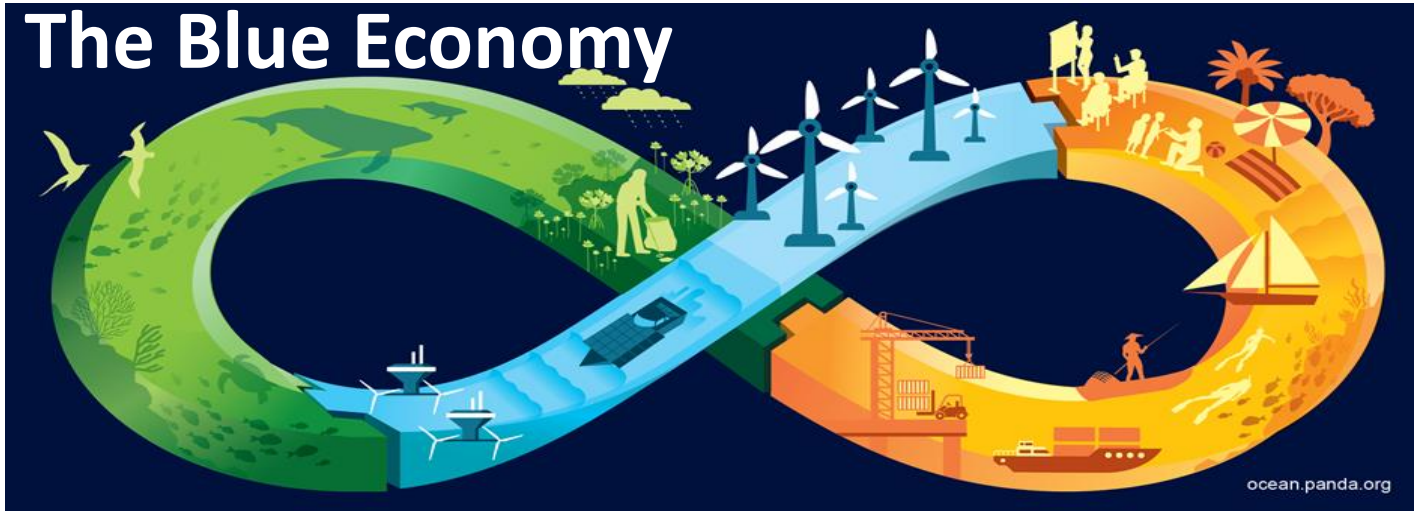
Potential Number of Household Offsets from Annual Sequestration of Seagrass Beds	
Min	Max

15 – 29 Thousand Total

*Currently, the 16 sites are approximated to have 0.0028 Gigatons of CO2 stored in its biomass and sediments. Annually, they are estimated to capture 0.000029 to 0.000054 Gigatons of CO2.
**Average Filipino household emission = 1.86 tons of CO2 annually
***It is estimated that seagrass captures around 8.44 and 15.9 Mg CO2 ha−1 year−1 (average minimum and maximum). Ganguly et al., 2018

Blue Economy : Opportunity





- Blue Carbon Credits
- Marine Renewable Energy (e.g. offshore wind, marine floating solar, Ocean RE – tidal , wave, etc)
- Surveys: MetOcean, Hydrography, etc
- Environmental Monitoring (e.g. Marine Protected Areas, Coral Reefs, etc)
- Vessel and Port Electrification
- Aquaculture (e.g. Seaweed, fish farming)
- Eco-Tourism, Water (e.g. Desalination), Marine & Offshore

**https://www.un.org/en/desa/exploring-potential-blue-economy*
***http://pemsea.org/sites/default/files/Regional_SOC_20190611.pdf*

Activities to Support Blue Economy Development

Blue [Carbon] Assets (e.g. Mangroves, Seagrass, Seaweeds, Coral Reefs, Biodiversity, Blue Economy 'Ecosystem', etc)

- Digital Transformation: Assessment & Valuation, Management (e.g. using digital tools, platform/s), Monetization (e.g. exchanges, use of APIs, etc)

Digitalization – Data, Digital Tools (Modules, APIs, Algorithms), and more (e.g. Software, Platforms, etc)

- Data Mgt, Visualization, Analytics (e.g. Suitability), Dashboarding, Digital Twins, Autonomous Ops, Remote Monitoring, Marketplace, etc

Technology and Project Development (Pilot, R&D, Innovation, Testbed)

- Urban Wind RE, Marine RE (Tidal, Offshore Wind/Solar, Wave, etc), Electrification (incl Vessels), Hydrogen, Blue Economy, Energy Recovery

Consulting and Advisory / Think Tank

- Technology, Industry, Market, Business Dev't, Fundraising Support, Techno-Economics, Proj. Pre-Dev't (e.g. FS, Pre-FEED, Envi, Social)

Field Survey (e.g. Marine, Offshore) **and Related Support Services**

- MetOcean, Hydrodynamics, Hydrography, Bathymetry, Geotechnical, Environmental (e.g. Fish Census, EIA, IEE, etc), Drone-based Surveys

Potential Pilot Projects





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

Systems and Eco-Systems' Integration

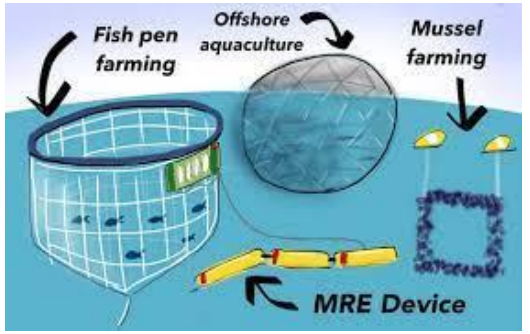
Energy Storage

Testbedding
Other Innovations
Technologies
Business Models
"Learn by Doing"

Transportation

Ice

Aquaculture



Ports/Marinas/Bays

Water Production

Reef Restoration,
Marine Area Monitoring

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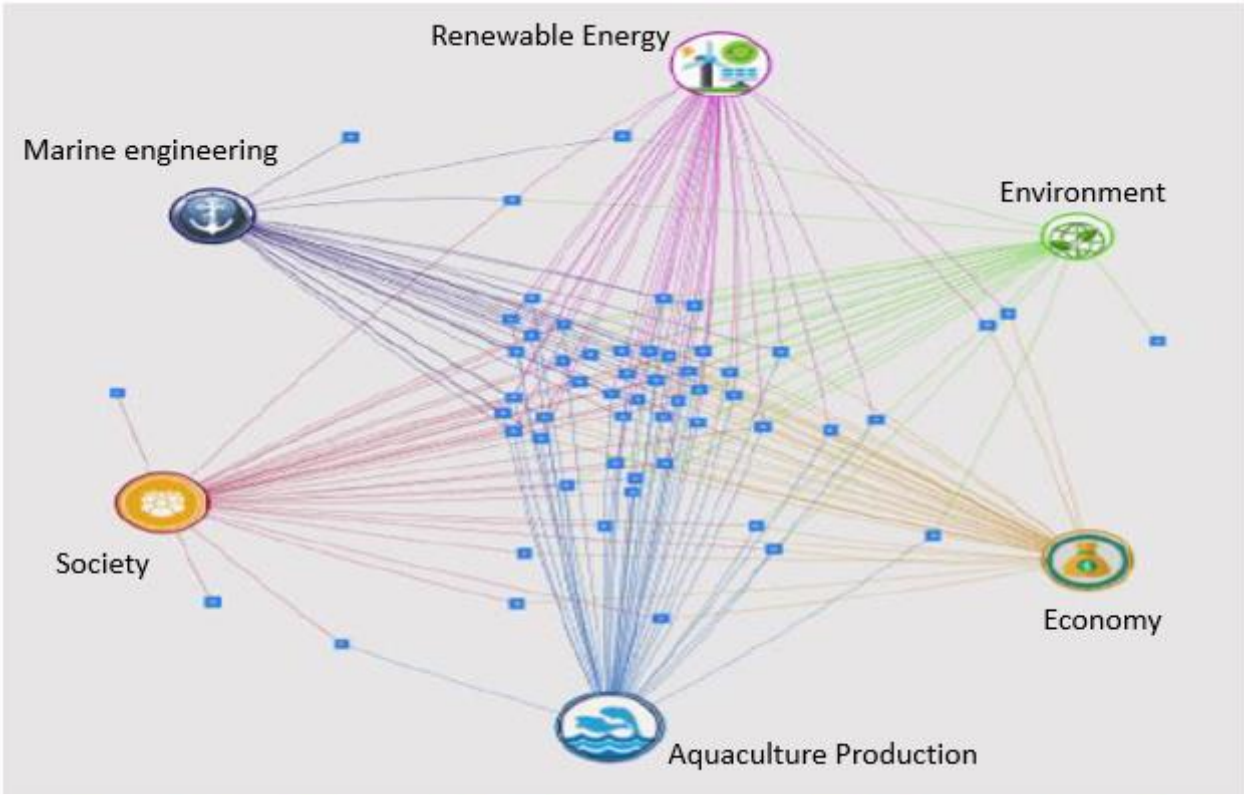
Blue Economy Risk Registry

An Interactive dashboard summarizing hazards identified across a broad set of domains cross-linked to Australia's emerging Blue Economy.

Project Goals:

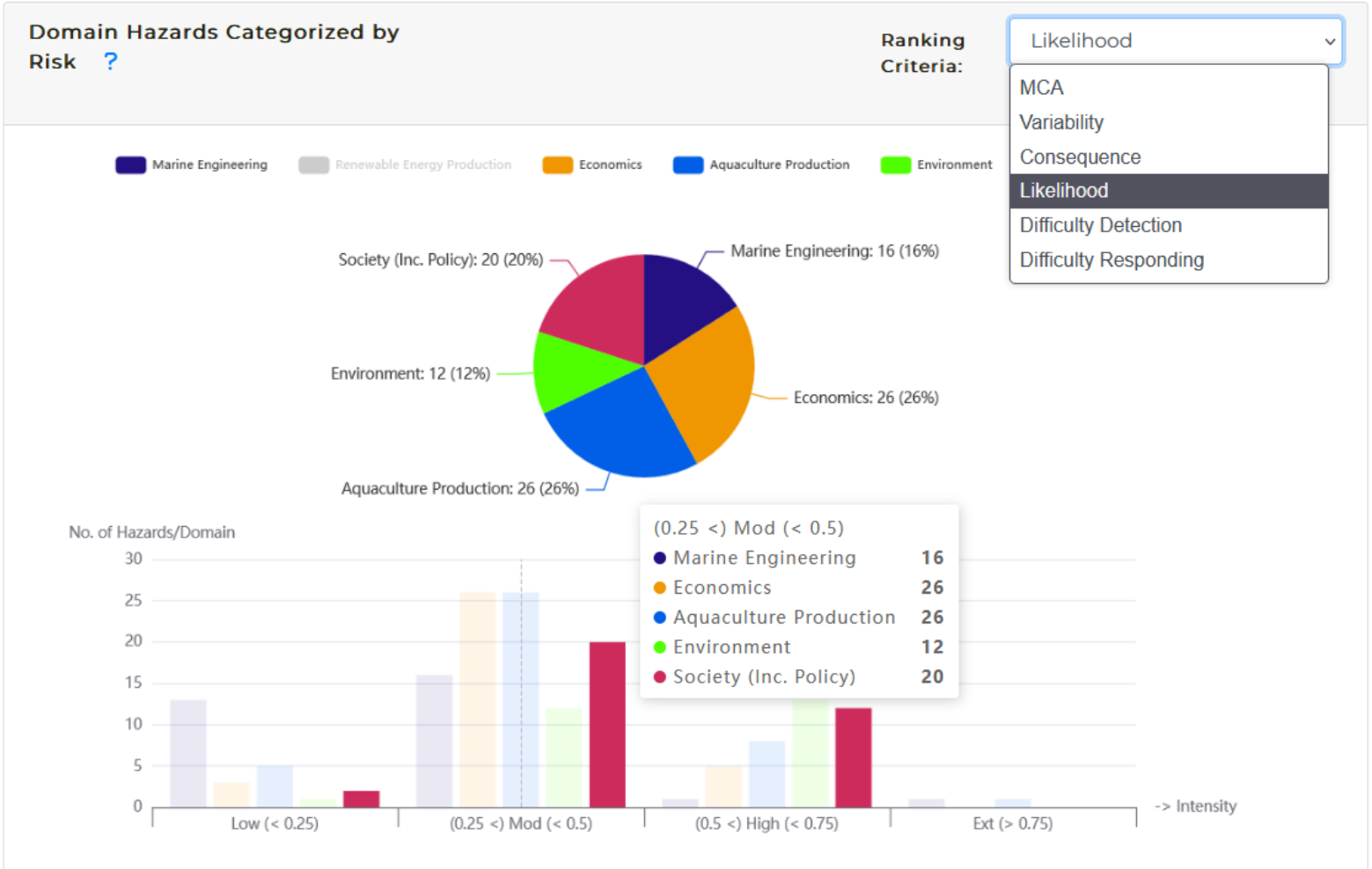
- Cross-linking domains and hazard to have an overview of shared hazards.
- Hazard Impact ranking to help authorities in making impact assessment and mitigation strategies.
- Help Government organizations in Policy-making for a sustainable blue economy.
- New entrants in Blue economy industry can identify their relevant hazards and plan accordingly.



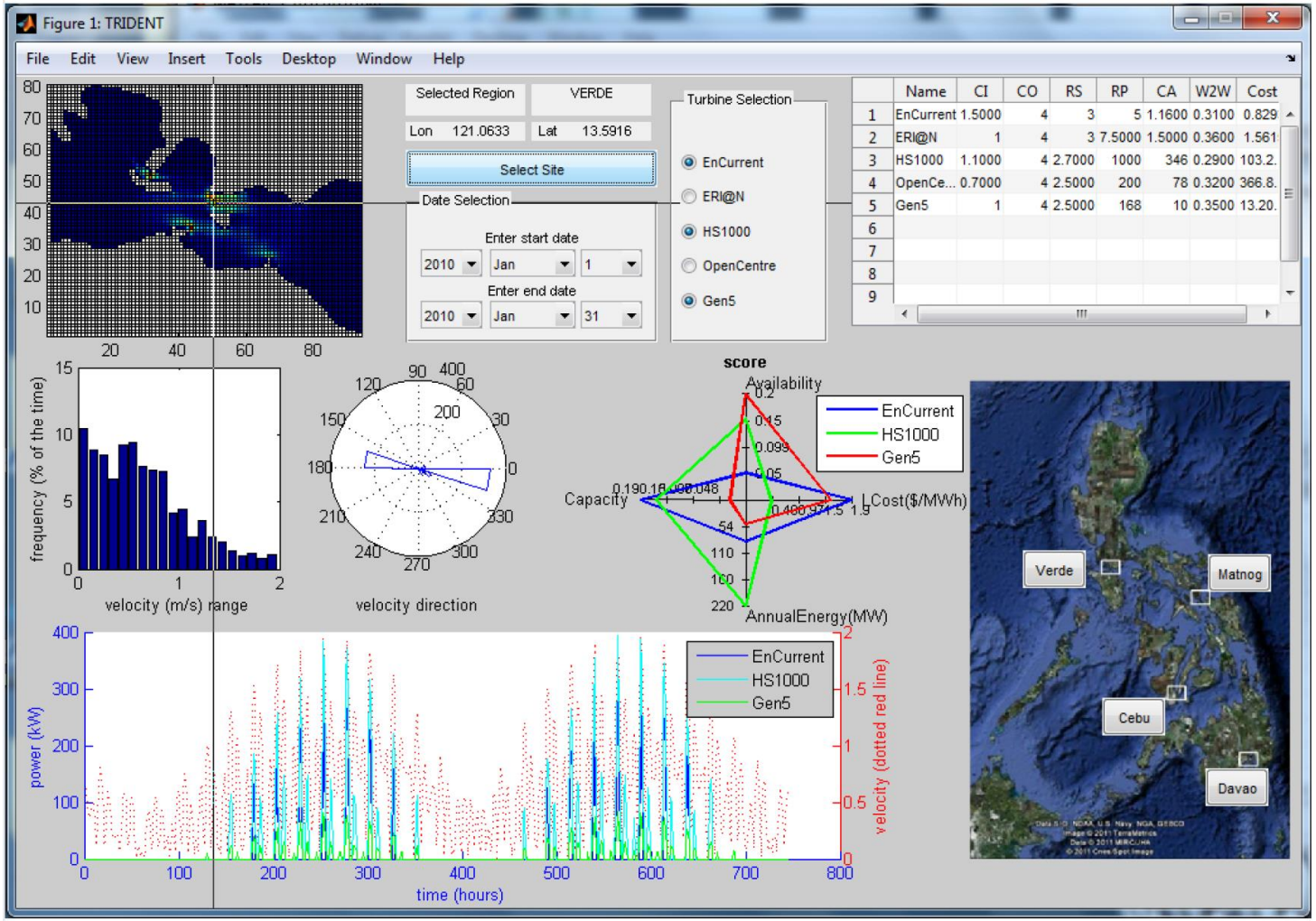
Digital Tools – Data Management, Analytics - Visualization, Dashboarding, etc

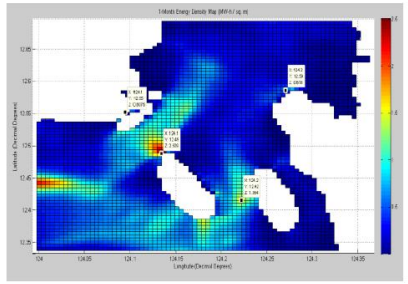
Hazards ranking based on following criteria and put into Risk categories according to their combined score (Multi Criteria Analysis)

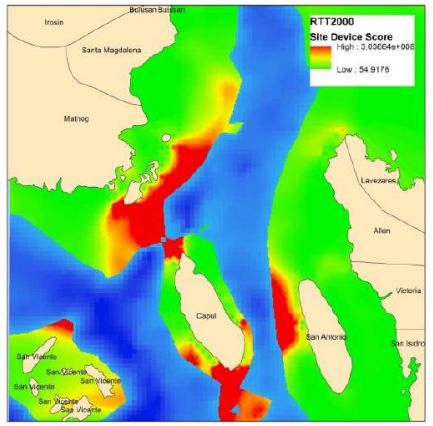
- The **likelihood** of the hazard having an impact.
- The **consequence** of that impact.
- How **difficult is it to detect** the impact.
- How **difficult it is to respond** to the impact.



Digital Tools (e.g. GIS) for Site & Resource Assessments, Techno-Economics, and Other Analyses





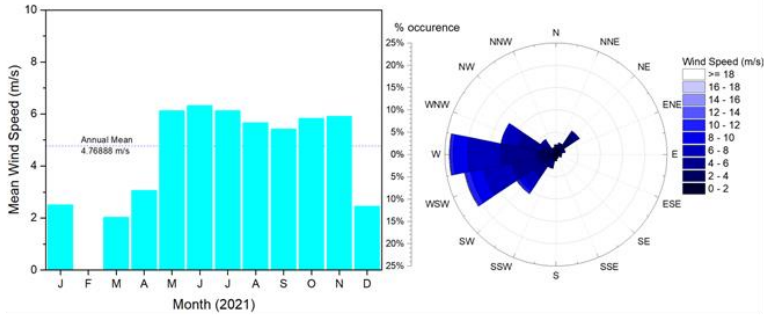


Digital Tools (e.g. GIS) for Site & Resource Assessments, Techno-Economics, and Other Analyses

Wind Renewable Energy Project Site Assessment and Planning Considerations

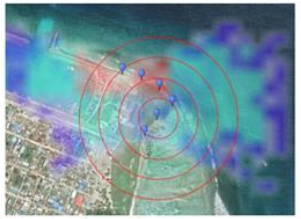
1. Resource Assessment
   - Wind Speed
2. Scenarios modeling
   - Wind turbine characteristics
   - Total capacity
   - Noise Analysis
   - Shadow Flicker Analysis
3. Environmental Impacts Mapping
4. Project Recommendations

1 Annual Wind Speed Data



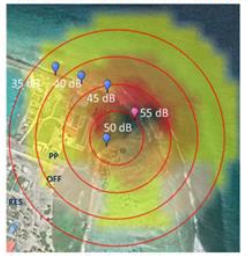
2

Array Configuration Scenario 1:
25 kW x 6 turbines

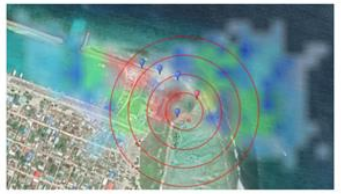


Shadow hours/year

Array Configuration Scenario 4:
25 kW x 4 turbines + 50kW x 1 Turbine



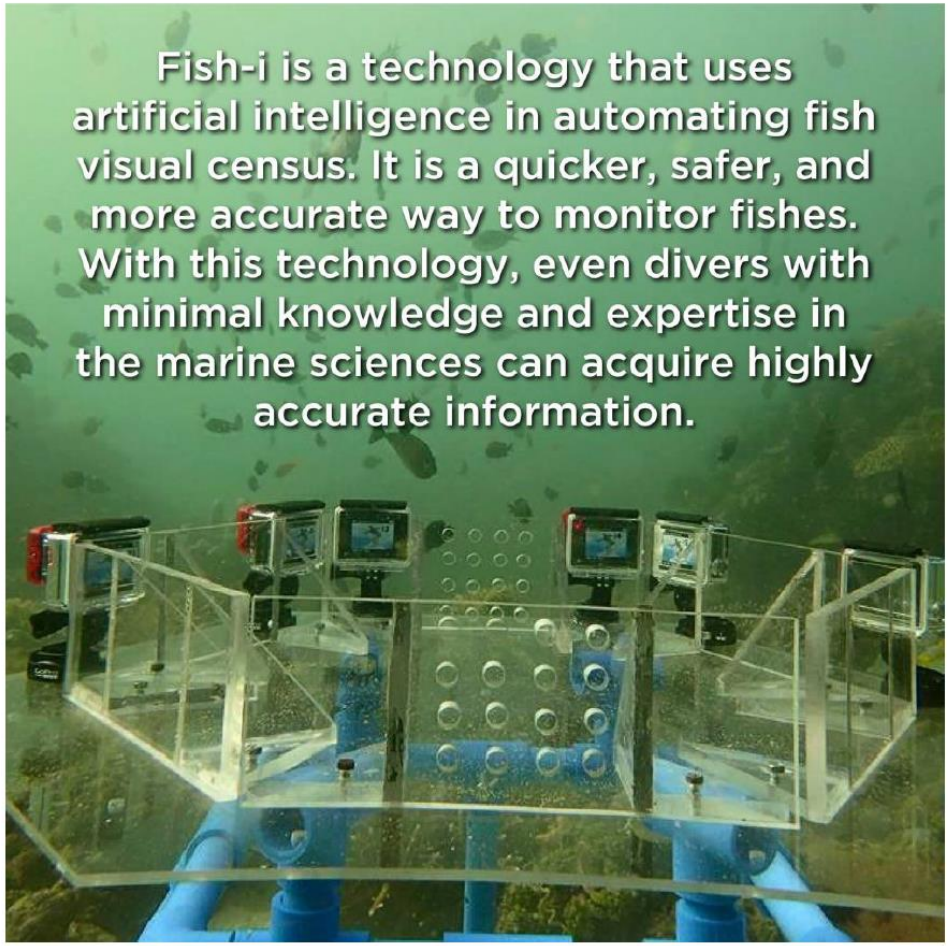
Noise Map 14 m/s (50 kW turbine curtailed at 10 m/s)

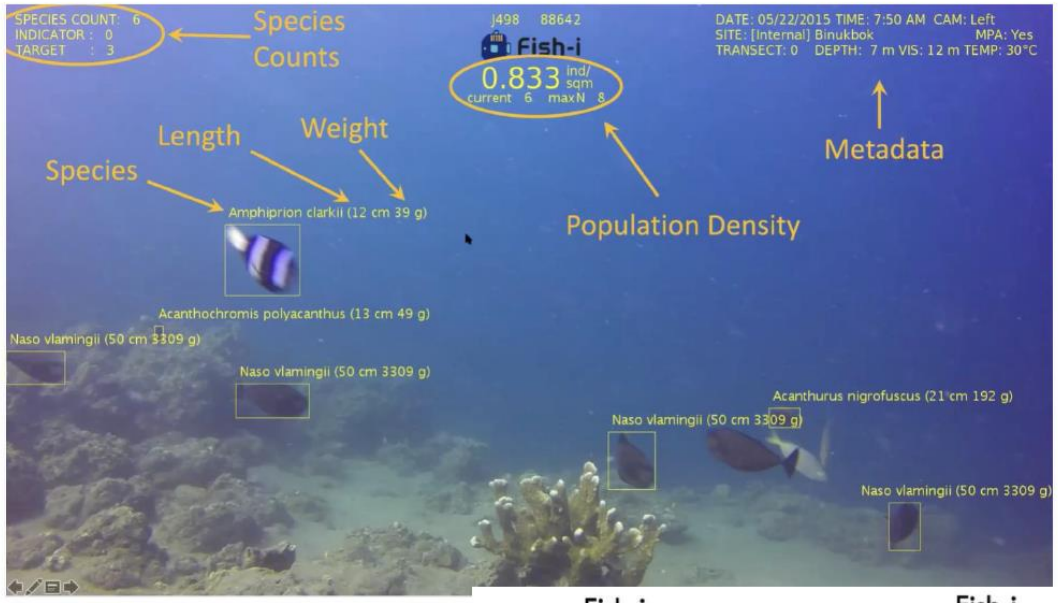


Shadow hours/year

3

Digital Tools (e.g. Computer Vision) for Environmental Monitoring





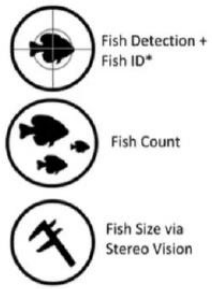
- ✓ Safer, faster, cheaper
- ✓ High scalability
- ✓ More frequent census

Fish-i Data Capture

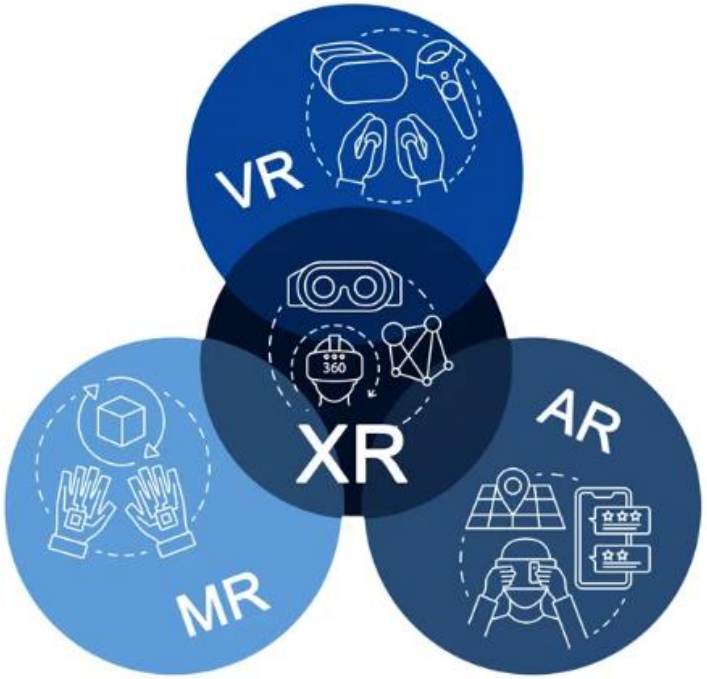
\+

Fish-i Data Analyzer

=

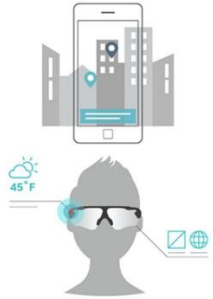


More Digital Tools – Extended Reality (XR), e.g. AR, MR, VR



Augmented Reality

Real world with digital information overlay

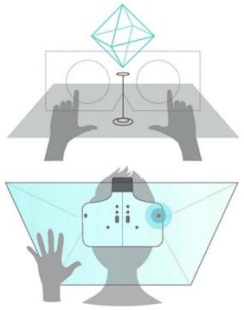


Augmented Reality Devices Example

ODG R-7 oder Smartphones/Tablets

Mixed Reality

Real and virtual are intertwined

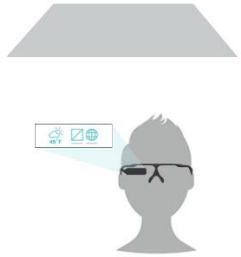


Mixed Reality Glasses Example

Microsoft HoloLens 2

Assisted Reality

Support through a small display in front of the eye

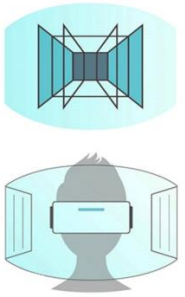


Assisted Reality Glasses Example

RealWear HMT-1

Virtual Reality

Completely closed, digital experience with no sense of the real world



Virtual Reality Glasses Example

Varjo VR-1

More Digital Tools – Extended Reality (XR), e.g. AR, MR, VR

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | SAAB

Saab – NTU Joint Lab

A Shared Interactive Space in Mixed Reality for Collaborative Digital Tower Operations

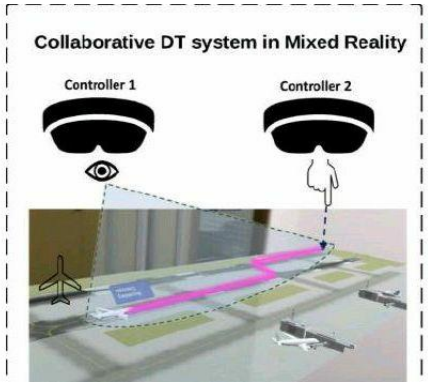
Pallavi Mohan, Sameer Alam, T.N. Mohammed Nadirsha and Nimrod Lilith
Saab-NTU Joint Lab, Nanyang Technological University Singapore

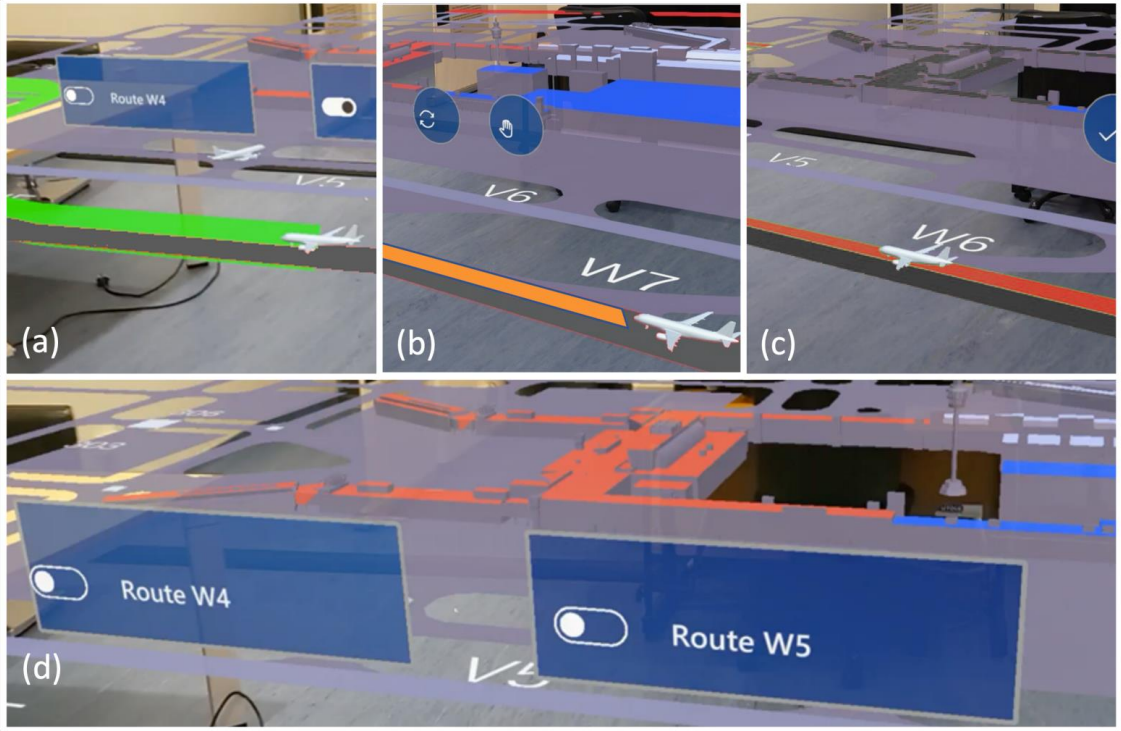
Asa Svensson
Dept. of Research & Innovation, LFV Air Navigation Services of Sweden

To collaborate

Can transform any room into an Air Traffic Control Tower - cost savings and efficiency

Results shows XR brings **enhanced situational awareness** with same work load and reduced Time to Decision





Interface of a Mixed Reality Air Traffic Control

More Digital Tools – Extended Reality (XR), e.g. AR, MR, VR

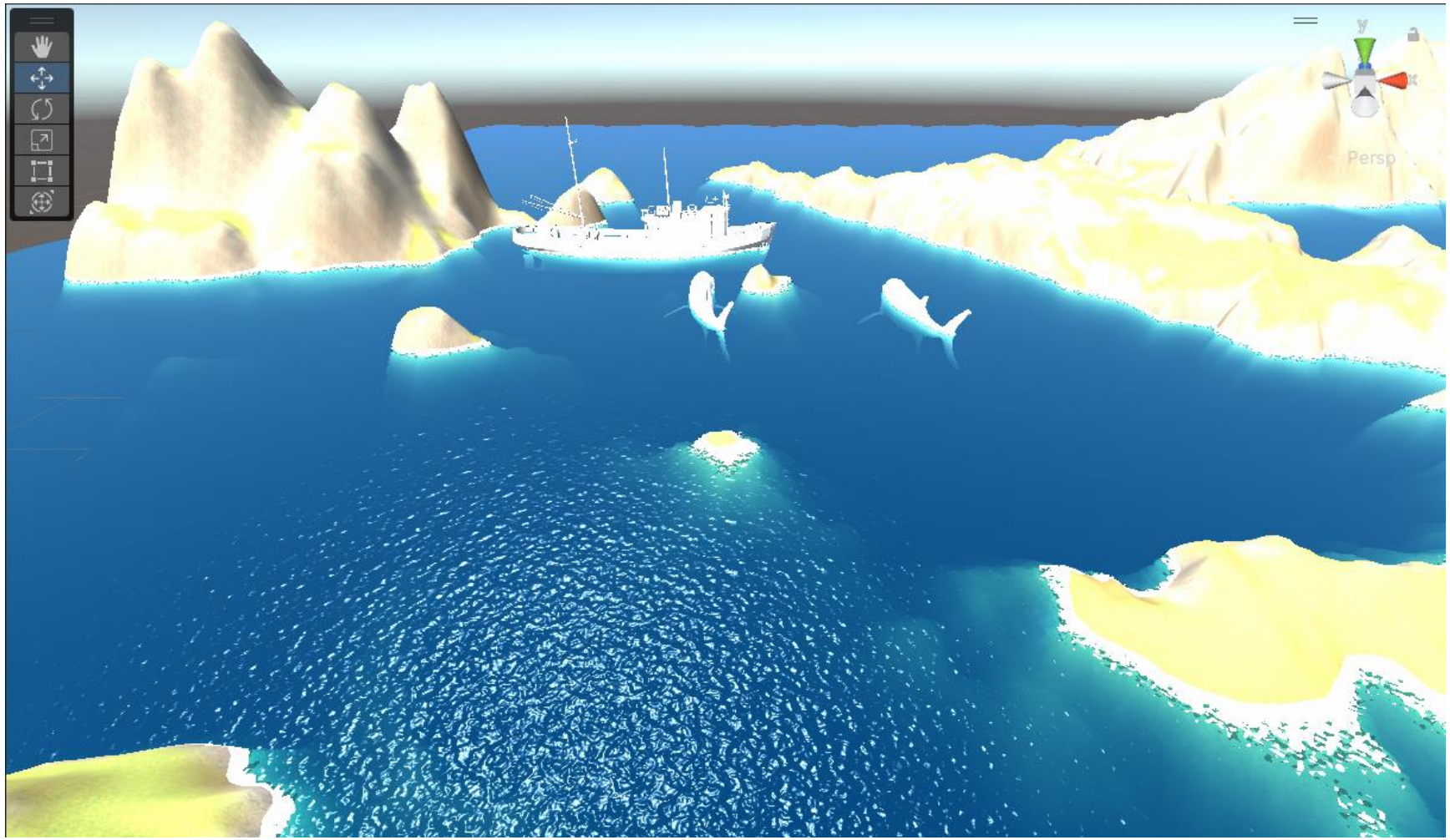


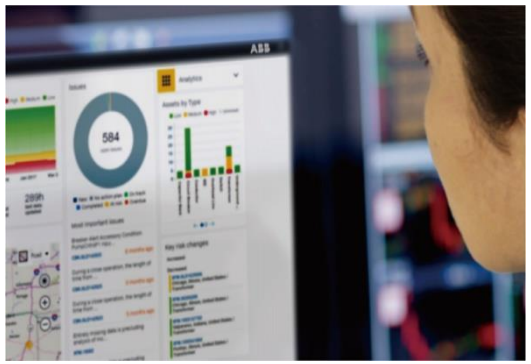
Image from a new Marine Mixed Reality project under development

Applications

- Advanced maintenance
- Better visualization & collaboration for training with holograms
- Remote assistance with Digital Twins
- Emergency response

Applications in many more industries..

- Healthcare
- Robotics
- Construction/Interior designing
- Retail
- Clothing etc



The **Digital Blue Online Platform** will include the following features:

1. Digital Twin for Tidal Energy System
2. Sustainability Dashboard (kWh, kgC02e, $ Savings, etc)
3. Project Website
4. Digital Educational (and Interactive) Content
5. Data Visualization & Data Analytics (e.g. Tidal Energy System)
6. Underwater Monitoring (Video-based) System for environmental interaction
7. Augmented Reality and other Digital Tools for Information, Education, and Communication
8. Smart Marine Renewable Energy Prediction System (considering Hydrodynamics, Environment, etc)

HITACHI
Inspire the Next

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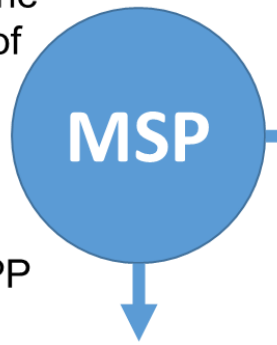
Digital Ecosystems Approach – Using Digital Tools and Appropriate Frameworks for Blue Economy Projects

Marine Spatial Planning (MSP)

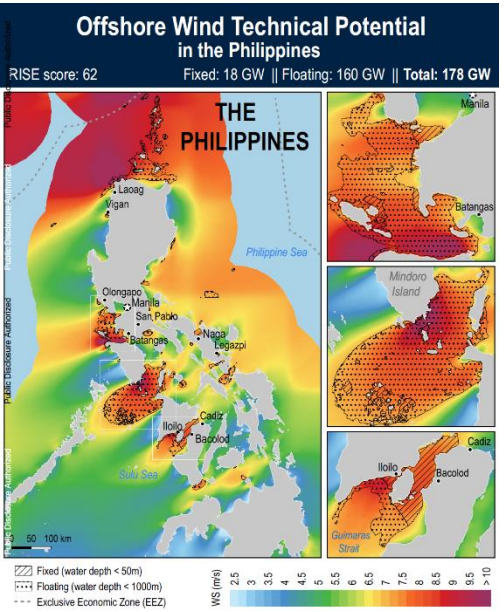
An integrated, policy-based approach to the regulation, management and protection of the marine environment, including the allocation of space that addresses the multiple, cumulative and potentially conflicting uses of the sea and thereby facilitates sustainable development (MSPP Consortium, 2006).

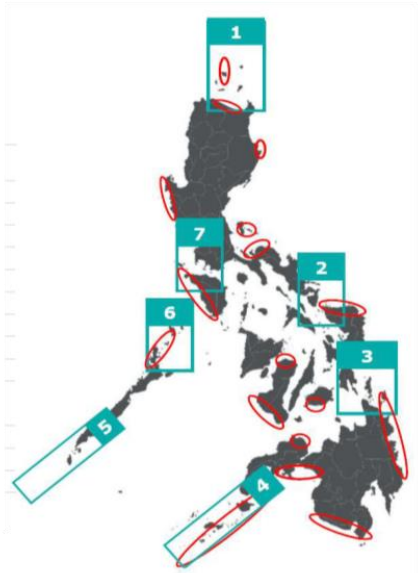


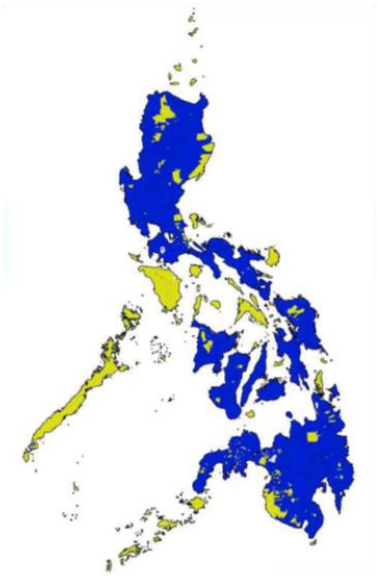
SECTOR	EXAMPLES	United Nations 17 SDG's
Transportation	Route Generation, Evaluation, Optimization, Traffic Management, Environmental Impact, Pollution Generation & Management	1, 3, 8, **9**, 11, 12, 13, **14**
Food Production	Optimized spatial development for fishing, aquaculture, multi-level aquaculture centers, offshore and nearshore hatcheries etc	**2**, **3**, 8, 11, **12**, 14
Zoning	Marine Reserves, Coastal Protection, Special Economic And Tourism	**1**, **8,** 9, 10, 12, 14, 16, 17
Energy	Marine Renewables ie Wind, Wave, Tidal, Floating Solar, Salinity and Thermal Gradients, Offshore/nearshore site evaluations	1, 2, **7, 8, 9,**
Resource Protection	Coastal, Cultural and Underwater Archeological Management, Aggregate extraction & mining activities	12, **14**, 16, 17

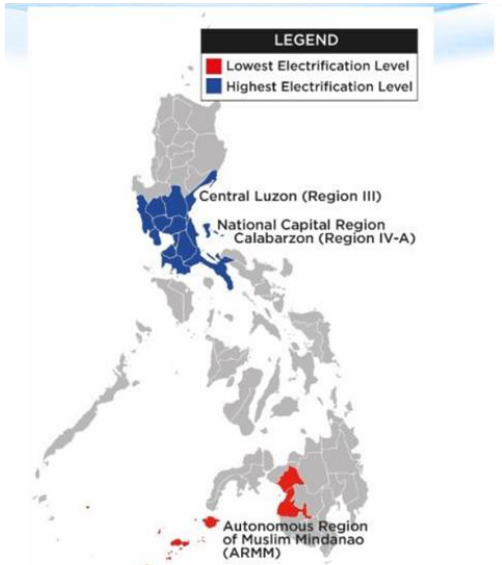
Digital Ecosystems Approach – Using Digital Tools and Appropriate Frameworks for Blue Economy Projects

fluid . energy . intelligence

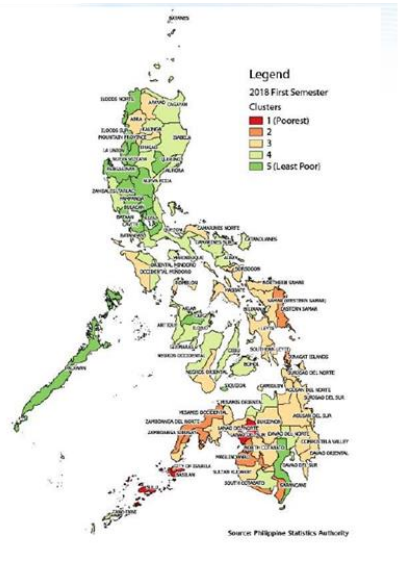








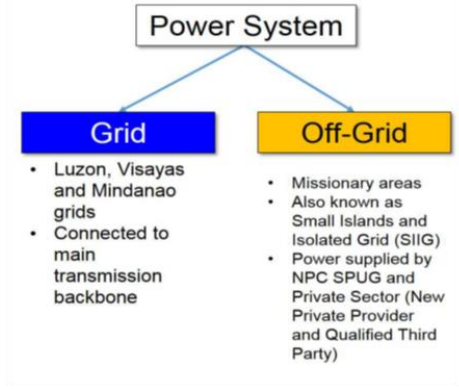
Highest and Lowest levels of electrification [3]



Poverty index in the Philippines (2018) [4]

Philippines' tidal in-stream and wave energy potential

No	Province / Region	Electrification rate*	Population (million)
1	Cagayan / II	91.8%	1.20
2	Catanduanes / V	88.7%	0.26
	Sorsogon / V	88.7%	0.79
	Northern Samar / VIII	87.2%	0.63
3	Southern Leyte / VIII	87.2%	0.42
	Surigao del Norte / XIII/Caraga	93.8%	0.49
4	Basilan / ARMM	38.7%	0.35
	Sulu / ARMM	38.7%	0.82
	Tawi-tawi / ARMM	38.7%	0.39
5	Palawan / IV-B	82.2%	0.85
6			
7	Batangas / IV-A	96.3%	2.69
	Occidental Mindoro / IV-B	82.2%	0.49
	Oriental Mindoro / IV-B	82.2%	0.84



Source	Potential
Geothermal	> 4,000 MW
Wind	> 76,600 MW
Hydropower	> 10,000 MW
Solar	> 5kW/m² per day
Ocean	> 170,000 MW
Biomass	> 500 MW (bagasse & rice hulls only)

from IRENA, DOE (2016) [5]

7,641
islands in the Philippines [6]

850M
deprived of access to electricity [1]

18%
rural communities [2]

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[1] International Energy Agency (IEA), "World Energy Outlook 2019 – Analysis - IEA." [Online]. Available: https://www.iea.org/reports/world-energy-outlook-2019. [Accessed: 26-May-2020]
[2] The World Bank, "Access to electricity, rural (% of rural population)." [Online]. Available: https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS. [Accessed: 26-May-2020].
[3] IRENA, Mini-Grid Deployment : a Study on the Philippines, no. October. 2017.
[4] Philippine Statistics Authority (PSA), "Cluster of Provinces, 1st Semester 2018 - Poverty.jpg," 2018. [Online]. Available: https://psa.gov.ph/sites/default/files/2018S1POV_Cluster of Provinces_gcsor.jpg. [Accessed: 05-Jun-2020].
[5] A. S. A. D. Santos, "Renewable Energy in the Philippines," International Renewable Energy Agency (IRENA), 2016. [Online]. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Events/2016/Dec/12/Philippines-presentation.pdf?la=en&hash=DEC515661934EE45D38FB632E6985581802CF3C7. [Accessed: 20-Apr-2020].
[6] Central Intelligence Agency (CIA), "East Asia/Southeast Asia :: Philippines — The World Factbook - Central Intelligence Agency." [Online]. Available: https://www.cia.gov/library/publications/the-world-factbook/geos/rp.html. [Accessed: 26-May-2020].

Marine Renewable Energy (MRE)

*"Renewable energy production which makes use of marine resources or marine space."**

Marine Renewable Energy

- Offshore Wind
- Floating Solar
- Marine biomass

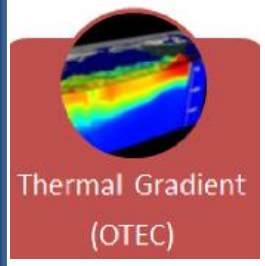
(micro- and macro-algae)

Ocean Renewable Energy (ORE)

- Currents (Ocean Current, Tidal Currents/In-Stream)
- Tides (Tidal Range)
- Waves
- Salinity / Osmotic Gradient
- Thermal Gradient

MRE ≠ ORE

ORE is a subset of MRE.



*European Science Foundation

Ocean Renewable Energy

OceanPixel

5 Ocean Renewable Energy Resources*

"Marine & Hydrokinetic / ***Marine Hydrokinetic (MHK)***" : Currents, Waves, and Tides

- **Ocean Current / Tidal In-Stream** energy is harvested by Current/Hydrokinetic turbines placed underwater where fast-flowing currents turn the generator blades similar to what wind does with wind turbines.
- **Tides (Tidal Range)** Tidal Barrages utilize the potential energy from the difference in height between high and low tides.
- **Wave** energy is produced from the surface motion of ocean waves or from pressure fluctuations below the surface.
- **Ocean Thermal** energy conversion (OTEC) uses the temperature difference between the surface seawaters (warm) and the deep seawaters (cool) to drive a heat engine to produce electricity.
- **Salinity Gradient** power is the available energy (or chemical potential) from the differences in salt concentration between the fresh water and seawater.

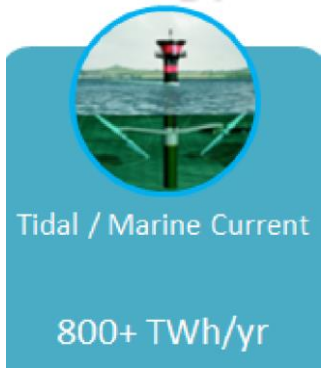
*IEA-OES

Marine-related RE Options

Floating – Solar, Wind

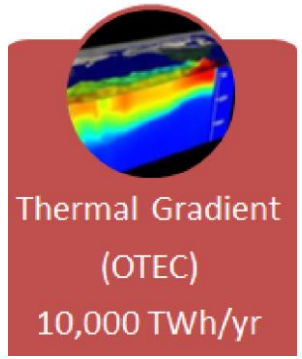
Very High Chance of Feasibility

Up to a certain depth



Resource: H
TRL*: High

Resource: H
TRL: Med



Resource: H
TRL: Med

*TRL = Technology Readiness Level

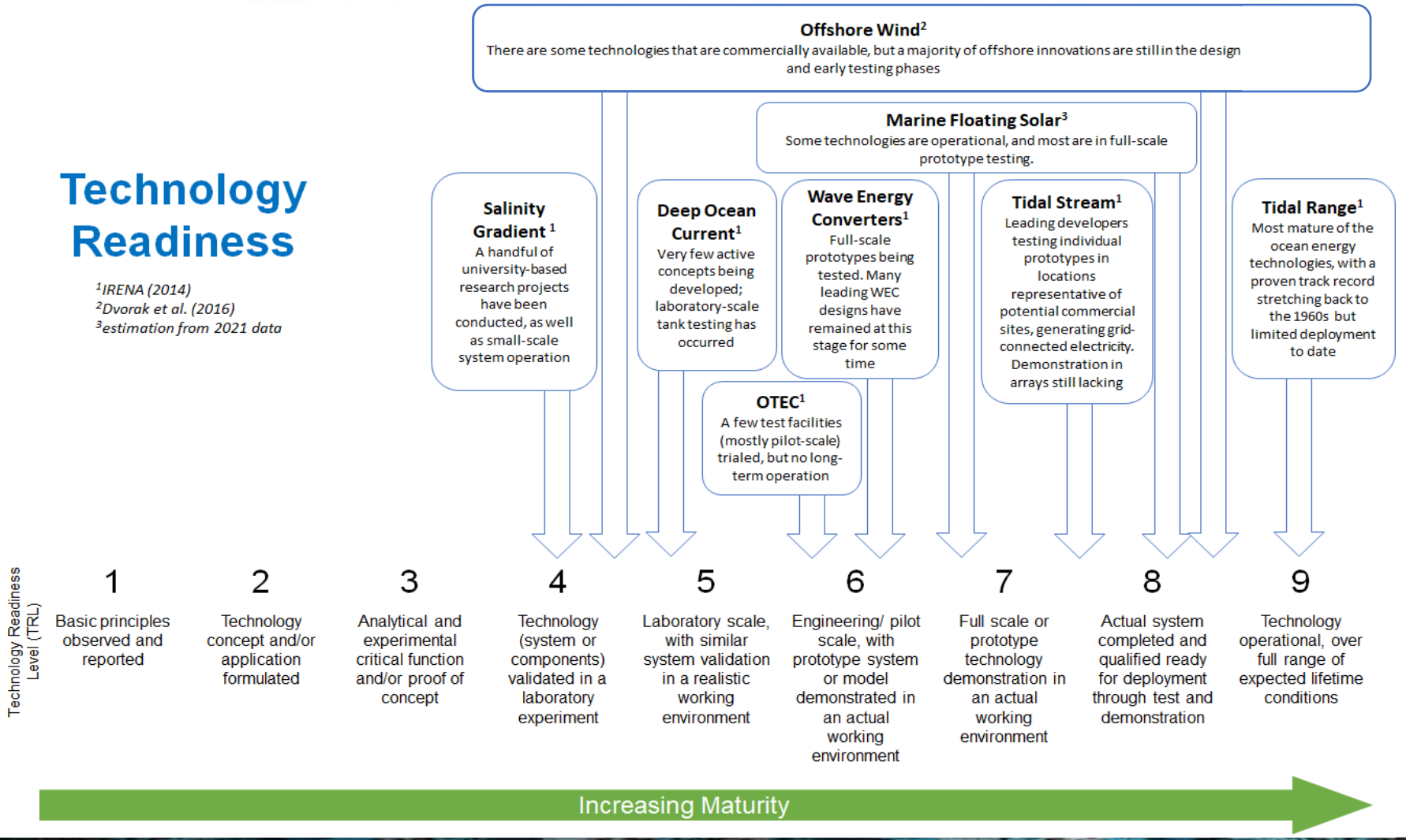
Present Technologies need >4m to be economically viable

- Already viable either with co-application or at certain scale
- Good for Energy Recovery for Desalination Plants

Marine Renewable Energy (MRE) Technology

Technology Readiness

[1]IRENA (2014)
[2]Dvorak et al. (2016)
[3]estimation 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**

Sustainable Energy – Islands Example

Total = > 5,000 MW deliverable capacity

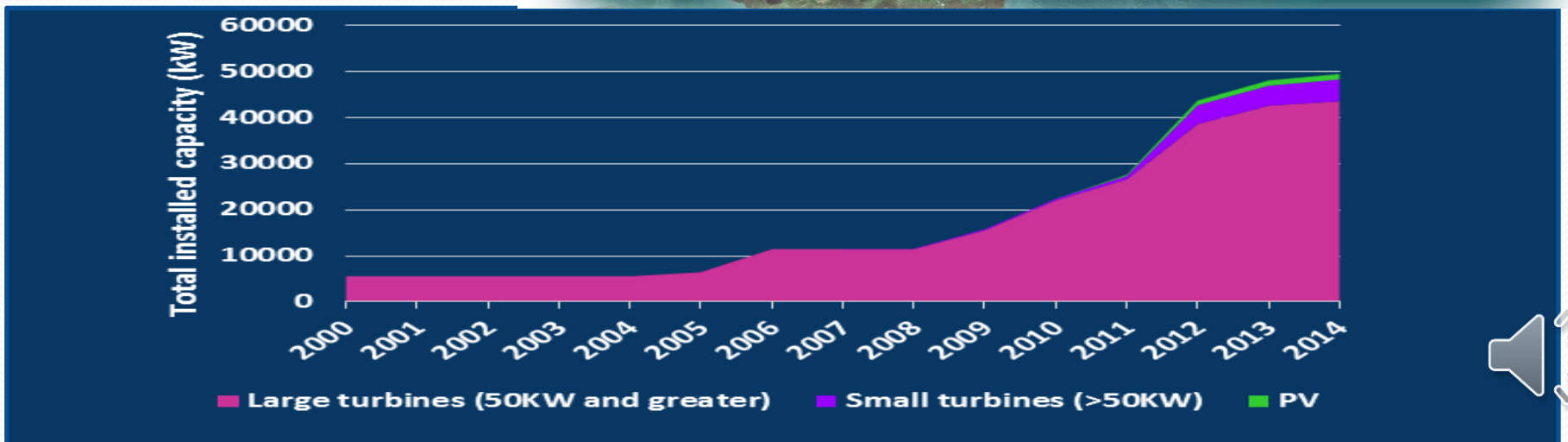
Key	
Onshore wind	40 MW existing/planned
New onshore wind	100-200 MW
Wave	500-1000 MW
Tidal	500-2,500 MW
Offshore wind	1000 MW
Wave leases	550 MW
Tidal leases	500 MW
Mirco & other	2.5 MW
Gas & other	20 MW
EMEC sites	5 + 7 MW

Dispersed

Dispersed and

Orkney Islands, North Scotland, UK

107% of electrical demand in Orkney met by renewables in 2014



Global Initiatives

OCEAN ENERGY SYSTEMS

EMEC ORKNEY
The European Marine Energy Centre Ltd

FORCE
Fundy Ocean Research Center for Energy

NETHERLANDS

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power		
Tidal Currents	130	3000
Salinity Gradient	50	

UK

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	3730	40000
Tidal Currents	5600	96000

CANADA

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Tidal Currents		20450
Tidal Power	20000	

SWEDEN

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	180	10400-10600
Tidal and Ocean Currents	7.5	

DENMARK

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power		115

BELGIUM

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power		Up to 20000

NORWAY

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	200	

CHINA

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	350	2860
Tidal Currents	170	4500
Tidal Power	3900	200

REPUBLIC OF KOREA

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	500	300
Tidal Currents	1000	1300
Tidal Power	1000	1300
OTEC	220	1000

USA

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power		1365
Tidal Currents		1350

PORTUGAL

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	700	

SPAIN

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	296	300

ASEAN CENTRE FOR ENERGY · ACE ·

SINGAPORE

RESOURCE	INSTALLED CAPACITY (kW)	CONSENTED PROJECTS (kW)
Wave Power	16	
Tidal and Ocean Currents		2.5

>1,000 Sites
200MW each

openhydro
a DCNS company

MEYGEN

ATLANTIS RESOURCES

LOCKHEED MARTIN

seacore
southeast asian collaboration for ocean renewable energy

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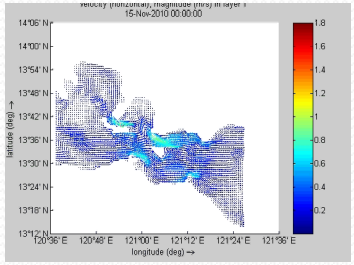
Developing Countries' Initiatives

Simulation Studies

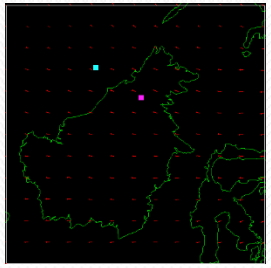


Myanmar
Tidal Barrage

Indonesia
Tidal Current Test

Europe, N. America, Australia

Brunei
Offshere Wind



Vietnam
Tidal Turbine Drive Train

Malaysia
OWC Test

Tow Tanks
(eg UTM, MMU, NTU)

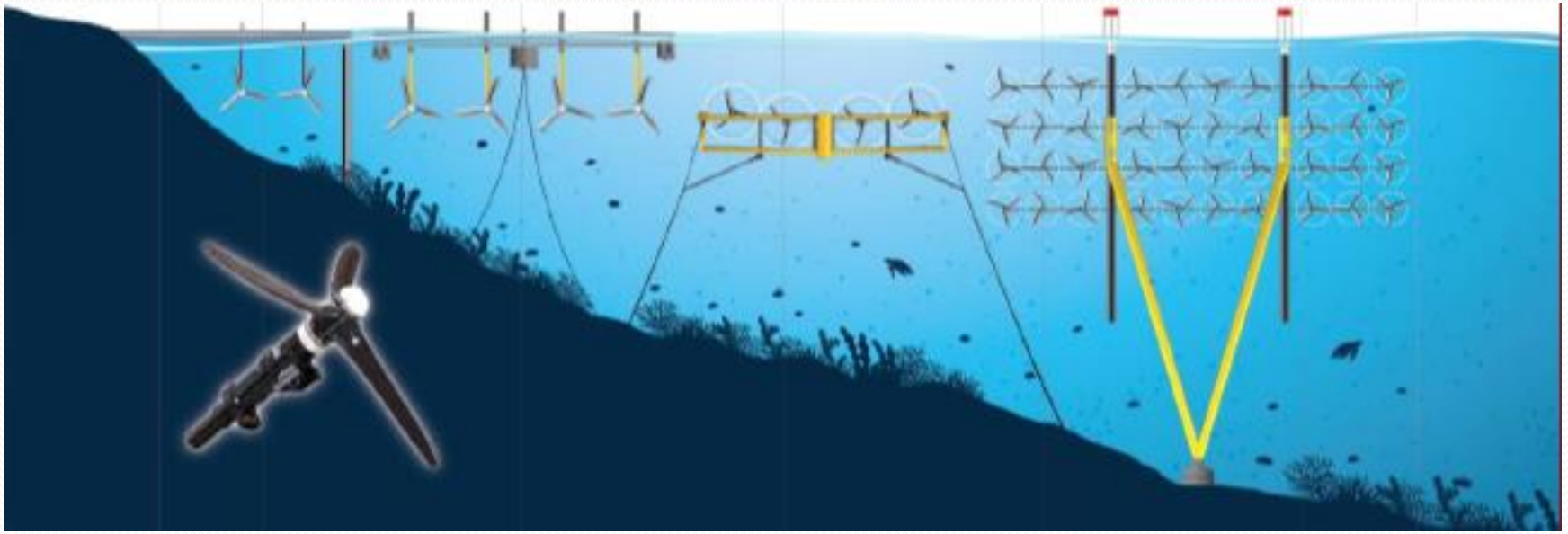
Philippines
Tidal Barrage

Singapore
Tidal Turbine Testing

Source: SEAcORE 2013

Ocean Energy - Configuration Options

(Tidal In-Stream Energy Device example)



- Jetty-based / fixed structure (e.g. bridges)
- Floating
- Submerged (neutrally-buoyant)
- Seabed-mounted
- Others? – Vessel-mounted?

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What is a Cushion Roller?

Cushion Rollers are components that hold floating platforms in place while absorber impacts that the platforms experience.

Technology Zones

Hs> 1m

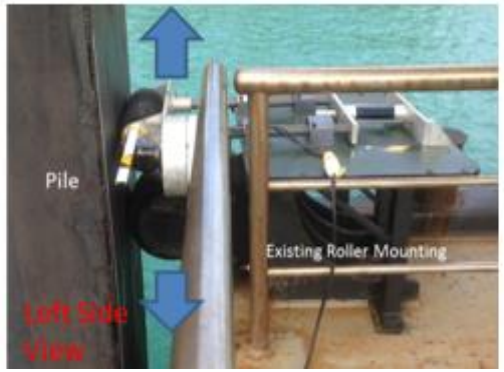
Medium Energy
Medium Risk
Array Approach

Hs> 0.5m

Huge Waves
High Energy
High Risk
Offshore Challenges

Hs < 0.5m

Multi-function Device
'Low Wave' Resource Capture



'Dry Setup'
Low Risk
Easier Maintenance

Technology Innovation – Competitive Edge

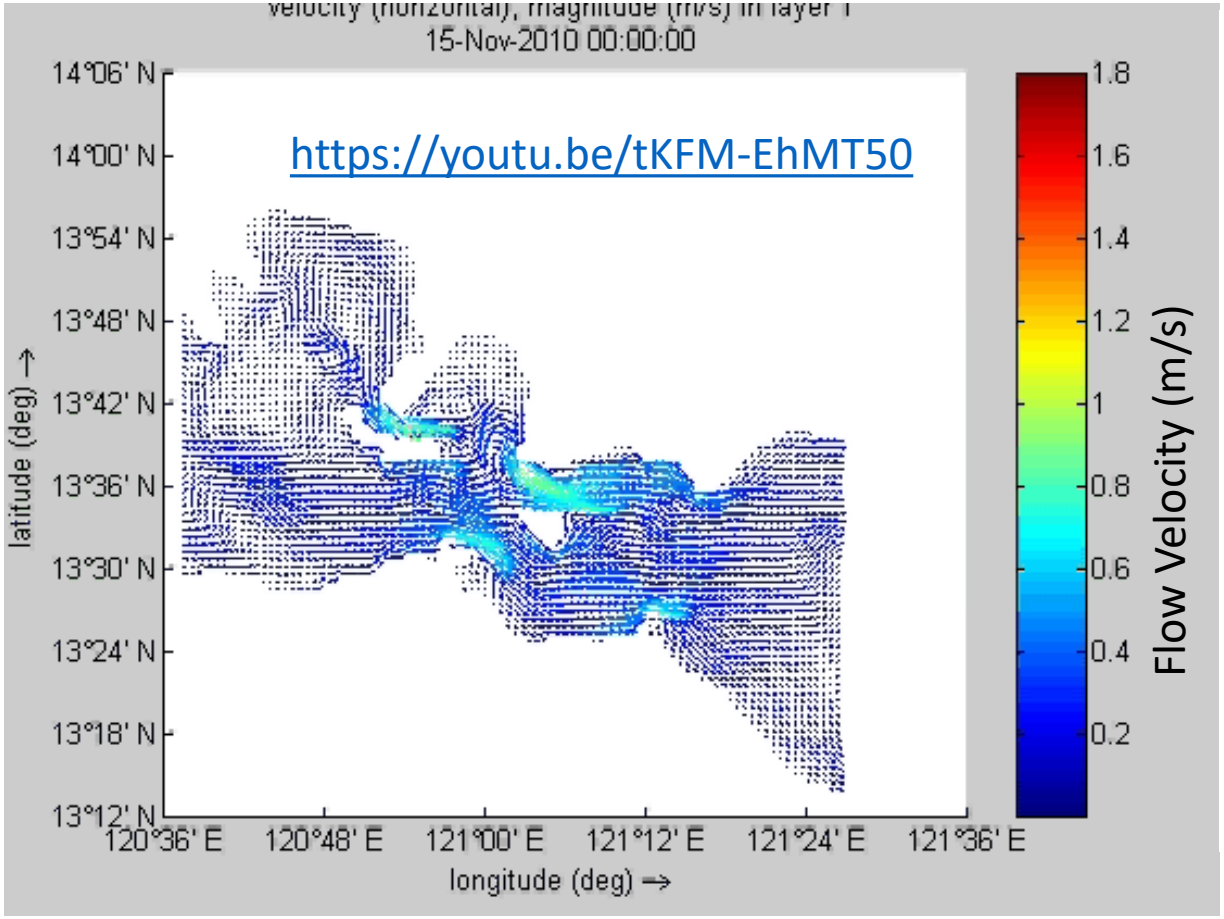
<u>As a Cushion Roller</u>

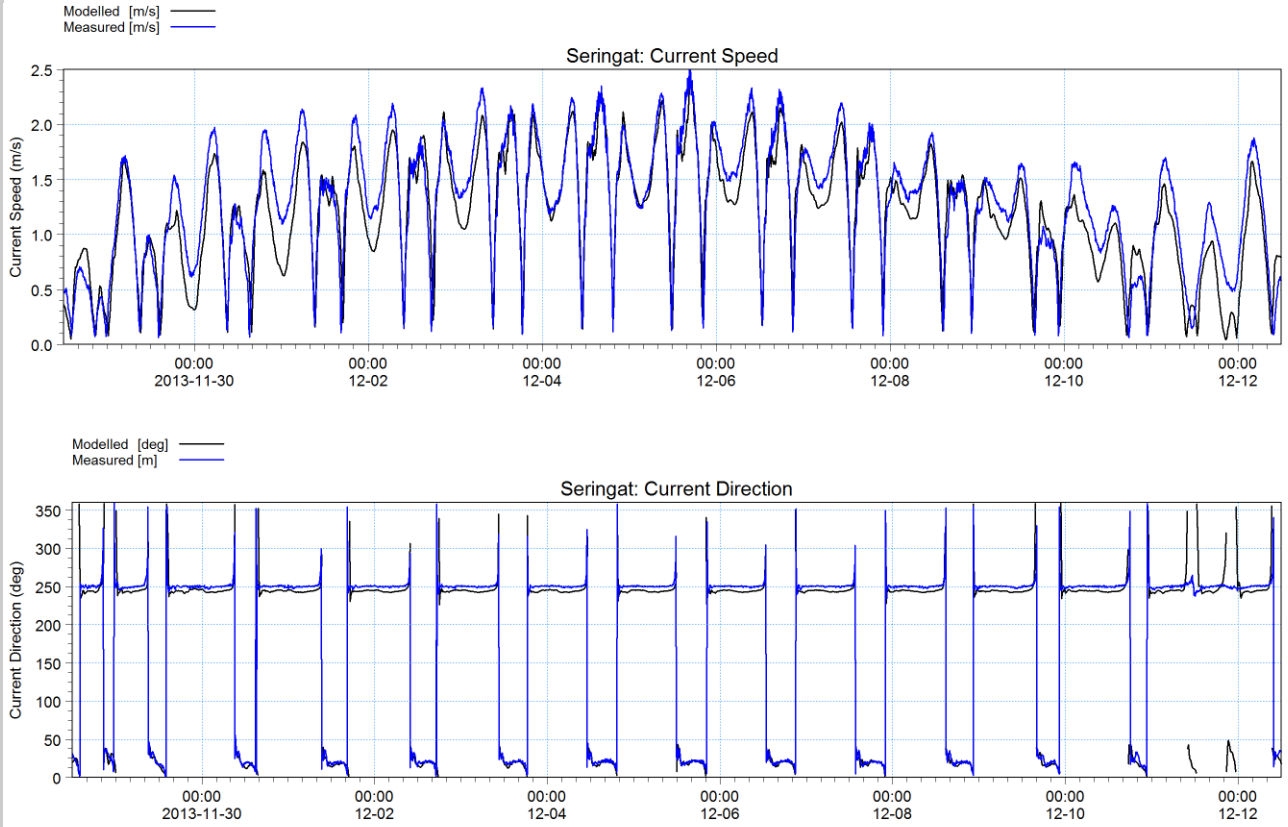
- First cushion roller to be able to produce electricity
  - Translate to cost savings
- Impact absorbing mechanism has potential for extended lifespan

<u>As a Wave Energy Device</u>

- Device is completely above water
  - Translate to reduced corrosion
  - Easier access for installation, maintenance and repair
- Able to generate under small waves conditions
  - Translate to greater range of application

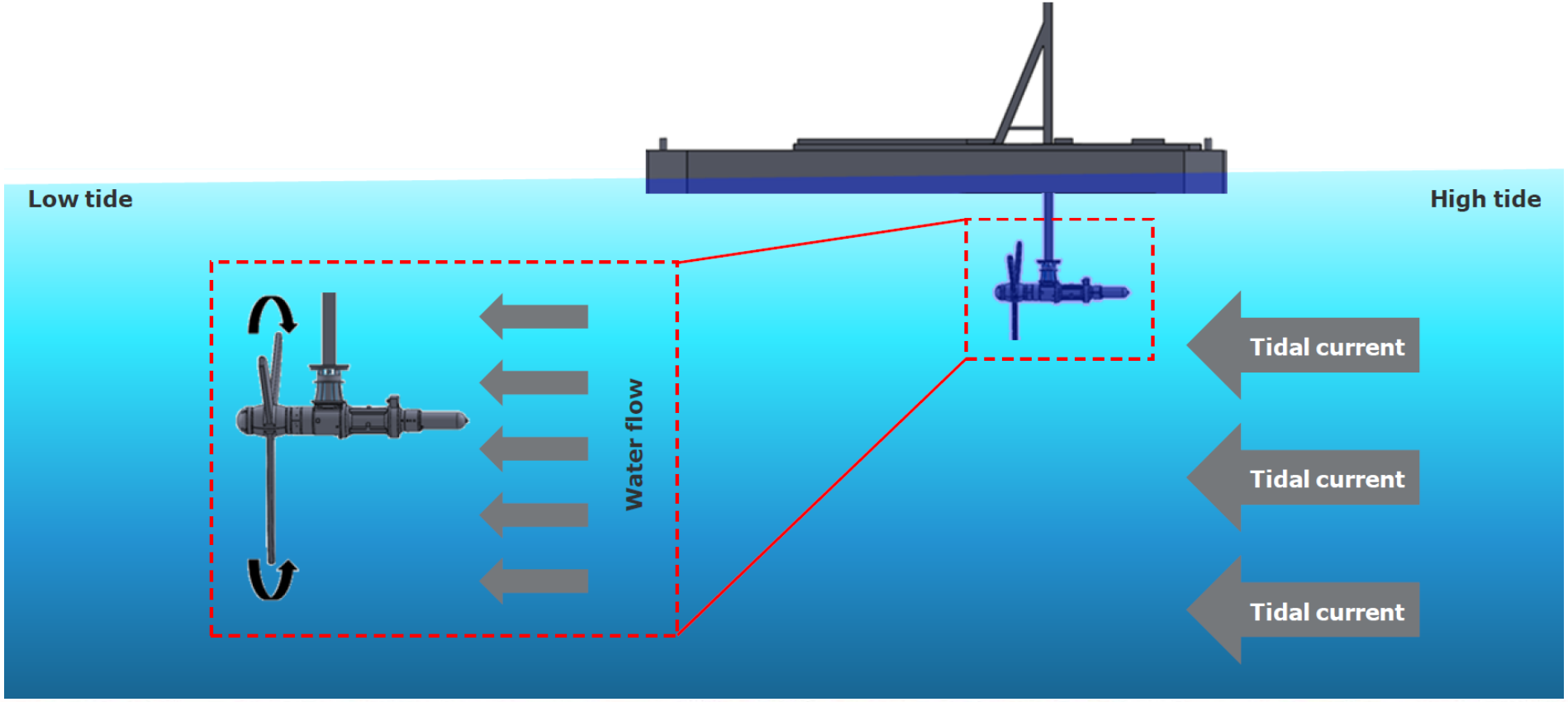
Tidal Currents: Visualized Examples



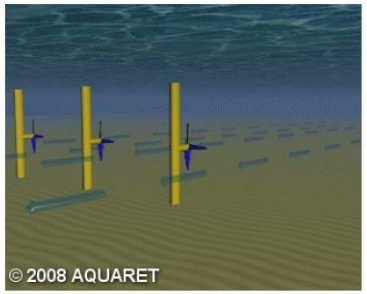


How tidal in-stream power generation works

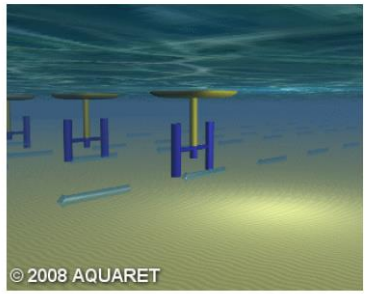
The influence of the moon and sun's gravity on the ocean produces high and low tides which create tidal currents in the coastal areas. The energy of the current which will drive the turbine rotation is forwarded to the generator and converted into electrical energy.



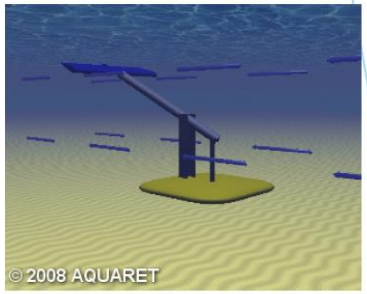
Flow / Current / In-Stream (e.g. Tidal, Ocean) Technology Type & Examples



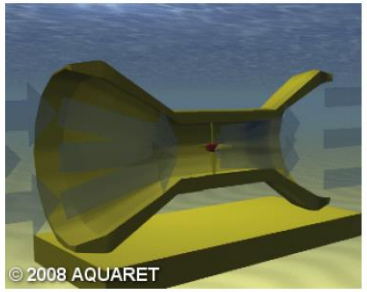
Horizontal axis



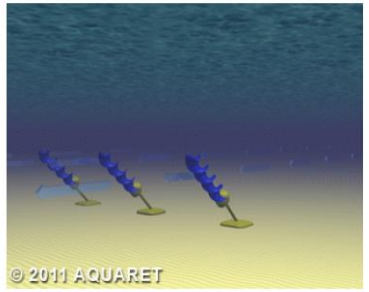
Vertical axis



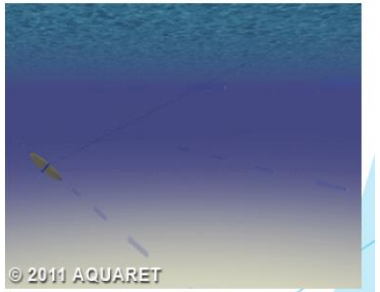
Oscillating hydrofoil



Ducted housing/Venturi



Archimedes Screw



Tidal Kite

New Energy Corp.

ENVIROTEK Demo: 70kW


Guinard (3.5kW to 20kW)


Orbital Marine (2MW)

Sabella (500kW to 1MW)

SME (280 to 420kW)


SIMEC Atlantis (2MW)


Nova Innovation (100kW)


Minesto(50kW)


Mako (~5kW to 20kW)

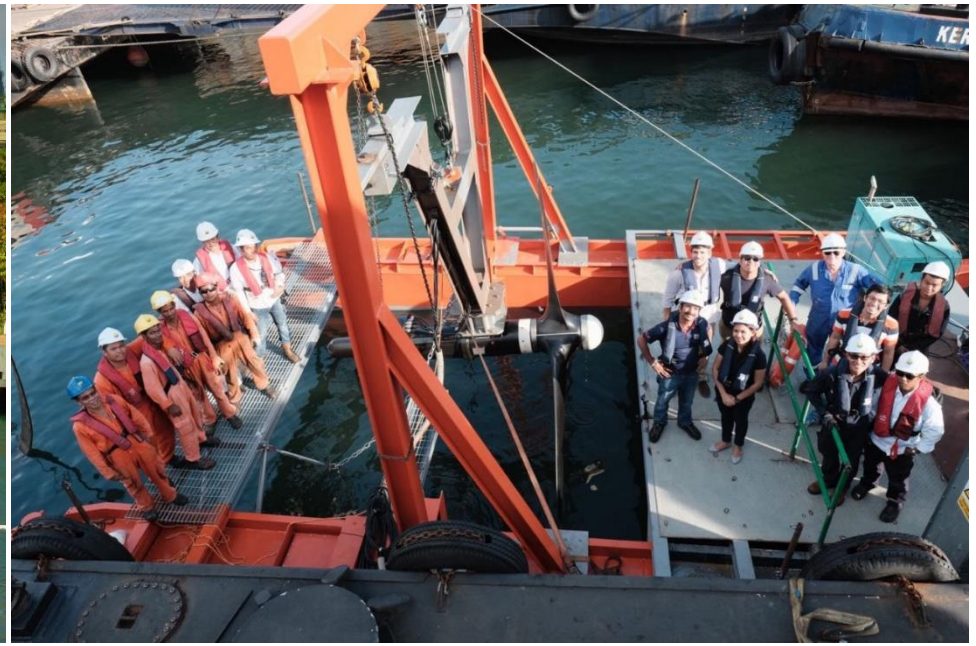
ORPC


New Energy Corp.

TIDAL IN-STREAM ENERGY DEMONSTRATION IN SG (50kW)

Client: Envirotek Pte Ltd **Collaborators:** Schottel Hydro, OceanPixel, LitaOcean, Sentosa, Aquatera, Orcades Marine, ITP, Braemar Offshore

Start: November 2015 *Deployment: February 2017* *End: February 2018*



OceanPixel

Envirotek Tidal Demo Project in Singapore (~3mins)

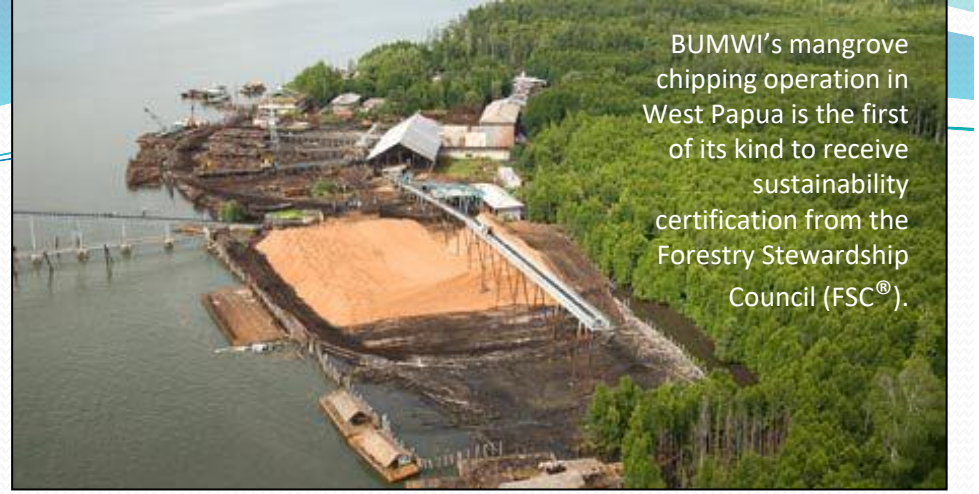
ENVIROTEK

NANYANG TECHNOLOGICAL UNIVERSITY
Energy Research Institute @ NTU

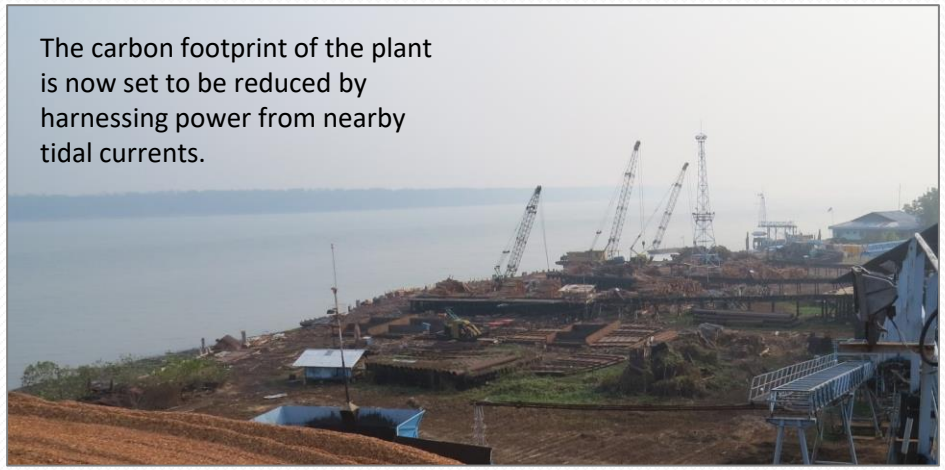
OceanPixel
fluid . energy . intelligence
www.oceanpixel.org

Lita Ocean Pte Ltd
www.litaocean.com

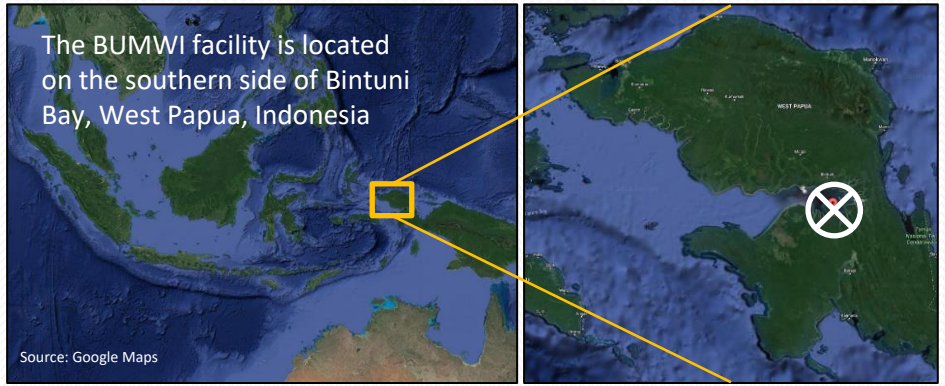
https://vimeo.com/212361278



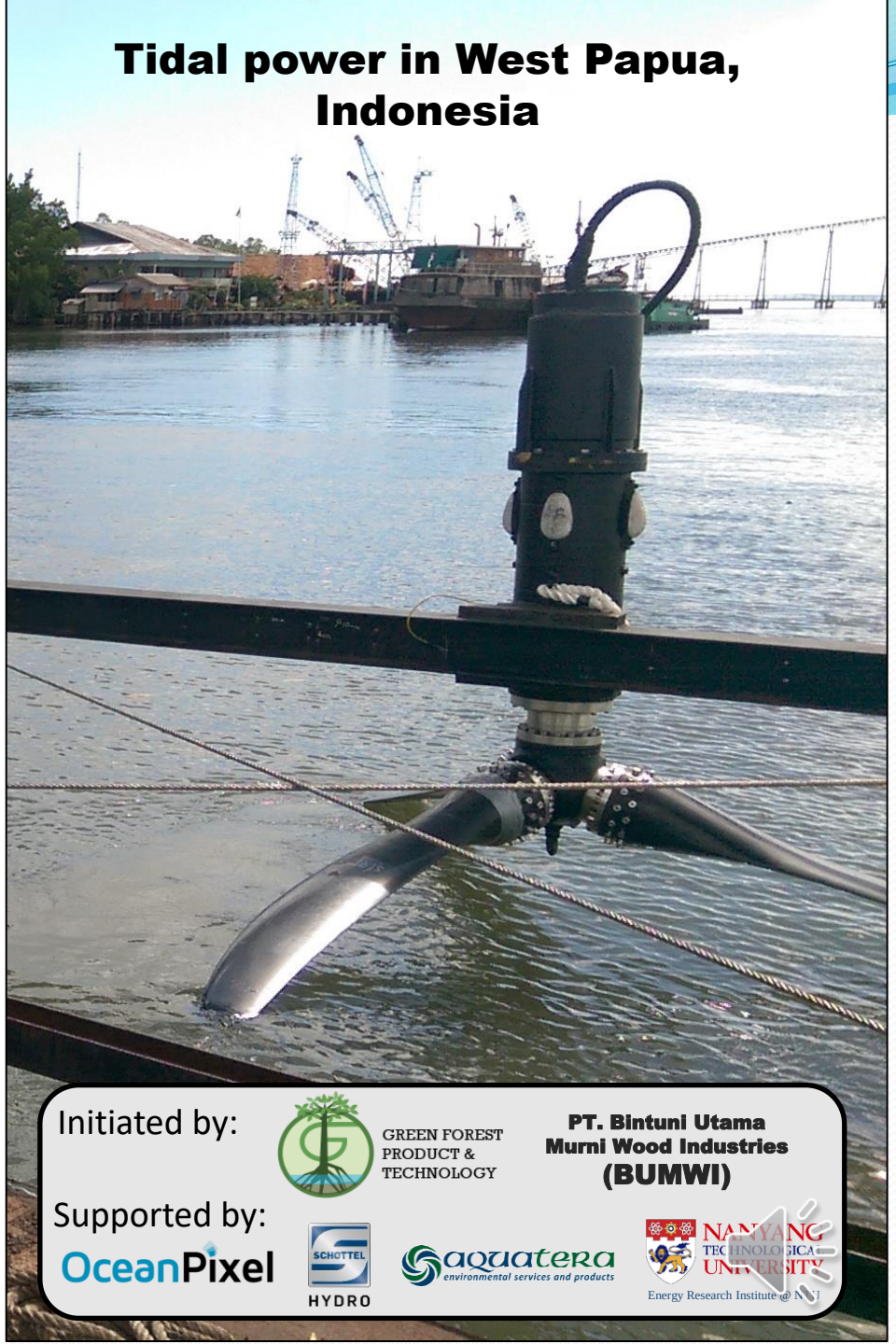
BUMWI's mangrove chipping operation in West Papua is the first of its kind to receive sustainability certification from the Forestry Stewardship Council (FSC®).



The carbon footprint of the plant is now set to be reduced by harnessing power from nearby tidal currents.



Tidal power in West Papua, Indonesia



Initiated by:

GREEN FOREST PRODUCT & TECHNOLOGY

PT. Bintuni Utama Murni Wood Industries (BUMWI)

Supported by:

OceanPixel

SCHOTTEL HYDRO

aquatera environmental services and products

NANYANG TECHNOLOGICAL UNIVERSITY

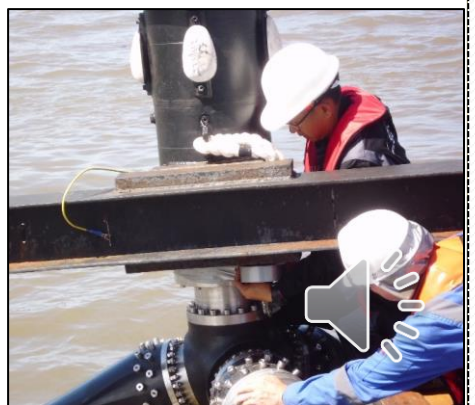
Energy Research Institute @ NTU

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

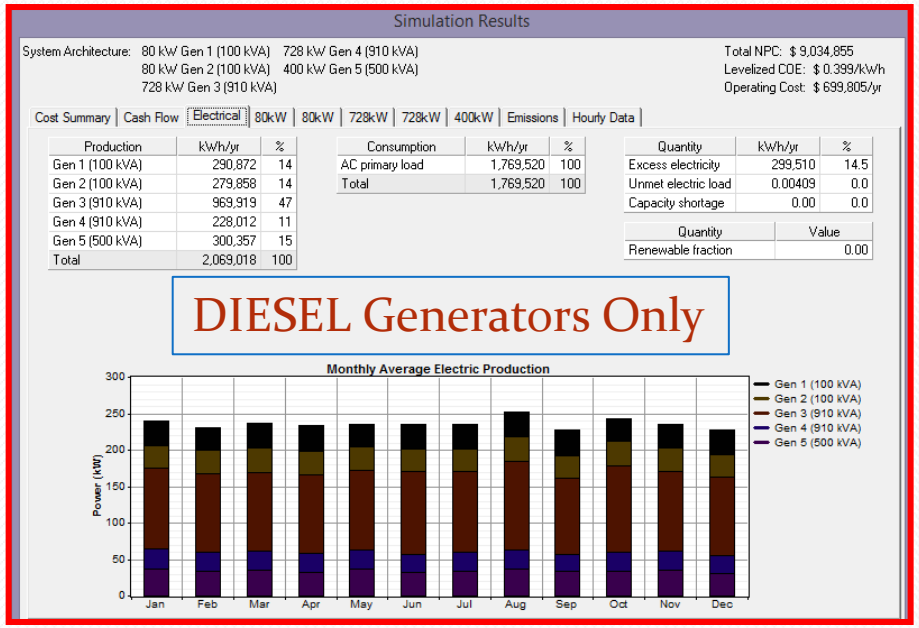
The tidal turbine is suspended below a floating barge in a simple and robust arrangement which allows for straightforward inspection and maintenance and can be easily replicated.

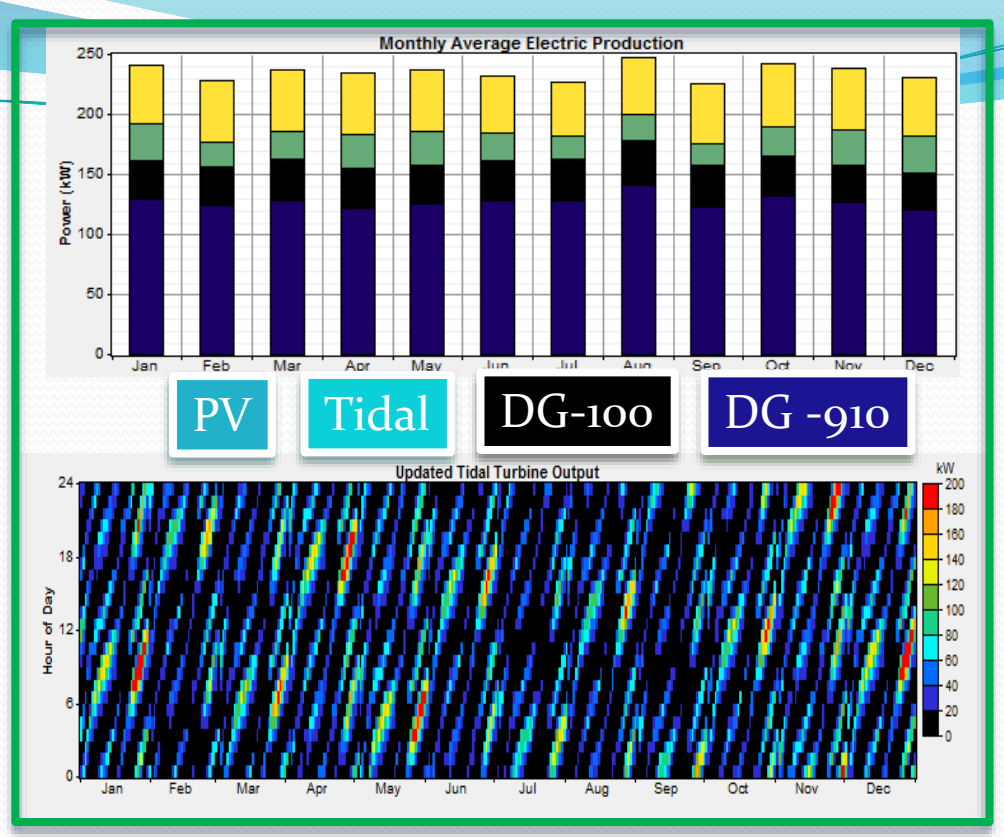
The project has proven the capability of a multi-company team to develop, implement and successfully deploy a tidal turbine in one of the most remote and areas of Indonesia.

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 an 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

Philippines' Potential Sites for Tidal In-Stream and Wave Energy

Philippines has more than 7 thousand islands, including remote islands which either do not have electricity access or rely heavily on diesel power generation. Some of these areas are suitable for tidal in-stream and wave energy power generation development.

Philippines' tidal in-stream and wave energy potential

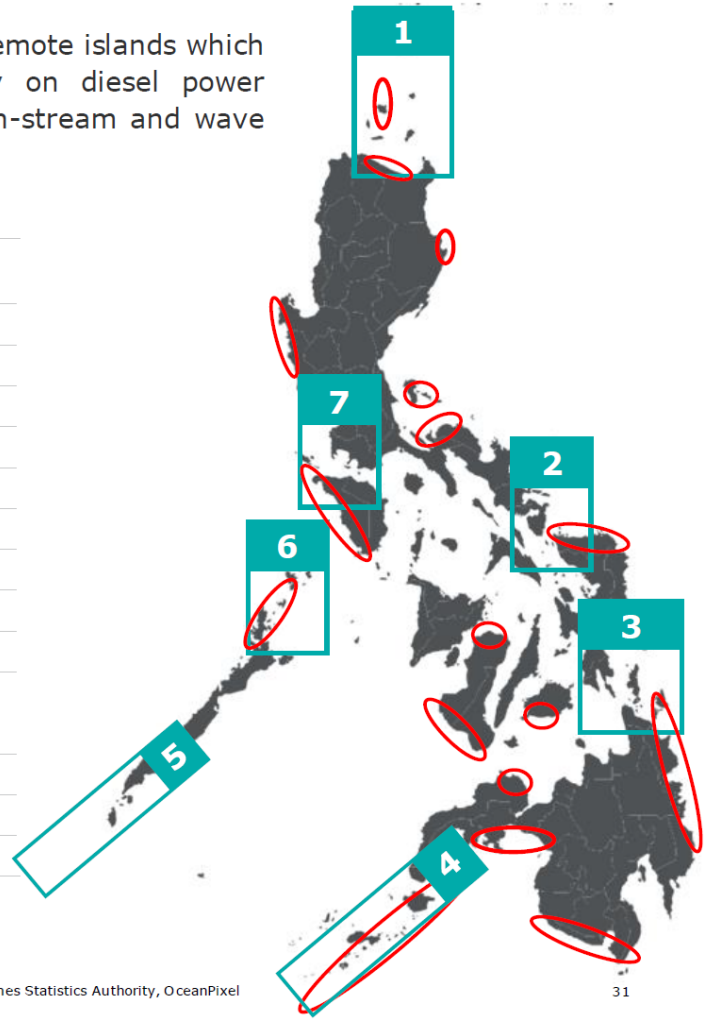
No	Province / Region	Electrification rate*	Population (million)
1	Cagayan / II	91.8%	1.20
2	Catanduanes / V	88.7%	0.26
	Sorsogon / V	88.7%	0.79
	Northern Samar / VIII	87.2%	0.63
3	Southern Leyte / VIII	87.2%	0.42
	Surigao del Norte / XIII/Caraga	93.8%	0.49
4	Basilan / ARMM	38.7%	0.35
	Sulu / ARMM	38.7%	0.82
	Tawi-tawi / ARMM	38.7%	0.39
5	Palawan / IV-B	82.2%	0.85
6			
7	Batangas / IV-A	96.3%	2.69
	Occidental Mindoro / IV-B	82.2%	0.49
	Oriental Mindoro / IV-B	82.2%	0.84

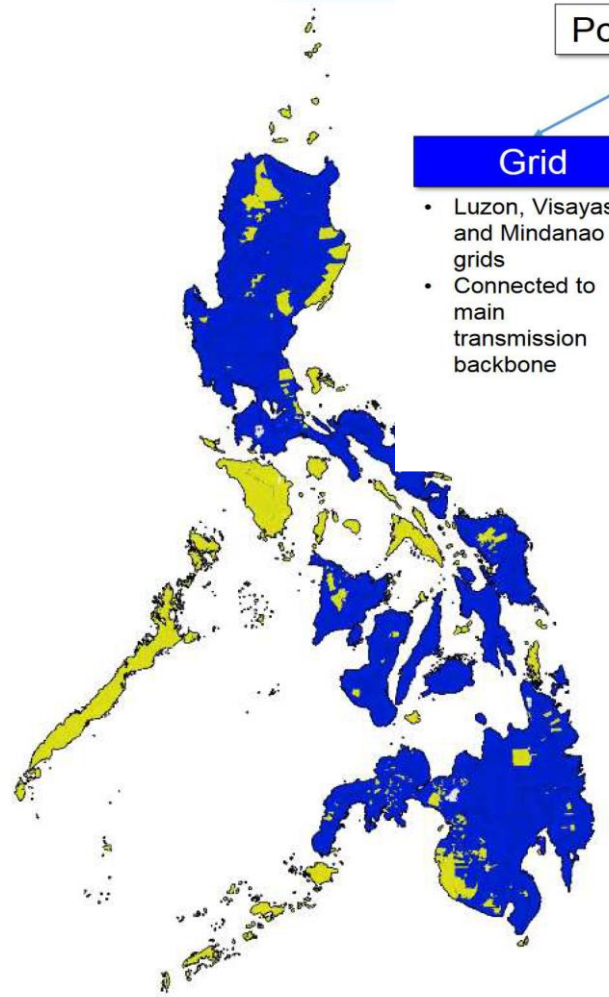
identified tidal current energy reserves

identified wave energy reserves

* electrification rate are identified in Region level

Source: Energy Research Institute at Nanyang Technological University, Philippines Department of Energy, Philippines Statistics Authority, OceanPixel





Power System

Grid

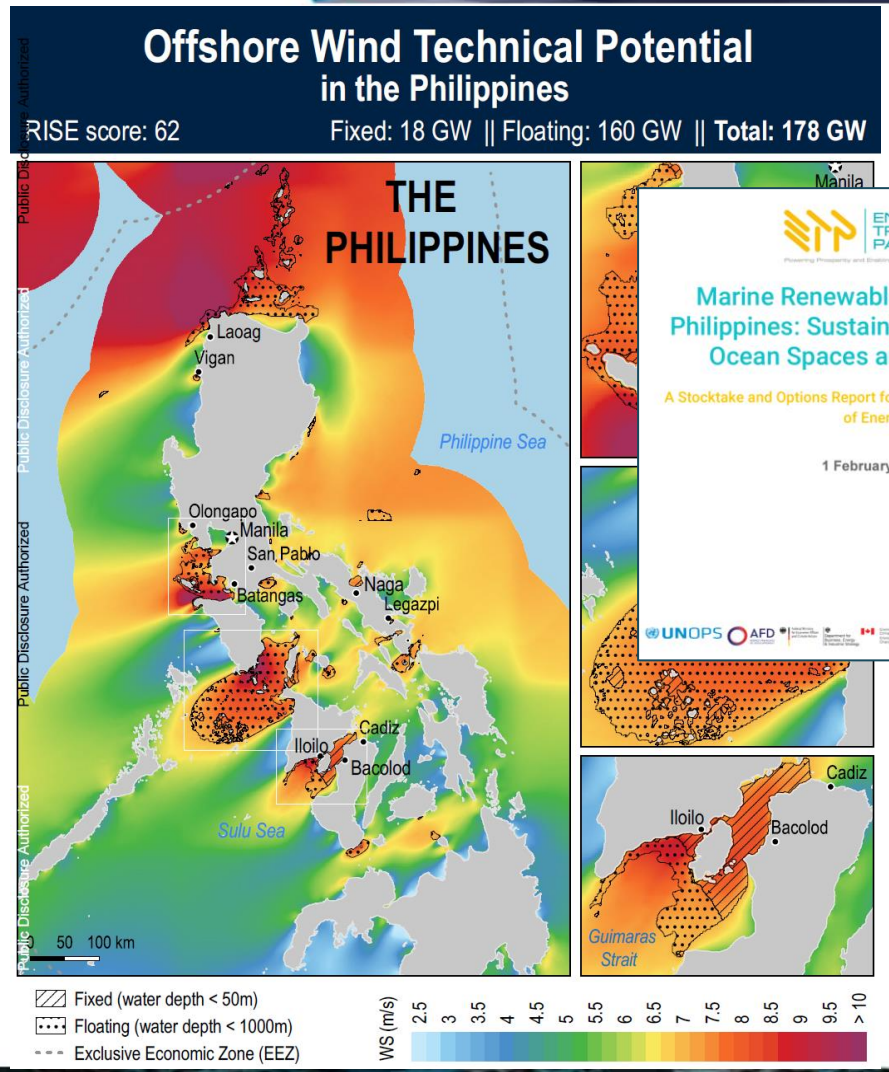
- Luzon, Visayas and Mindanao grids
- Connected to main transmission backbone

Off-Grid

- Missionary areas
- Also known as Small Islands and Isolated Grid (SIIG)
- Power supplied by NPC SPUG and Private Sector (New Private Provider and Qualified Third Party)

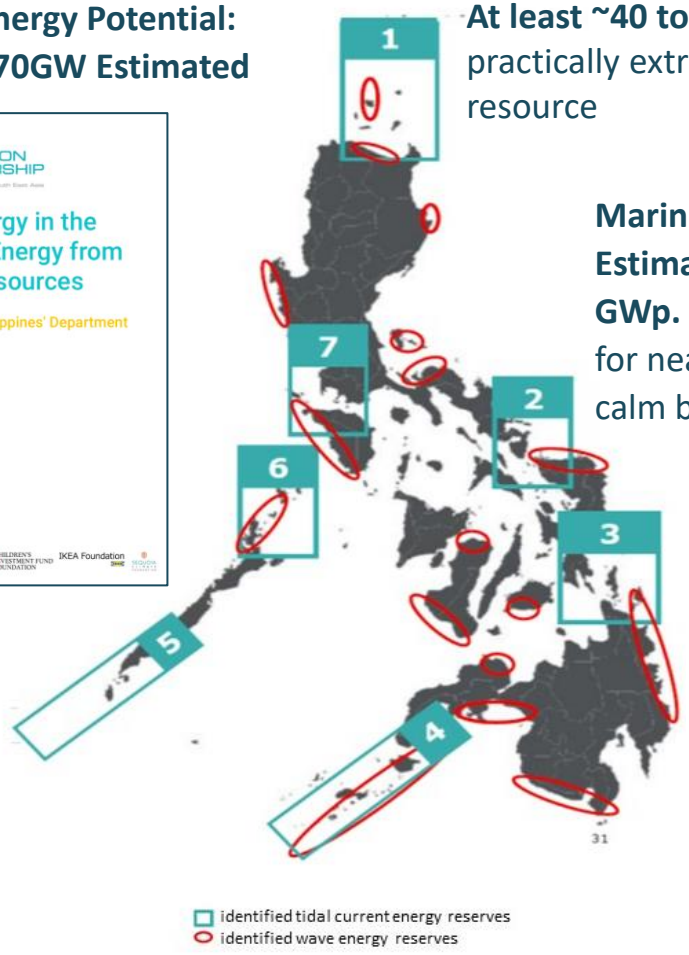
Philippines Marine Renewable Energy (MRE) Resource Maps

https://www.energytransitionpartnership.org/resource/marine-renewable-energy-in-the-philippines-sustainable-energy-from-ocean-spaces-and-resources/



Ocean Renewable Energy Potential: 170GW Estimated

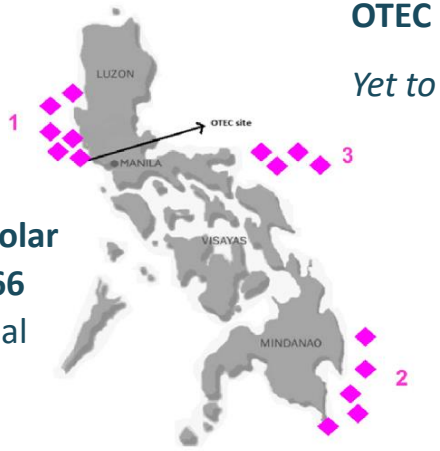
Tidal In-Stream (Current) At least ~40 to 60GW of practically extractable resource



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

OTEC Potential

Yet to be quantified

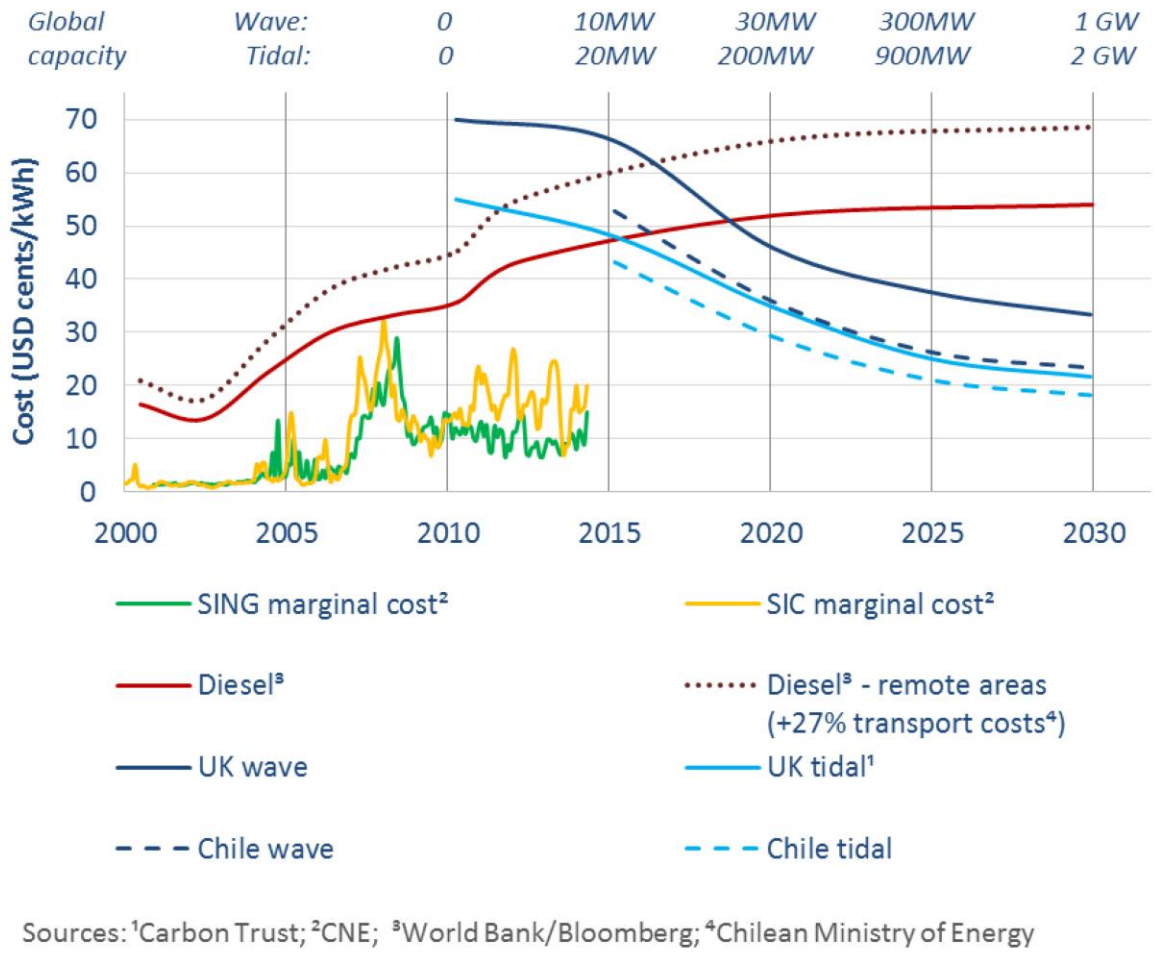


OTEC Route to Grid Parity

Wave Potential

Yet to be quantified

Wave and tidal



Sources: [1]Carbon Trust; [2]CNE; [3]World Bank/Bloomberg; [4]Chilean Ministry of Energy

Marine energy markets:

LONG TERM
Grid electricity

MEDIUM TERM
Diesel replacement; water pumping and desalination (mines)

SHORT TERM
Remote diesel replacement

In the HYBRIDShip project of Fiskestrand Holding launched in 2016, a diesel-powered ferry was converted to hydrogen.

"Energy Observer" is currently touring the world to demonstrate the potential of hydrogen as a power source.

Electrification of Maritime Transportation – “E-Boats”

Asset – Electric outrigger vessel: pilot and market demonstration

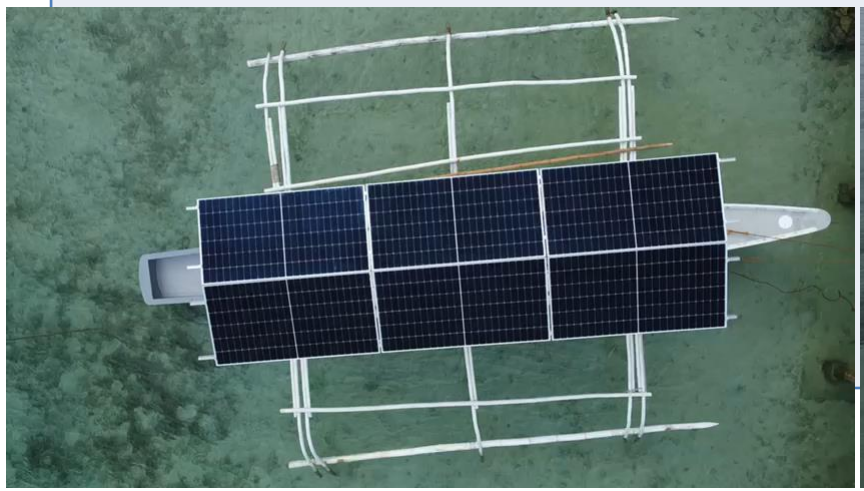
Vision – a clear transition to green maritime transport solutions, supported by sustainable business ecosystems which help protect marine and coastal resources and communities

Overview – The incubation and delivery of this asset will increase the long-term sustainability of marine ecotourism, fishing and maritime transport in ‘sustainable island states’ by replacing traditional diesel engine boats by low carbon fleets and vessels with clean, affordable and reliable electric propulsion systems, which can be charged locally using renewable energy-based electrical infrastructure.

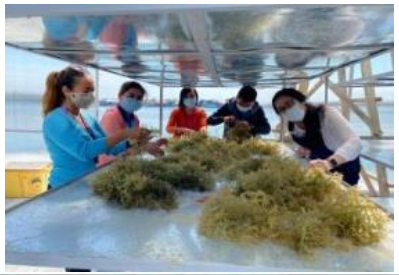
Opportunity – through this asset, the Company can establish itself at the forefront of the decarbonation of maritime transport sectors with key local delivery partners in South East Asia. Roll-out and scaled uptake of the asset will also require local renewable energy generation to support charging and other associated infrastructure, creating wider opportunities for the Company and its partners.

Traditional passenger ferry, Samal, Philippines

Traditional whale watching boat, Donsol, Philippines



I-PURE: Integration of Productive Uses of Renewable Energy Mindanao, Philippines



The inextricable linkage between water, energy, and food

I-PURE MINDANAO

Integration of Productive Uses of Renewable Energy for Inclusive and Sustainable Energization in Mindanao

PURE PICONG
Picong, Landao Del Sur
Solar Powered Water Pump

PURE TULUNAN
Tulunan, North Cotabato
Solar Powered Corn Sheller and Miller

PURE ARAKAN
Arakan, North Cotabato
Solar Powered Corn Sheller and Miller

PURE KIDAPAWAN
Solar-powered rice miller

PURE GLAN
Glan, Sarangani Province
Solar-Powered Ice Maker

COTELCO PVM
1500 Households
Locations TBD

PURE NINOY AQUINO
Ninoy Aquino, Sultan Kudarat
Solar-Powered Water Pump

PURE TAWI-TAWI
Sitangkai and Sibutu, Tawi-Tawi
Solar Powered Seaweeds Dryer

TAWELCO Barangay Line Extension Project
2184 Households
Sibutu and Sitangkai, Tawi-Tawi

PURE KALAMANSIG
Kalamansig, Sultan Kudarat
Solar Powered Coffee Dryer and Miller

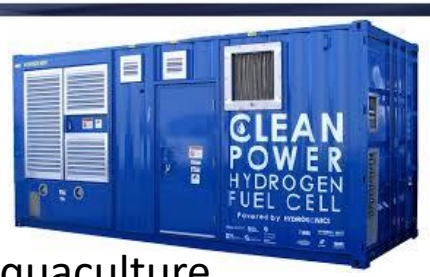
PURE LEBAK
Lebak, Sultan Kudarat
Solar Powered Water

PURE BAGUMBAYAN
Bagumbayan, Sultan Kudarat
Solar-powered Corn Sheller and Miller

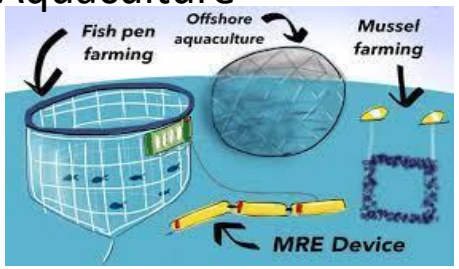
SOCOTECO II PVM
1577 Households
Glan, Sarangani Province

Scoping Demo and Pilot Project Options

Transportation



Aquaculture



Testbedding
Other Innovations
Technologies
Business Models
"Learn by Doing"

Marine Renewable Energy: Tidal In-Stream
(and/or others: Marine Solar, Offshore Wind, Wave

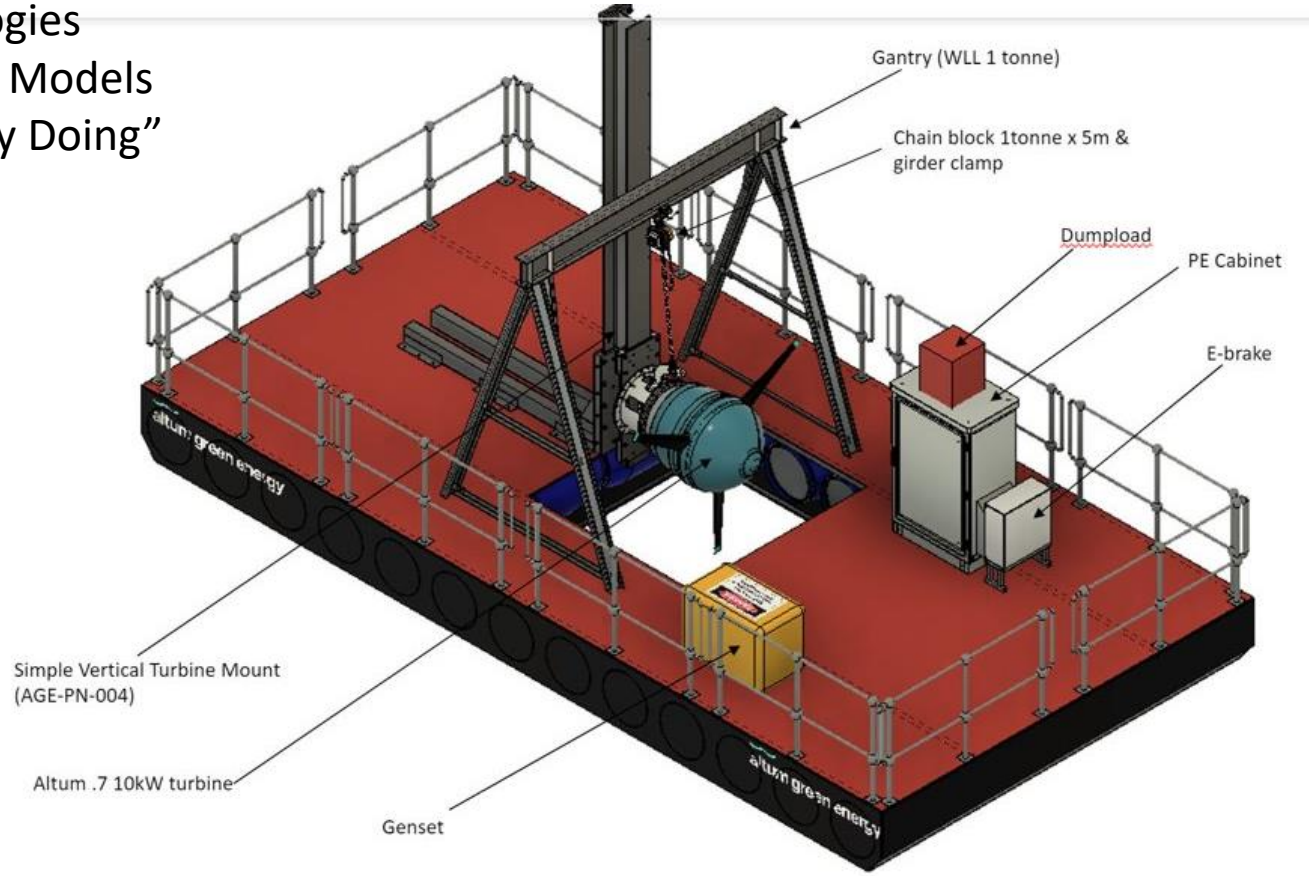
Ice

Water Production

Reef Restoration,
Marine Area Monitoring

Eco-Systems' Integration

Ports/Marinas/Bays



Water Production

Reef Restoration,
Marine Area Monitoring

OceanPixel

MARES – principles in action

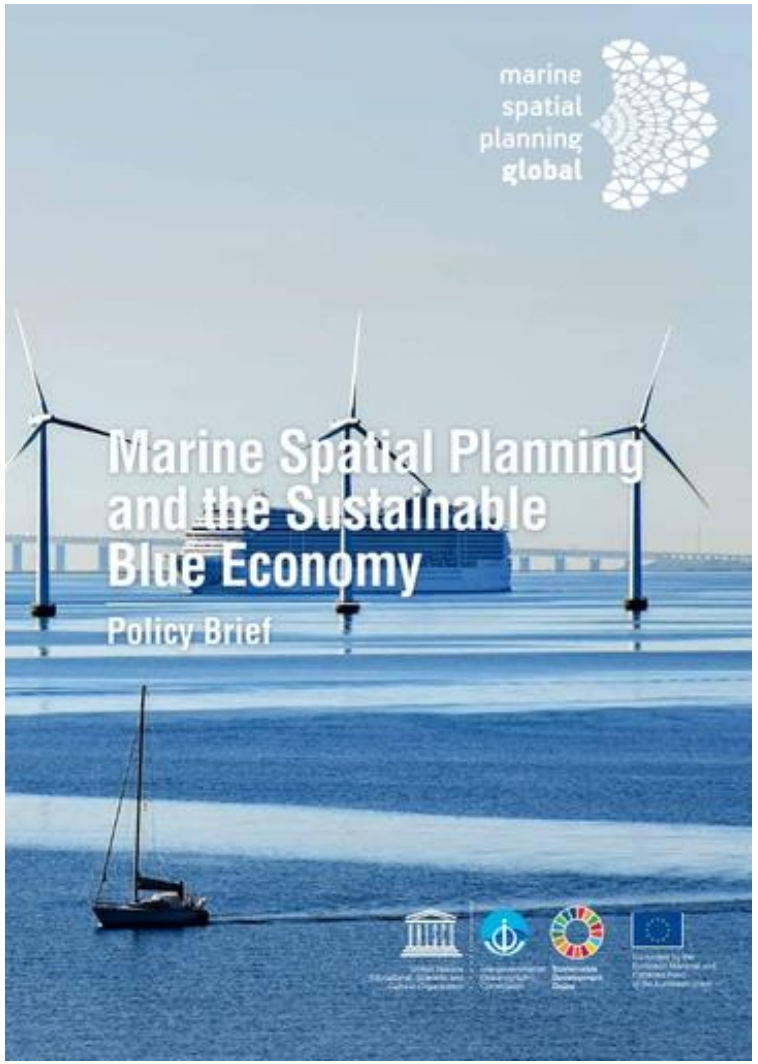
- Harnessing marine renewable energy
  - Ocean thermal energy conversion
  - Floating solar renewable energy
- Using MRE to regenerate coral reefs
- Next generation marine aquaculture
- Green marine hydrogen
- Rigs to reefs for ocean regeneration

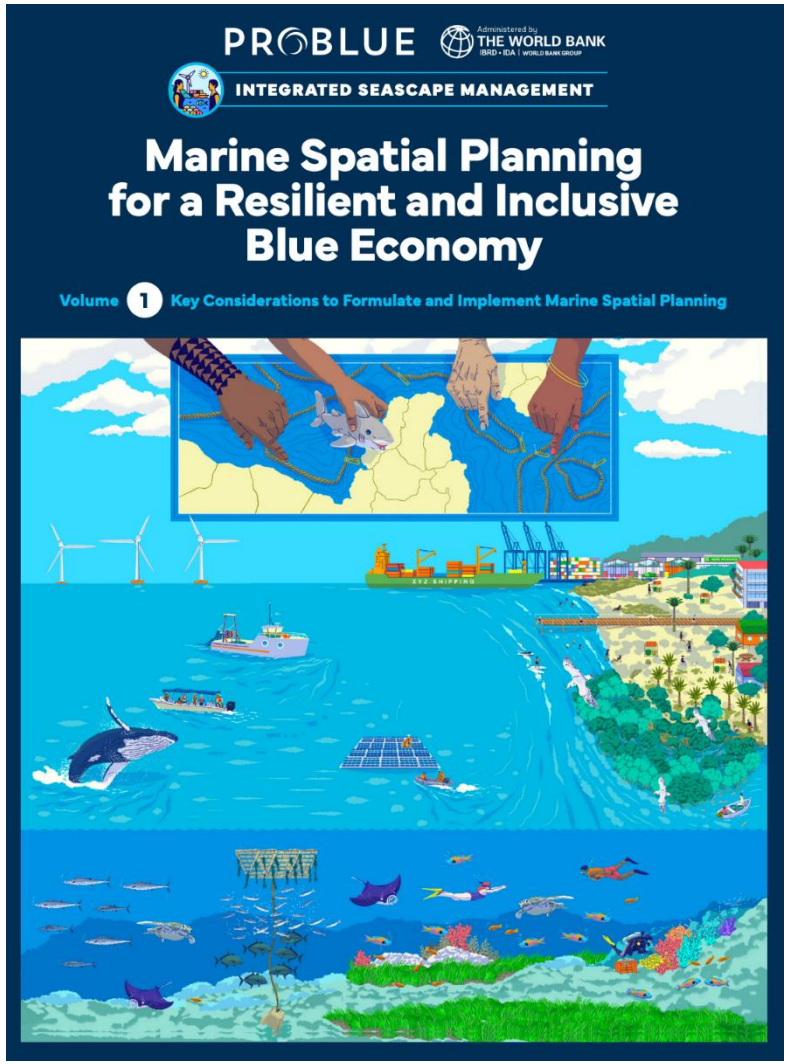
[ADB Data Room - MARES]

MARES starts with marine renewable energy…

scalable, regenerative…

MARES – integrated planning is key





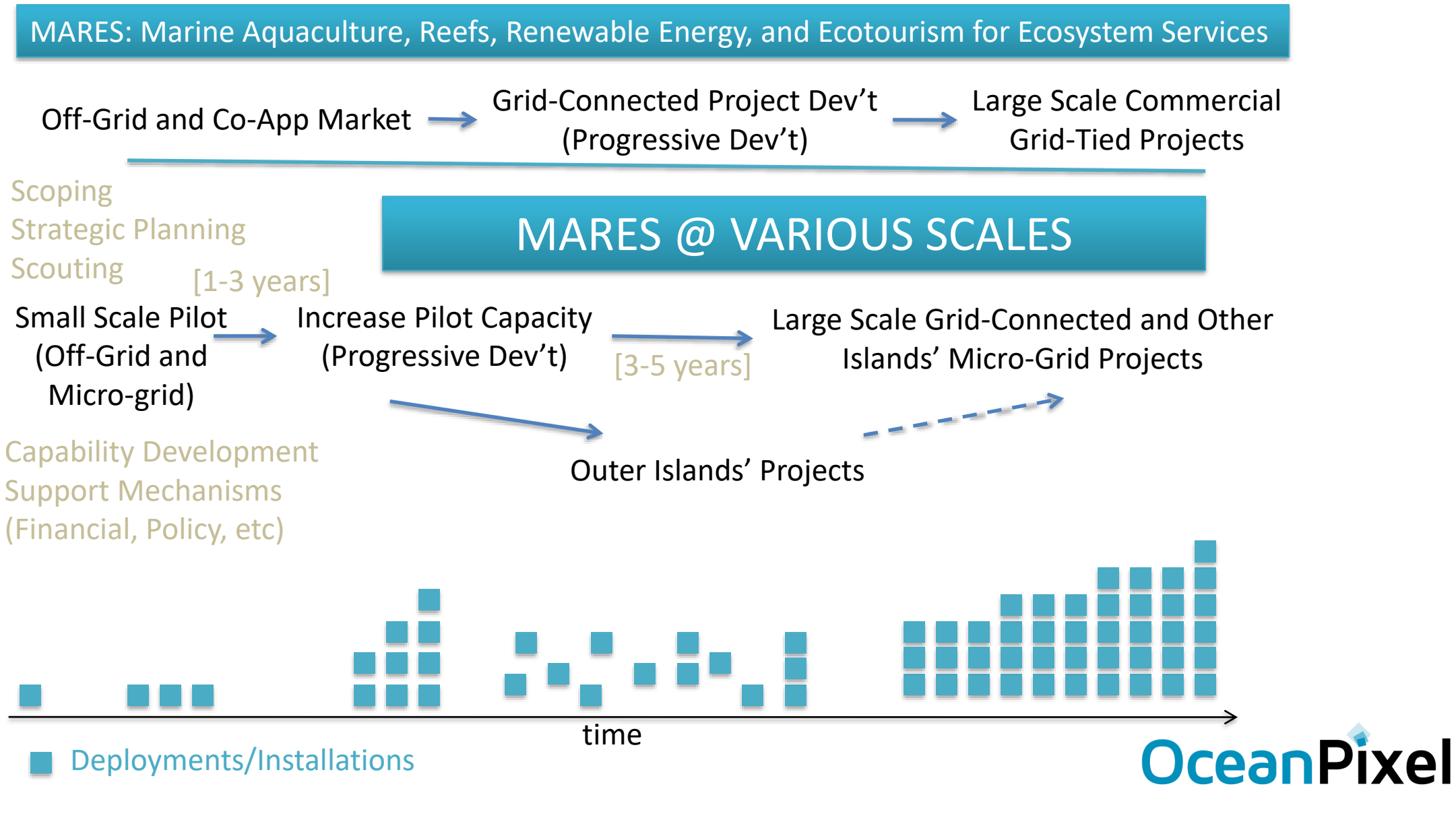
ORION Vision

Clean Energy Project

Scalable, regenerative…

ORION project team working with government, industry and infrastructure owners

Hybridized Progressive Blue Economy Dev't Pathways



OceanPixel

Treasures and Troubles

Navigating the High Blue Seas

Too few fish, too many mouths to feed

Filipinos Seafood Consumption falling from **36 kg per capita annually (1993) to 14.32 kg per capita (2018-2019)**

Philippines' Untapped Marine Riches

Despite exceptional biological wealth, there are many undiscovered species and untapped potential for biotechnological applications. Based on primary and available secondary data, the marine ecosystems (excluding the continental shelf) can contribute a conservative monetary value of **US$ 966.6 billion** to the economy (Azanza et.al., 2017)

- Blue Carbon
- Marine Pharmaceuticals e.g. .for cancer management
- Marine Cosmetics and Personal Care
- Marine Biotechnology
- Marine Minerals

Rich Seas, Poor Fishers

Php 9,804

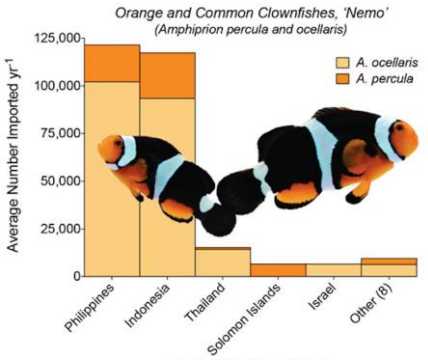
Ave. skilled fishery workers earning per month, the lowest wage rate across occupations in the country (PSA, 2022)

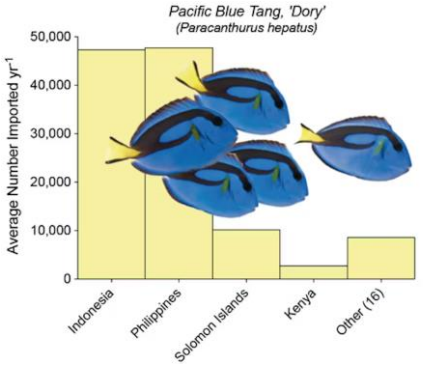
1.6 million

people contributing PhP 196 billion country's GDP for fisheries (SEAFDEC, 2018)

FINDING NEMO AND DORY

Cyanide fishing involves the addition of poison into the water in order to stun the fish. Once they have been collected, they can later be sold as live fish. © H. Hall/SeaTops.com





1,200 marine species marine ornamental species traded in the Philippines

8.9 million, 3,957 MT individuals and volume of marine ornamental animals exchanged per year, contributing **PHP 208,165,576 (FOB)** in the country's annual trade

98-100% Percentage of wild-caught native/endemic marine ornamental species traded/exported

(Muyot et.al, 2019)

CORE PROBLEMS

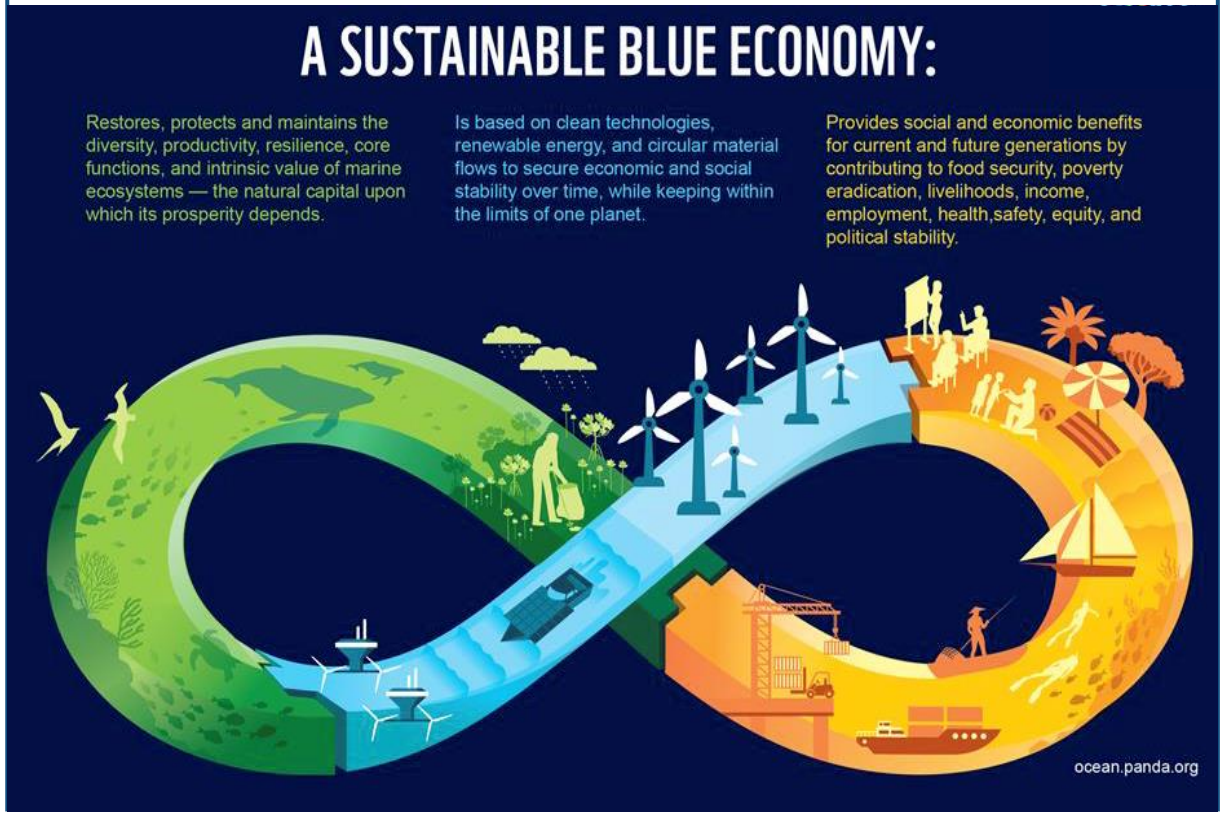
- Overfishing
- Marine Pollution
- Unsustainable Coastal Development
- Access to Finance and Technology
- Competing Interests and Stakeholder Conflicts
- Poverty
- Climate Change
- Food, Energy, and Water Security
- Loss of marine biodiversity
- Exacerbation of destructive practices for fishing
- Alteration of biota in ecosystems
- Population growth
- Lack of regulation and Enforcement
- Limited Awareness and Education
- Ocean Governance and International Cooperation

Seizing the tide of possibilities

BLUE ECONOMY:

oceans as the next great economic frontier

The UN specifies Blue Economy as a range of economic activities related to oceans, seas and coastal areas, and whether these activities are sustainable and socially equitable.



OCEAN CREST

Collaborative, Research, Education, and Stewardship for Transformative Ocean Initiative

is a **Blue Ecosystem Cluster Builder** that focused on fostering sustainable development and conservation of marine ecosystems within the framework of the blue economy. It aims to promote a harmonious balance between economic growth, improved livelihoods, and environmental health.

VISION AND OBJECTIVES

To create **a future where our oceans thrive and flourish in harmony with sustainable economic activities**. It envisions a world where collaborative efforts, cutting-edge research, and responsible stewardship of marine resources lead to thriving marine ecosystems, vibrant coastal communities, and a prosperous blue economy. Ocean CREST strives for a future where the benefits of the ocean are harnessed responsibly, ensuring the well-being of both present and future generations.

Key Objectives:

- **Sustainable Development**
- **Ecosystem Conservation and Restoration**
- **Stakeholder Engagement**
- **Policy Advocacy**
- **Capacity building and knowledge sharing**

UNIVERSITY of SAN CARLOS
QRS
OceanPixel fluid . energy . intelligence
gibeon consultancy corporation

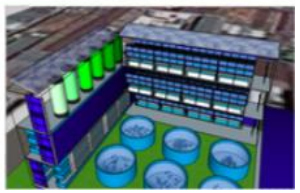
Blue Projects and Technologies

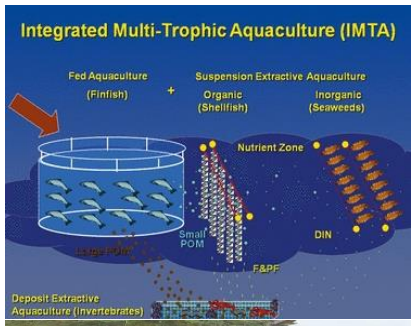
PRODUCTION
FISHERIES & MARICULTURE

OCEAN CREST LAB.

Location: USC Marine Station, Maribago, Lapu-lapu City

The **OCEAN CREST LAB**, is a groundbreaking initiative in transformative regenerative mariculture practices. This state-of-the-art facility pioneers sustainable methods that drive innovation across multiple sectors in **seafood, marine ornamental, pharmaceuticals, food additives, nutraceuticals, and cosmetics**.





PORTERAGE
MARITIME TRANSPORT

POWER FOR PRODUCTIVE USE
OCEAN / MARINE RENEWABLE ENERGY FOR FOOD, TRANSPORT, WATER (Desalination)

Marine Solar | Offshore Wind | Tidal In-Stream| Wave | Productive Use of RE

PROTECTION
CONSERVATION & RESTORATION

REEF STOCK ENHANCEMENT REGENERATION

MARINE ANIMAL RESCUE

POLICY
OCEAN GOVERNANCE & S

CARBON ASSET INVENTORY MONITORING PLANNING DEVELOPMENT MANAGEMENT

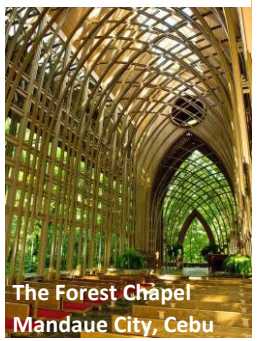
PHARMACEUTICALS
MARINE BIOTECHNOLOGY

Marine Medicine: Uncovering the Cancer Pharmacy beneath the waves

*In vitro investigating of anticancer activity of **focuxanthin** from marine brown seaweed species*

PLEASURE
REGENERATIVE TOURISM

MANGROVE MANDAUE MANGROVE ECOPARK



BLUEAPP.

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Riding the sustainable tide: Anticipated Impacts from Ocean 'CREST' Commitments

OCEAN CREST

Climate Change Mitigation | Biodiversity Conservation | Pioneering Research & Dev't
Enhancing Food + Energy + Water Security & Supply of Sustainable Raw Materials
Advancing Sustainability Promoting Economic Growth | Public Awareness and Education
Ocean Literacy | Conservation of Marine Biodiversity | Community Empowerment | Policy Influence

C- Conscientious. We commit to promoting and supporting sustainable economic activities that utilize ocean resources responsibly. This involves identifying and promoting industries such as sustainable fisheries, marine tourism, renewable energy, and aquaculture that contribute to the blue economy while minimizing negative impacts on marine ecosystems.

R - Regeneration. We will actively engage with various stakeholders, including local communities, vulnerable groups, businesses, and government agencies. By involving these stakeholders, our project aims to foster collaboration, ensure inclusivity, and leverage diverse perspectives to create effective strategies for sustainable blue ecosystem management.

E – Enabling. We actively contribute to policy discussions and advocacy efforts related to the blue economy and marine conservation. Ocean CREST provides scientific expertise, research findings, and recommendations to policymakers, aiming to influence the development and implementation of regulations and policies that support sustainable ocean management.

S- Safeguarding. We emphasize the conservation and restoration of marine ecosystems. This includes implementing measures to protect vulnerable habitats, restoring degraded areas, and promoting sustainable fishing practices to ensure the long-term health and resilience of the ocean.

T – Transformative. Ocean CREST focuses on enhancing the understanding and capacity of stakeholders in sustainable ocean management. This involves organizing training programs, workshops, and knowledge-sharing initiatives to disseminate best practices, promote awareness of marine conservation issues, and facilitate the adoption of sustainable approaches.

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Sustainability + Impact Investment

USD ~5M (PhP ~285M)

5-year program (>10 projects)

IMPACT BY THE NUMBERS

>0.300M people of which majority are local, women and youth, will have livelihood in various sectors, including mariculture operations, processing and packaging, research and development, and tourism-related services. This job creation (direct and indirect) helps stimulate local economies, reduce unemployment rates, and contribute to overall economic well-being.

a significant portion, from **10% up to 100%,** of the stock produced is for the sole purpose of stock enhancement (rewilding).

10 parks in 10 years Through careful planning, implementation, and monitoring, the mariculture parks can realize its potential as a model of sustainable aquaculture, benefiting both present and future generations.

>10M (USD) annual revenue generation potential that can positively impacts society through job creation, economic growth, social investments, and sustainable practices.

Building the Sustainable Future Blue Economy

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Enabling MARES
(Marine Aquaculture, Reefs, Renewable Energy, & Ecotourism for Ecosystem Services)

Long-Term Sustainability
Global Competitiveness
New Products & Services

Regenerative Marine Industries

Hydrogen Economy, etc

Impact-Driven Projects

Inward Investment

Coordination

Alignment

Capability Dev't

Synergy

Offshore
Marine
Maritime
Logistics
Clean Tech
Energy
Intelligence

Enriched Regional Ecosystem

Marine & Maritime Sustainability Hub Stage

Seed stage

Various Efforts

Agencies

R&D

Pilots

Network

SMEs

Industries

Tools and Ecosystems

- Dashboarding, Geographic Information System (GIS)
- Marine Spatial Planning, Techno-Economics
- Computer Vision, Artificial Intelligence / Machine Learning
- Augmented Reality , Virtual Reality, Mixed Reality
- Internet-of-Things (IoT)
- Collaborative Perception
- Nature-based Solutions
- Multi-Sectoral Synergies: Food-Water-Energy Nexus, etc
- And more!

CARBON ASSET INVENTORY MONITORING PLANNING DEVELOPMENT MANAGEMENT

Potential Cohesive, Synergistic, Multi-Function Pilot Projects towards Blue Economy Development







REEF REGENERATION STOCK ENHANCEMENT

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

Systems and Eco-Systems' Integration

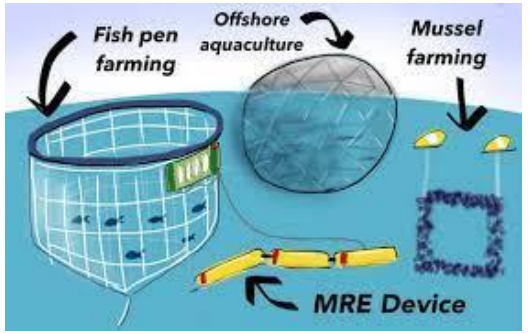
Energy Storage

Testbedding
Other Innovations
Technologies
Business Models
"Learn by Doing"

Transportation

Ice

Aquaculture



Ports/Marinas/Bays

Water Production

Reef Restoration,
Marine Area Monitoring

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Summary / Conclusions / Recommendations

- **Blue Assets Exist (Huge, yet to be tapped Potential)**
  - Food, Energy, Water, Marine Space, and more!
    - Mangroves, Seagrass, Coral, Seaweeds,…
    - Marine Solar, Offshore Wind (both already commercially viable), Tidal Currents, and Waves, OTEC, & (maybe) Salinity Gradient
    - Tourism, Transport, Shipping, Fishing, Aquaculture,
  - Need for a **Resource & Expertise Inventory** + Review and Suitability Studies for Pilot Projects
- **Progressive Development Approach Towards a Blue Economy**
  - Holistic Awareness and Establishment of a Local, Regional, and National **Knowledge Hubs**, Frameworks, & Strategies
  - Leverage the Marine/Maritime Ecosystem of the Country/Region(s)
  - Capability Development – Local Supply Chain (especially Services)
  - Demonstration and Pilot Projects can accelerate the uptake
  - Hybrid Systems and Co-Application will be key to success
- **"Blue-Greening" Marine and Maritime Ecosystems**
  - Lower Hanging Fruits – Green Vessels, Green Ports, Blue Loops / Clusters, etc
  - **'Blue Mindset'** for Suite of Applications/Technologies/Solutions/ Sectors – Energy, Transport, Aquaculture, Water, Ice, Tourism, Hydrogen, Blue Carbon, Others?
  - Detailed planning of a Sustainable Integrated Development for Islands and Coasts

Thank You! ☺

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