Volume 36 | 季刊 Quarterly

國際海洋資訊
International Ocean Information

Vol. 36
2025 AUTUMN

專題人物 People Stories | 藍色經濟 Blue Economy | 海洋永續 Healthy Oceans and Seas | 海洋治理 Ocean Governcance

塑膠污染協商
Plastic Pollution Negotiation

2025臺灣海洋國際論壇
2025 Taiwan International Ocean Forum

海洋委員會 Ocean Affairs Council

Editor's Note

In July, the Ocean Affairs Council hosted the 2025 Taiwan International Ocean Forum, bringing together representatives from over fifteen countries and more than a hundred political and economic leaders and experts in Taipei for high-level dialogues on national security and the blue economy. Alongside Issue 35 of International Ocean Information, which focused on "Maritime Security," this issue examines the "Blue Economy," exploring energy, finance, society, governance, and ecology at the intersection of global vision and local practice.

The blue economy refers to 'the sustainable use of ocean resources to promote economic growth, improve livelihoods and employment, while maintaining the health of marine ecosystems. In 2023, it was valued globally at USD 3–6 trillion and at around NT$1.22 trillion in Taiwan, or 5.4% of GDP.

This special issue presents a diverse set of perspectives. In the energy sector, Chairman Min-chieh Chuang highlighted wave, current, and thermal gradient energy as areas uniquely suited to Taiwan, noting that technological innovation and inter-ministerial collaboration could accelerate their industrialization. Professor Yao-jen Hsiao emphasized the "Satoumi" concept, stressing social participation and ecological restoration as key pathways for embedding the blue economy locally. From an international standpoint, Rokhmin Dahuri argued that the blue economy can serve as a strategic tool for emerging nations to strengthen global leadership, proposing mechanisms such as blue bonds and South–South cooperation. Additionally, Michael C. Huang introduced the Ocean Impact Navigator (OIN), a framework that connects capital with innovation through impact-based investment metrics.

In terms of governance, Cynthia Barzuna called for National Sustainable Ocean Plans (SOPs) to integrate conservation, economy, and security while closing funding gaps. Efrat Landau-Lev argued that seaweed should be treated as infrastructure for carbon storage, food, and climate resilience. Hila Ehrenreich advocated for scalable green innovation, urging regulatory reform to replace polluting systems. Chi-chen Chang pointed to Somaliland–Taiwan collaboration as proof that training and industry engagement can empower women as leaders in the blue economy.

This issue spotlights three changemakers. Cynthia Barzuna is shaping policy to make healthy oceans a smart investment. Minako Inoue launched the Blue Seafood Guide to guide consumers toward sustainable seafood. And Taiwanese youth Huai-pu Chen merges ocean voyages with tech skills to bring Taiwan's younger generation to the global arena.

The Ocean Affairs Council has made youth participation in global ocean affairs a top priority. At this September's Ocean Challenges International Youth Forum, over one hundred young people from fifteen countries shared proposals, with students from Japan, India, and Taiwan working together on practical ocean solutions. Thanks to the Youth Dream-Building Program, Taiwanese youth are also venturing to Japan, France, and beyond—expanding their horizons and shaping the next generation of ocean leaders.

Marine debris remains one of the toughest global challenges. While July's talks on a plastics treaty stalled, the Ocean Affairs Council pressed ahead with the Indo-Pacific Marine Debris Governance Platform—partnering with Japan's Clean Ocean Material Alliance, engaging domestic industries at Japan's Circular Economy Expo, and signing an MOA with Indonesia's Habibie Center, the platform's first international cooperation agreement. With the BBNJ Agreement close to reaching sixty ratifications, a new era of high seas governance is on the horizon. These milestones show that the blue economy must grow alongside international rules and environmental protection to ensure sustainability.

In summary, this issue of International Ocean Information not only highlights Taiwan's progress in the blue economy but also connects global perspectives to outline a shared blueprint across energy, finance, and governance. By working across disciplines, we hope to shape a sustainable, prosperous, and secure ocean future for Taiwan and the world.

Blueprints for a Sustainable Ocean: Cynthia Barzuna's Global Leadership in Blue Economy Governance

Amid the global climate crisis and mounting pressures on ocean resources and sustainable governance, Cynthia Barzuna stands out as one of the key figures driving the transition toward sustainable governance and a blue economy. With a rich interdisciplinary background and hands-on experience, she earned her undergraduate degree in law and a master's degree in international law and trade from Carlos III University in Spain, along with a specialized diploma in globalization and economic liberalization. In addition to her legal and economic expertise, Barzuna is a leading figure in the design of blue economy policy and actions on international cooperation initiatives.

After graduation, Barzuna returned to Costa Rica to serve as Vice Minister of Water and Oceans, gaining valuable policy and institutional experience. She recognized that engaging local communities and Indigenous peoples was key to successful implementation. During her term, she led the expansion of Cocos Island National Park and its marine protected areas, which enabled Costa Rica to meet its 2021 goal of protecting 31% of its EEZ and established the

country as a global leader in ocean conservation. She also introduced the Green Fins certification to reduce ecological impact and boost tourism appeal. Believing that "conservation creates economic value," she sees marine tourism, ecotourism, and sustainable fisheries as drivers of community development. These efforts enhanced Costa Rica's international standing and reflected her leadership in cross-sector coordination and sustainable governance.

Barzuna's global vision is rooted in deep local experience. She redefines the blue economy beyond the traditional "balance between conservation and development," advocating that only a healthy ocean—founded on sustainable use—can address challenges like acidification, sea-level rise, and warming. By preserving natural capital and ecosystem services, she sees conservation not as an obstacle, but as a key driver of industrial resilience, economic growth, and regional prosperity.

Cynthia Barzuna currently serves as the Global Deputy Director of the Ocean Program at the World Resources Institute (WRI), where she leads the Ocean Action 2030 coalition. She advances Sustainable Ocean Plans (SOPs) by integrating policy planning, scientific assessment, community engagement, and financial alignment—turning the blue economy into actionable national strategies.

Barzuna's promotion of Sustainable Ocean Plans (SOPs) offers a unified policy framework to address the fragmentation of global ocean governance. By integrating regulatory reform, strategic investment, marine spatial planning, integrated coastal and watershed management, and protected area systems, SOPs foster cross-sector coordination, enhance resource efficiency, and drive sustainable transformation of ocean industries.

SOPs are more than technical policy documents—they serve as essential tools for driving societal transformation toward sustainability. Aligned with the Paris Agreement, the 2030 Agenda, and the Global Biodiversity Framework, they provide countries with a blueprint for integrated management of the interactions between marine ecosystems, society, and the economy. By enhancing regulatory stability and risk predictability, SOPs attract investment, reduce development conflicts, and create livelihoods in vulnerable coastal communities. At their core, SOPs reflect an investment logic where environmental protection is not a cost burden, but a productive asset generating economic returns.

In July 2025, Barzuna was invited to speak at the Taiwan International Ocean Forum (TIOF), where she emphasized that "prosperity, productivity, and protection" are the three pillars of a sustainable blue economy, with ocean security as its foundation. She highlighted how SOPs enhance maritime domain awareness (MDA) and policy coherence, and praised Taiwan's commitment of USD 77.5 million to combat illegal fishing as a key driver of regional security and blue economic growth.

She further emphasized, "The ocean is our greatest ally against climate change, biodiversity loss, and overfishing." Through a bottom-up, integrative strategy, Barzuna demonstrates cross-sector leadership—combining institutional effectiveness with visionary goals. She reminds us that a healthy ocean is not only an environmental duty, but also the smartest investment for future economic stability.

From Science to Action —
MINAKO IUE's Ocean Sustainability Revolution

As one of the world's key maritime nations, Japan has long enjoyed abundant fisheries resources. However, traditional ocean industries now face unprecedented challenges due to compounding factors—including declining fish catches, a sharp decrease of over 30% in employment within the fisheries and aquaculture sectors between 2013 and 2022, and escalating climate change impacts such as sea level rise, coastal erosion, and increasingly severe weather events, which could cost Japan approximately 3.72% of its GDP by 2050. In response, the Japanese government has recently introduced a new policy framework centered on the "blue economy," aiming to shift industrial priorities toward emerging sectors such as offshore wind power, deep-sea mining, and marine biotechnology in pursuit of a balance between economic growth and marine ecosystem preservation. Nevertheless, if this strategy relies solely on government leadership and industrial technological advancement, it may fail to deliver a truly comprehensive and lasting sustainable transformation.

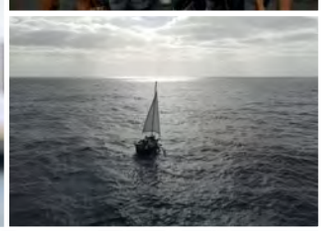
Dr. Minako Iue is undoubtedly a key driving force behind this transformation. She majored in sociolinguistics at the University of the Sacred Heart, studied installation art in London, and later moved to New York after getting married. Upon returning to Japan, she founded Sailors for the Sea Japan (SFSJ) in 2011 and currently serves as its Chair and CEO, bringing international ocean conservation principles into Japan. In 2025, Sailors for the Sea Japan was granted consultative status with the United Nations Economic and Social Council (ECOSOC). Dr. Minako Iue promotes marine protection and sustainable consumption through the integration of science, public awareness, and policy advocacy. Dr. Minako Iue holds a Ph.D. in Global Environmental Studies from Kyoto University and has served as a project researcher at the University of Tokyo's Atmosphere and Ocean Research Institute, and as a specially appointed associate professor at the Research Institute for Humanity and Nature. Her interdisciplinary background and international experience enable her to address marine issues from multiple perspectives. She exemplifies a systems-thinking approach when addressing complex environmental challenges, which sets her apart from conventional environmentalists.

She is also a key driver of Japan's blue economy. She is best known for founding the country's first science-based seafood rating program—the Blue Seafood Guide. By offering recommended seafood and transparent sources, the guide helps consumers make ocean-friendly choices, reshaping market demand and influencing industry behavior. The guide evaluates seafood, using its own scientific methodology. With straightforward classifications and accessible messaging, it enables the public to understand and support sustainable fisheries. This goes beyond public education, and serves as a market intervention strategy driven by consumer influence on the supply chain. In a country like Japan where seafood consumption is high, the Blue Seafood Guide offers a concrete way to bring the Sustainable Development Goals (SDGs) into everyday life.

In addition to her active role in policy and research, Dr. Minako Iue effectively uses the media to broaden her influence. She has long served as a regular columnist for major outlets such as Forbes Japan, 25ans, and OCEANS. She has also spoken on ocean sustainability at numerous international forums, including the 2022 and upcoming 2025 United Nations Ocean Conferences (UNOC), the Our Ocean Conferences, and the World Ocean Summit. Regardless of whether she's speaking to policymakers or to the public, she tailors her message to the audience, translating sustainability into tangible lifestyle actions and shared social values.

In 2021, she received a Special Award at the Tokyo Sustainable Seafood Summit, where she appeared alongside Tokyo Governor Yuriko Koike—a recognition of her key role in advancing Japan's marine conservation and sustainability agenda. With her cross-sector experience, strategic approach, and emotionally compelling advocacy, Dr. Iue has shown how establishing sustainability as a mainstream value in Japan can lay a solid foundation for a future of ocean-based economic and ecological harmony.

Crossing the Atlantic: Young Taiwanese Sailor Chen Huai-Pu Charts a Course of National Pride Through Action



As a "Fish Prince" growing up by the shores of Keelung who transformed himself into the "King of the Sea" across the North Atlantic, Chen Huai-Pu has become a name that resonates with Taiwan's younger generation—not only as a self-directed, high-achieving student of electrical engineering at National Taiwan University, but also as a dreamer whose unwavering passion for the ocean defines his journey.

From a young age, Chen Huai-Pu was passionate about marine ecology. In junior and senior high

school, he spent hours daily observing fish in his aquarium, developing a keen eye for life's subtle details—an inner drive that later fueled his pursuit of sailing and ocean conservation. His long-time fascination with fish led him to wonder: "If fish swim faster than water currents, why can't that be used to generate power?" In 2019, his "fish-powered energy" concept earned him First Prize in Engineering at the Taiwan International Science Fair and Second Place in Mechanics at the Intel ISEF, securing his direct admission to NTU's Department of Electrical Engineering.

After entering NTU's top engineering program, Chen Huai-Pu chose not to be limited by traditional academics. He joined the university's innovative Exploratory Learning Program, which allowed him a year of self-directed learning without pausing his studies. He spent this time in Mexico training in professional sailing and attempting a non-motorized Pacific crossing. Though the voyage fell short, it became a pivotal experience—building his mental resilience and cross-cultural communication, laying the groundwork for future challenges.

Chen Huai-Pu is not only the youngest Asian ever to be certified as a Royal Yachting Association (RYA) Yachtmaster, but also made headlines with his bold transatlantic voyage. With the full support of ARGO Yacht Club, he set sail on December 25, 2024—Christmas Day—from the Canary Islands off the coast of Western Sahara in Africa, embarking on an epic journey across the North Atlantic. Together aboard a 36-foot sailboat, Chen worked with his 4 crewmates from Sweden and Germany to complete this formidable crossing, relying solely on human strength, seamanship, and a shared conviction.

Notably, he chose to rely solely on traditional celestial navigation—completely avoiding modern technologies. Using only the sun, moon, stars, a sextant, and a chronometer, he calculated the sailboat's position across the Atlantic. After 47 days facing strong winds, shifting currents, and extreme weather, the crew demonstrated exceptional sailing skills and teamwork, successfully reaching the Caribbean in February 2025.

From "Fish Prince" to "King of the Sea," Chen Huai-Pu has proven the enduring power of ancient ocean-crossing wisdom. His journey embodies a form of youth-driven creativity that awakens one's instinct, experience, and skill—offering a rare and invaluable reminder in this age of digital precision.

In 2022, Chen Huai-Pu was nominated by Taiwan's Ocean Affairs Council as the first youth ambassador to officially represent Taiwan at the 7th Our Ocean Conference in Palau. There, through dialogue with John Kerry, U.S. President Biden's former climate envoy, he brought Taiwanese youth perspectives on ocean issues to the global stage. In 2025, he has received support from the Ministry of Education's Youth Dream-Building Program and will set sail in an engineless sailboat on an adventurous journey to the Arctic and Antarctic.

By grounding his electrical engineering background in hands-on maritime experience, Chen Huai-Pu embodies exceptional navigational mastery through his Atlantic crossing. Through unwavering passion and perseverance, he has proven that Taiwanese youth are capable of more than coding, test scores, or academic rankings—they can cross oceans and step confidently onto the world stage. His journey demonstrates how the combination of passion-driven goals, institutional support, and learning through real-world practice can unlock the full potential of young people. Looking ahead, Chen aspires to help Taiwan become a true maritime nation by establishing a localized sailing education system. His dream is not only to navigate the seas, but to make the ocean a launching point for youth to explore the world.

Chen Huai-Pu's story embodies a synthesis of educational innovation, youthful courage, and cross-disciplinary practice in Taiwan. It challenges us to reconsider the meaning of "achievement". His journey shows that education should inspire to unleash one's unlimited potential, instead of forcing the conveyance of knowledge. His actions and achievements offer inspiration for more young people in Taiwan to embrace the ocean and understand nature—in a spirit of openness, freedom, and harmonious coexistence.

Leveraging Taiwan's Strengths in Ocean Energy Development

Min-Chieh Chuang
Chairperson, Taiwan Ocean Energy Development Association

Keywords:
Ocean Energy Development, Renewable Energy Transition, Carbon Reduction & Net-Zero Targets, International Cooperation & Market Deployment

Min-Chieh Chuang serves as Chairman of Taiwan Ocean Energy Development Association. He has extensive experience in ocean energy and renewable energy sectors, specializing in ocean energy site development and system integration. He also serves as manager at Fullen Ocean Energy Technology and Tianrongbao Energy-Saving Technology, dedicated to promoting Taiwan's ocean energy and sustainable energy development.

Introduction

Taiwan is surrounded by the sea and endowed with diverse and abundant marine resources. The vast ocean energy lies right at our doorstep—abundant and inexhaustible, and highly promising as a renewable energy option. Its predictability also makes it an ideal balancing partner to wind and solar power, and it is the lowest-carbon energy source across the full lifecycle of power systems (IPCC, 2011).

To enhance carbon reduction efforts, ocean energy should be incorporated into national decarbonization plans, with stronger incentives to accelerate the realization of Taiwan's net-zero targets. Although ocean energy has yet to reach large-scale commercial deployment globally, major technology-leading countries have already begun laying out their positions in the international market. Global target is to achieve 300 GW of installed ocean energy capacity by 2050, including 180 GW from wave energy and 120 GW from tidal energy. It is expected that, in the near future, this will generate substantial economic growth and carbon reduction benefits (Ocean Energy Systems [OES], 2023).

Therefore, Taiwan should leverage its unique marine environment, strong manufacturing base, and advanced R&D capabilities to seize this opportunity through early strategic planning. Domestically, it can help meet the growing demand for renewable energy, stimulate private investment, foster industrial upgrading, and create job opportunities. Internationally, it can strengthen industrial competitiveness, tap into the vast global export market, and promote international cooperation and exchange (Ocean Basic Act, 2019; Ocean Industry Development Act, 2023; Executive Yuan, 2020).

Several companies and research institutions in Taiwan have already entered the demonstration site development and open-sea verification stages . These include the first 100 kW-level wave energy commercial demonstration site, with several megawatt-scale sites expected to be completed before 2030; the world's first megawatt-scale ocean thermal energy conversion (OTEC) plant in Hualien, currently undergoing environmental impact assessment, and expect-

ed to be completed before 2028; and in the area of ocean current energy, a 100 kW-level current turbine is about to enter a long-term open-sea testing phase.

However, during this development process, obstacles such as insufficient national policy support and promotion, fragmented maritime regulations managed by different authorities, complicated permitting procedures, and inadequate R&D funding have significantly delayed progress in demonstration site application and investment acquisition (Chuang, 2021a; Chuang, 2023a). To accelerate the development of marine energy in Taiwan, cross-ministerial collaboration and public participation are essential (Chuang, 2022).

In addition to outlining the current state of marine energy technology development (National Cheng Kung University, 2021; UAnalyze Industrial Data Center, 2024; Liberty Times, 2021), this paper also summarizes key factors for the successful promotion of marine and other renewable energies worldwide and proposes recommendations aimed at leveraging Taiwan's unique resources to build an internationally competitive marine energy industry and achieve a sustainable energy transition. .

Types of Marine Energy, Application Sites, and Potential

Marine energy refers to energy generated through oceanic motion processes. According to the Renewable Energy Development Act, marine energy includes wave energy, current (tidal stream) energy, ocean thermal energy, tidal energy, and salinity gradient energy.

The Industrial Technology Research Institute (ITRI) has identified areas with favorable development potential based on various oceanographic and topographic conditions (Figure 2). Among these, wave energy, ocean current energy, and ocean thermal energy have the highest potential and represent the most promising marine energy types for development in Taiwan.

The following introduces the types of marine energy and their current development status in Taiwan:

Figure 1. The Importance of Ocean Energy
Photo Credit: Taiwan Ocean Energy Association

Figure 2. Potential Sites for Ocean Energy in Taiwan
Photo credit: Green Energy Research Institute, Industrial Technology Research Institute (ITRI)

Wave Energy

Wave energy primarily utilizes the vertical motion of waves or variations in water pressure to generate electricity. Compared to other renewable energy sources, the energy density of wave energy is approximately four times that of wind energy. This means that, for the same volume or surface area, wave energy can produce more electricity than wind energy, making it more advantageous in terms of spatial efficiency.

Due to variations in suitable terrain, water depth, and wave conditions, a wide range of wave energy conversion devices has been developed. Based on operating principles, these devices can be categorized into more than ten types (Figure 3). According to installation location, wave energy systems can be classified into onshore and offshore units. Onshore systems are widely recognized for their high reliability, ease of maintenance, and minimal environmental impact. Offshore systems, depending on water depth and installation methods, can be further divided into surface-mounted and subsea types.

According to previous analysis, the total wave energy around Taiwan is roughly estimated to exceed 100 GW, with more than 25 GW of exploitable potential. The main areas of potential are located in the northeastern region, offshore of Penghu to the Yun-Chang Rise, and offshore of Pingtung. Additionally, several fishing and commercial port areas also have development potential exceeding tens of megawatts.

Ocean Current Energy:

Ocean Current Energy primarily generates electricity by harnessing strong and stable ocean currents such as the Kuroshio Current. Taiwan's eastern waters are traversed by the Kuroshio, the world's second-largest ocean current in the North Pacific. It flows steadily and passes just about 30 km off the coast, making it one of the most favorable areas in the world for ocean current development.

The main stream of the current flows between Taiwan's eastern coast and Green Island, with peak flow speeds reaching 1–1.5 m/s. The total energy is roughly estimated to exceed 100 GW, with over 6 GW considered technically exploitable. If effectively utilized, it could serve as a renewable source of baseload power in Taiwan, enhancing national energy autonomy and security.

Currently, Taiwan's ocean current energy technologies are being developed through research projects led by Academia Sinica and the National Academy of Marine

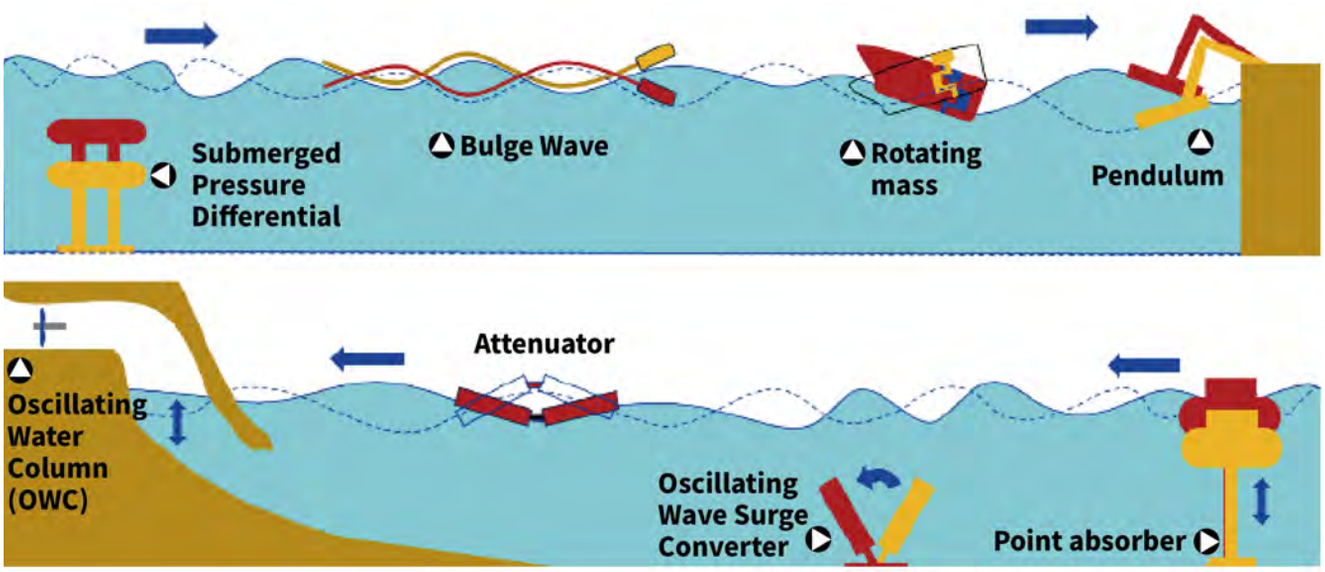


Figure 3. Technical Principles of Various Wave Energy Converters
Photo credit: Taiwan Ocean Energy Development Association

Research under the Ocean Affairs Council. Key power generation technologies have been progressively developed. They are now conducting long-term open-sea trials for 100 kW-class devices, while also building the industrial supply chain, marine engineering capabilities, and talent training required for a future commercial ocean current power sector.

Ocean Thermal Energy Conversion (OTEC):

OTEC mainly generates electricity by using warm surface seawater and cold deep seawater to perform heat exchange, converting thermal energy into electrical energy. The greater the temperature difference, the higher the power generation efficiency.

Since the ocean's thermal gradient remains relatively constant year-round, OTEC offers a more stable power generation method compared to solar or wind energy. It can be installed either onshore (land-based systems) or offshore (floating platforms), as shown in Figure 4. Taiwan's eastern waters offer the greatest potential for OTEC development, with an estimated exploitable capacity of about 2.4 GW.

Due to the high cost of deep seawater intake, currently only the Heping Power Plant is in the process of applying for installation. In terms of commercial application models, scholars have proposed combining OTEC with hot springs, deep ocean water, or geothermal development to reduce construction costs.

Tidal Energy:

Tidal energy generates electricity by harnessing the rise and fall of ocean tides to drive turbines. Unlike intermittent energy sources such as solar and wind, tidal energy offers a key advantage—high predictability, allowing for accurate forecasts years in advance.

There are two main methods of tidal energy generation:

1. Tidal Barrage System:

This method utilizes the rise and fall of the tide—storing water during high tide and releasing it during low tide—to drive turbines and generate electricity.

Tidal barrage is the earliest marine energy technology to reach commercial application. Due to the need for constructing barrages, it involves high costs. As a result, operational tidal power plants around the world are located in areas with tidal ranges of over 10 meters to achieve higher energy output.

Taiwan's Taichung, Kinmen, and Matsu regions have relatively favorable conditions, but the tidal range is only 5 to 6 meters, which has deterred commercial investment.

2. Tidal Stream System:

Tidal stream system captures the kinetic energy of tidal currents; faster flow speeds result in higher power output. Unlike ocean currents, tidal currents flow in a bidirectional (oscillating) pattern, while ocean currents flow unidirectionally.

Because of the high degree of technical overlap in turbine design, some classify tidal stream energy as a subset of ocean current energy.

Many countries have prioritized tidal stream energy as a key development area. Taiwan has not specifically assessed this potential, so no domestic companies

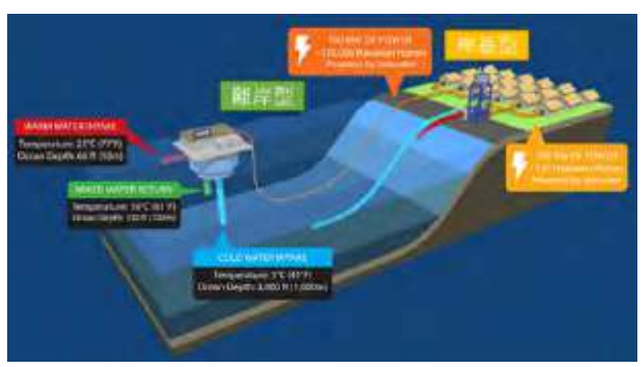


Figure 4. Schematic of Onshore and Offshore Ocean Thermal Energy Conversion (OTEC) Systems
Photo credit: Ocean Thermal Energy Conversion

have entered the field, though some international developers have begun exploring possible installation sites in Taiwan.

Salinity Gradient Energy:

Salinity gradient energy generation harnesses the osmotic pressure difference between seawater and freshwater. It is typically installed near river estuaries. Currently, there are only a few existing cases.

Figure 5. Schematic of a Salinity Gradient Power Plant
Photo credit: Sweetch Energy

Global Development Goals and Promotion Strategies:

In 2023, the International Energy Agency – Ocean Energy Systems (IEA-OES) released a global development roadmap for ocean energy toward 2050 (Ocean Energy Systems [OES], 2023), with a goal of reaching 300 GW of installed capacity by 2050, including 180 GW of wave energy and 120 GW of tidal stream energy. This would create 680,000 direct jobs, contribute USD 340 billion in gross value added (GVA), and reduce over 500 million tons of carbon emissions.

The report outlines four strategic pillars for action: market incentives, technology advancement, infrastructure development, and legislative and regulatory frameworks.It specifically highlights that the higher the cost-reduction rate, the sooner commercial viability can be achieved.This would in turn reduce the investment required through market incentive schemes (such as Feed-in Tariffs or Contracts for Difference), as shown in Table 1.

Table 1. Investment Costs of Market Incentive Policies under Different Cost Reduction Scenarios

Cost Reduction Rate	Investment in Market Incentive Policies
15%	USD 74 billion
12.5%	USD 170 billion
10%	USD 378 billion

At present, major technology-leading countries have successively proposed long-term strategies for the development of ocean energy, aiming to take the lead in the global market and position ocean energy as the next key energy industry following offshore wind power. Among them, Europe has been the most proactive exemplifying a development model characterized by long-term policies, sustained financial support, and multilateral collaboration.

The European Union is the most active region in the world in promoting ocean energy. Since 2014, it has included ocean energy as a key development objective. Over the past decade, EU member states and the private sector have jointly invested more than €4 billion in ocean energy research and pilot projects. Through long-term policy subsidies and demonstration programs, the EU has consistently supported technological innovation while continuously refining its R&D plans and development strategies related to ocean energy.

A key factor in Europe's global leadership in ocean energy development was the establishment of the European Marine Energy Centre (EMEC) in 2003 in the Orkney Islands of Scotland. EMEC is supported and operated by a wide range of stakeholders, including government bodies, research institutions, utility companies, ocean energy developers, and industry associations. This broad support ensures coordinated progress in technological, policy, and market dimensions, driving the development and commercialization of ocean energy technologies.

Currently, EMEC has become the world's leading testing facility for ocean energy technologies. It also collaborates with other countries to conduct cross-na-

tional testing and expand diversified business activities. In addition to offering testing services, EMEC plays a critical role in the commercial development of ocean energy in Europe. Its roles include participating in policy advisory processes, promoting policy frameworks conducive to ocean energy development, providing market research, policy analysis, and commercialization guidance to developers, and assisting with project funding applications and investment sourcing.

Concrete Recommendations for Ocean Energy Development

Based on the promotion strategies of ocean energy in Europe, it can be concluded that the development of ocean energy requires long-term support in terms of policies, regulations, funding, and market mechanisms to drive continuous investment and generation of technology, talent, and supply chains, with the goal of achieving large-scale commercialization and deployment, as illustrated in Figure 6.

With discussions above, this analysis consolidates the promotion approaches of ocean energy both domestically and internationally, along with the successful development experiences of other renewable energy sources such as offshore wind, solar, and small hydropower. The study summarizes strategic recommendations spanning from technical feasibility, commercialization, and scaling-up, to alignment with the 2050 global market goals. The recommendations are outlined as follows:

Leveraging Taiwan's Unique Resources

1. Unique Marine Resources

Taiwan is surrounded by vast maritime areas endowed with abundant wave, ocean current, and thermal gradient energy resources. These natural assets provide Taiwan with a unique advantage in developing marine energy.

Taiwan can focus on the development of these specific marine energy technologies and tailor design and application strategies based on regional oceanic conditions.

2. Industrial Base and Technological Innovation

Taiwan's strong manufacturing foundation and advanced technological research capabilities can accelerate the development and commercialization of marine energy equipment. Continuous innovation in marine energy technology should be promoted to enhance Taiwan's competitiveness in the global marine energy sector.

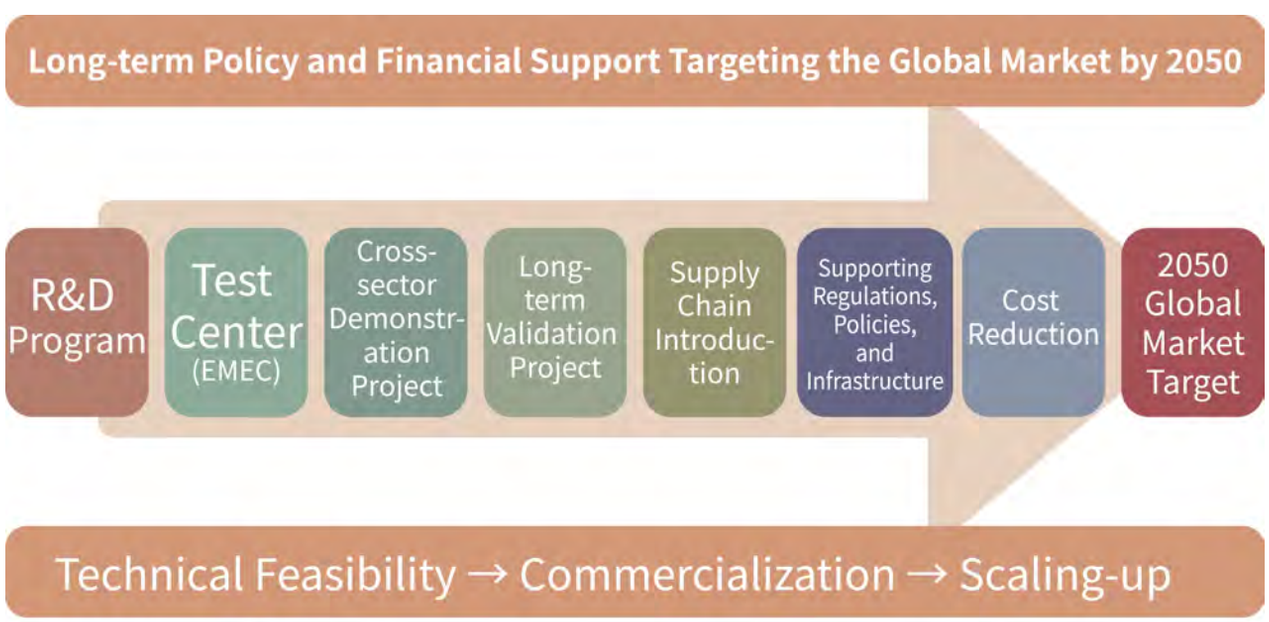


Figure 6. Promotion Strategy from Technical Feasibility to Targeting the 2050 Global Market
Photo credit: Illustration by the Editorial Team

Inter-Ministerial and Public–Private Collaboration

Inter-Ministerial Coordination

A Through the establishment of an inter-ministerial coordination mechanism, a comprehensive long-term policy framework and development plan for ocean energy should be formulated. Ocean energy should be integrated into the national net-zero emissions action plan, encompassing areas such as technological R&D, site development, industry advancement, international market cooperation, talent cultivation, and environmental protection, to ensure the smooth alignment and flow of policies, resources, and support systems.

B Given the complex web of maritime-related regulations and the cumbersome permitting procedures, inter-ministerial coordination is needed to streamline regulatory frameworks. This includes clarifying application processes and spatial jurisdictions to simplify administrative workflows, reduce time costs, create an industry-friendly environment, and lower investment risks. In the future, the review system should be integrated with advanced AI technologies to establish a one-stop online application platform, thereby improving administrative efficiency and accelerating development—an approach that can also apply to other renewable energy sectors.

Public-Private Collaboration

A Establish a dedicated incubation mechanism for the emerging ocean energy industry to support its development "from the ground up." This includes fostering a comprehensive upstream and downstream supply chain, and promoting talent cultivation, thereby ensuring fairness and sustainability in the labor market.

B Encourage early involvement of the supply chain in the development of ocean energy equipment and technologies, both domestically and internationally, to accelerate cost reduction and facilitate early realization of large-scale commercial applications.

C Promote the upgrading of manufacturing sectors related to ocean energy to enhance Taiwan's capacity in ocean energy equipment production. The goal is to establish a competitive, localized supply chain that spans technology development, equipment manufacturing, and operations and maintenance, thereby building a comprehensive industrial ecosystem. Local Government and Community Engagement

Local Government and Community Engagement

A Local governments should provide essential support and resources for ocean energy projects, including site identification, ensuring social acceptance, and overseeing environmental monitoring.

B Encourage the participation of social enterprises and community-owned power plants by promoting community collaboration, private investment, or local government leadership.

C Promote microgrid systems tailored for offshore islands, fishing villages, coastal remote areas, and Indigenous coastal communities. These systems can enhance local energy autonomy, improve supply stability, and provide residents with reliable and affordable electricity.

D Organize public education and outreach initiatives to raise awareness and foster public support for ocean energy, thereby building a broad societal consensus for sustainable energy development.

Financial Collaboration: Providing Market Incentives and Strengthening Public–Private Investment Mechanisms

Most ocean energy technologies are still at a stage where costs and associated risks remain high. Although feed-in tariffs for ocean energy have been introduced to support stable revenue streams, it is not feasible to rely solely on market players to drive development on their own.

Without clear government targets or sufficient market visibility, private investors are unlikely to commit substantial capital to bear the high development costs and uncertain prospects. Therefore, public funding and policy-based subsidies are needed to boost investor confidence, in order to attract both domestic and international investment across all stages—from R&D to commercial deployment.

Conclusion

Taiwan possesses abundant ocean resources and geographical advantages, and ocean energy, as a key component of renewable energy, will play a vital role in energy transition and carbon reduction goal. To achieve long-term development in the field of ocean energy ,it is essential to establish cross-ministerial collaboration and promote active societal engagement.

Resources from local governments, civil society, research institutions, and private enterprises must be integrated, to leverage Taiwan's unique model of ocean energy development and expand into the global market.

References

Intergovernmental Panel on Climate Change (IPCC). (2011). Special report on renewable energy sources and climate change mitigation. Cambridge University Press.

Ocean Energy Systems (OES). (2023). International roadmap for 300 GW ocean energy development by 2050.

UAnalyze Industry Data Center. (2024, January 2). €32 million focuses on new offshore energy star: Portugal project unveils the growth story of wave energy. https://uanalyze.com.tw/articles/101577396

National Cheng Kung University. (2021, November 1). Integrating southern research power: Developing the first domestic onshore-arm wave power generator. https://web.ncku.edu.tw/p/404-1000-276240.php?Lang=zh-tw

Liberty Times. (2021, January 14). Breakthrough in ocean current power generation! National test site and port base completed planning. Liberty Times. https://news.ltn.com.tw/news/life/breakingnews/3410410

Tai, C.-Y. (2023, November). Draft testing procedures for Taiwan ocean current energy testing sites. Chung-Hua Institution for Economic Research. https://www.cier.edu.tw/publish/projects/detail/4110

Fundamental Act of Oceans. (2019, August 21).

Act for the Development of the Ocean Industry. (2023, May 24).

Chen, M.-C. (2017). Feasibility study on integrating deep ocean water and hot spring water in eastern Taiwan for ocean thermal energy conversion (Master's thesis, National Dong Hwa University).

Chuang, M.-C. (2021a, June 22). Developing Taiwan's ocean energy requires setting a "national target framework." The News Lens. https://www.thenewslens.com/article/152449

Chuang, M.-C. (2021b, September). Designing ocean energy systems from the perspective of generators and key component technologies. Journal of Ocean (Inaugural issue). Taiwan Ocean Industry Association.

Chuang, M.-C. (2022, December). A study on the design and planning of wave energy power generation systems. Quarterly of Ocean and Underwater Technology, 32(4). Chinese Society of Ocean and Underwater Technology.

Chuang, M.-C. (2023a, January 19). Pursuing new directions in ocean energy: The rise and challenges of Taiwan's hybrid marine energy. Rhythms Monthly. https://www.rhythms-monthly.com/?p=47938

Chuang, M.-C. (2023d, November). From R&D to realization: Accelerating Taiwan's ocean energy industry development. Journal of Ocean. Taiwan Ocean Industry Association.

Reconnecting Human and Ocean: Pursuing Sustainable Blue Economy Through Satoumi Practice

Yao-Jen Hsiao
Associate Professor and Director, Graduate Institute of Applied Economics, National Taiwan Ocean University

Keywords:
Caspian Sea, Blue Economy, Marine Industry, Ecosystem Services, Social-Ecological Production Landscapes and Seascapes (SEPLS)

Yao-Jen Hsiao serves as Associate Professor and Director of the Graduate Institute of Applied Economics at National Taiwan Ocean University. He specializes in fisheries economics, marine economics, and financial econometric analysis. He is dedicated to fishing community research and guidance, earning him the Agricultural Extension Educator Award in 2020.

21st Century as the Century of the Oceans

Approximately 71% of the surface area of Earth is covered by oceans, providing food security for over 3 billion people and facilitating 80% of the global cargo transportation. In addition, about 98% of international internet traffic is transmitted through submarine cables, which underscores the criticality of the oceans.

Entering the 21st century, major coastal states have recognized and assessed the value of their marine industries, formulating corresponding policies for protection and development. The oceans are now viewed as key drivers for employment, innovation, and advantages in competition. Globally, the ocean economy grew from USD 1.3 trillion in 1995 to USD 2.6 trillion in 2020, accounting for approximately 3-4% of global GDP. During this period, its growth outpaced that of the global economy. More than 75% of growth on ocean economy was driven by countries in the Asia-Pacific region, with East Asia alone contributing 56% of global ocean economy growth (OECD, 2024). These developments have confirmed the assertion made in Agenda 21 adopted in the United Nations Conference on Environment and Development (UNCED) in 1992, that the 21st century will be the "century of the oceans."

International Initiatives and the Promotion of the Blue Economy as Means to Achieve Sustainable Growth of Marine Industries

Throughout history, humanity's pursuit of economic growth has resulted in a series of challenges that have profound impacts on marine environments. These include the overexploitation of marine resources due to overfishing and the widespread occurrence of illegal, unreported, and unregulated (IUU) fishing, the carbon emissions generated by marine economic activities (which account for approximately 11% of global emissions), and the accumulation of waste and plastics leading to marine debris. Additionally, various forms of marine development have contributed to the destruction of marine environments and ecosystem degradation, as well as the compounded threats posed by global climate change, including sea-level rise, flooding, and coastal erosion. These have all further undermined the prospects for the sustainable development of the ocean economy and its societal well-being.

To promote the sustainable development and utilization of the oceans, the United Nations Conference on Sustainable Development in 2011 highlighted the blue economy as a potential pathway to enhance

ocean sustainability. In 2014, it further introduced the Blue Economy Concept Paper, which in turn spurred proactive promotion and implementation of the blue economy in recent years by countries such as the United States, the European Union, and Australia, as well as international organizations including the United Nations, the Organization for Economic Co-operation and Development (OECD), and the World Bank. These endeavors aim to advance an ocean industry that promotes intergenerational equity and justice both domestically and internationally, fosters equitable prosperity among people of the present generation, and continuously advances human well-being. However, the economic activities as well as products or services of the ocean industry are mostly considered public goods or common-pool resources. Therefore, how to implement the blue economy in practice becomes a pivotal issue in determining whether the oceans can truly achieve sustainable development.

Society and Ecosystems as the Foundation of Sustainable Development

Approximately 75% of terrestrial environments and 66% of marine environments worldwide have been altered by human activities (Díaz et al., 2019). Around 50% of salt marshes, 35% of mangroves, 29% of seagrasses, and 30% of coral reefs have degraded or disappeared (Steffen et al., 2018), leading to the gradual loss of biodiversity and ecosystem services, and further affecting the sustainable use and management of coastal community resource systems (Kozar et al., 2020). In addition, coastal zones are one of the critical ecosystem areas in the world, accounting for approximately 22% of global ecosystem services (ESs) (Costanza et al., 2014). Therefore, how to maintain regional ecosystems poses a significant challenge for humanity.

Since the release of the Millennium Ecosystem Assessment (MA) in 2005, there has been increasing interest in exploring ways to sustainably utilize biodiversity (MA, 2005). Ostrom (2009) suggested that human activities—whether through organizations or government policies—are directly or indirectly linked to ecosystems, and therefore proposed the concept of social-ecological systems (SESs). This concept seeks to link natural and social sciences to facilitate the sustainable development of both society and ecosystems.

In 2010, the Tenth Meeting of the Conference of the Parties (COP10) to the Convention on Biological Diversity launched the International Partnership for the Satoyama Initiative (IPSI) as an important instrument for achieving the Aichi Biodiversity Targets and for realizing objectives related to biodiversity conservation, the preservation of local traditional knowledge, and community development. The Satoyama Initiative introduced the concept of socio-ecological production landscapes and seascapes (SEPLS), which aims to enhance the adaptive capacities of communities. It also aims to promote the conservation and sustainable use of local production landscapes and seascapes, including agriculture, forestry, fisheries, and animal husbandry, thereby achieving the goals of local economic, social, and ecological sustainability. Moreover, efforts have been directed toward maintaining or restoring socio-ecological production landscapes (Li & Wang, 2015) by applying the three-fold approach, which highlights the integration of wisdom to conserve diverse ecosystem services and values, the combination of traditional knowledge with modern science, and the exploration of innovative forms of co-management systems.

Enhancing Productivity and Biodiversity through Satoumi Practices

Building on the development of Satoyama, the Japanese scholar Yanagi (1998) also introduced the concept of "Satoumi", defining it as "coastal areas where both productivity and biodiversity are enhanced through human intervention or the interaction between humans and nature." This concept emphasizes how humans and the ocean can coexist in a symbiotic relationship, fostering a balance between marine ecological-cultural landscapes and social-ecological systems, and ultimately advancing overall sustainability. However, beyond considering various ecosystem indicators to ensure marine species and habitats, it is also important to create labor land-

scapes that connect humans with the ocean (Yanagi, 2011).

Coastal communities are often located in environmentally sensitive areas and exert profound influences on social, economic, cultural, and geographical dynamics. In the face of declining ecological conditions and weakening social capital, it is essential to build local residents' understanding of environmental and community operational mechanisms; strengthen coastal community culture and ecosystem services; develop environmental education and citizen science awareness and initiatives through Satoumi practices; empower residents to enhance social capital and community capacity; foster employment and create job opportunities; and thereby promote the reorganization and adaptive capacity of social-ecological systems to enhance community resilience.

Past examples include the Mao'ao community in New Taipei City, the Dong'ao community in Yilan, coastal areas in Taoyuan, and Taijiang National Park. These communities have actively employed Satoumi practices to cultivate ecological and scientific knowledge among residents and the public, enabling them to understand and support marine management policies and environmental sustainability, while also strengthening the connections and interactions between human life and the marine environment.

Satoumi and the Blue Economy Both Focus on the Practical Implementation of Sustainable Development

Satoumi Resilience Assessment Workshop

In order to assess the capacity of landscapes and seascapes to absorb or recover from various disturbances and pressures—including impacts on ecosystem

Method

A Safeguard the health and connectivity of forest, river, village, and sea components.

B Utilize natural resources within forest-river-village-sea areas.

C Developing traditional knowledge and integrate it with modern science and technology.

D Strengthening community-based collaborative governance.

E Enhance household livelihoods and community welfare.

Figure 1. 20 Resilience Indicators of SEPLS
Photo credit: Yao-Jen Hsiao

processes and socioeconomic activities—without causing long-term damage; to fully leverage available social, economic, and environmental resources through networks so that communities can adapt to and mitigate risks and threats; and to maintain the sound structure and ecosystem service functions of socio-ecological production landscapes and seascapes (SEPLS) (Ford et al., 2020), international organizations took coordinated action.

Specifically, the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS), Bioversity International, the Institute for Global Environmental Strategies (IGES), and the United Nations Development Programme (UNDP) jointly released the "Indicators of Resilience in Socio-ecological Production Landscapes and Seascapes (SEPLS)" in 2014. This tool identified five key dimensions: (1) landscape/seascape diversity and ecosystem protection; (2) biodiversity; (3) knowledge and innovation; (4) governance and social equity; and (5) livelihoods and well-being, encompassing a total of 20 resilience indicators (Figure 1). These indicators serve as tools that enable local communities to engage in adaptive management of their landscapes and seascapes. Communities can hence strengthen their capacity to cope with social, economic, and environmental shocks, thereby improving their environmental and economic conditions, enhancing the social and ecological resilience of their landscapes and seascapes, and ultimately achieving a society in harmony with nature (UNU-IAS et al., 2014).

In addition, Satoumi practices employ Resilience Assessment Workshops (RAWs) to help local communities fully understand the conditions and dynamics of their landscapes and seascapes. These workshops provide a framework for communities to discuss and analyze their current social-ecological situations, formulate strategies to strengthen resilience, enhance

Action

A1 diversity and functionality of the components in forest-river-village-sea systems.
A2 connectivity among elements within forest-river-village-sea systems.
A3 natural recovery and regenerative capacity of forest-river-village-sea after disturbances.
A4 protection and restoration of areas impacted by human (socioeconomic) disturbances and threats.

B1 diversity and use of local food sources.
B2 conservation and cultivation of local agricultural products and native species.
B3 sustainable local fisheries that promote circular resource use.
B4 sustainable use of shared resources within forest-river-village-sea systems.

C1 transfer of local traditional knowledge.
C2 documentation and archiving of local traditional knowledge.
C3 local fishery innovations integrating traditional knowledge with modern approaches.
C4 recognition and respect for aspects of traditional knowledge from different genders.

D1 empowerment over the use of forest-river-village-sea resources.
D2 overall governance mechanism of forest-river-village-sea.
D3 community internal social capital of the forest-river-village-sea operation.
D4 participation and benefit-sharing among forest-river-village-sea operation community .

E1 adaptive capacity of local residents for the alternating use of landscapes and seascapes across different times and spatial contexts.
E2 income diversity derived from forest-river-village-sea ecosystem-based activities.
E3 overall health conditions of local residents and the environment.
E4 public infrastructure.

adaptive management capacity, and reinforce stakeholder communication. They invite representative landscapes, seascapes, local groups, and relevant stakeholders to participate together, jointly assisting communities in developing and evaluating SEPLS resilience indicators (Figure 2) .

Moreover, stakeholder platform meetings bring together community residents, key stakeholders, and government agencies to jointly assess and share perspectives on governance, including regulations, communication, and organizational mechanisms at both governmental and community levels. This practice also strengthens cooperation among participants and policymakers in shaping management plans (Sun et al., 2020; Dublin & Natori, 2020). Such processes help communities identify key factors influencing resilience, foster intergenerational learning, strengthen traditional ecological production, and integrate traditional knowledge into science and policy. By conducting systematic assessments and responses, they also encourage relevant government agencies to recognize the actions of management taken to rebuild and maintain resilience. Through collaboration among communities and stakeholders, institutional, cognitive, economic, social, cultural, and technological solutions can be advanced across ecosystems, thus balancing the development of social-ecological systems (Satoyama Initiative, 2024).

The RISC Assessment Framework for Blue Economy

To ensure the sustainable development of the blue economy, the OECD has developed an assessment framework for resilient, inclusive, sustainable, and circular (RISC) blue economies in cities and regions (or RISC-proof) (Figure 3). Between July 2022 and September 2023, the OECD had collected assessment results from more than 80 cities, regions, basin organizations, and small island developing states (SIDS) (OECD, 2024).

The RISC assessment framework is not intended as a reporting tool, monitoring system, or set of standards. Rather, it fosters a comprehensive diagnosis of the

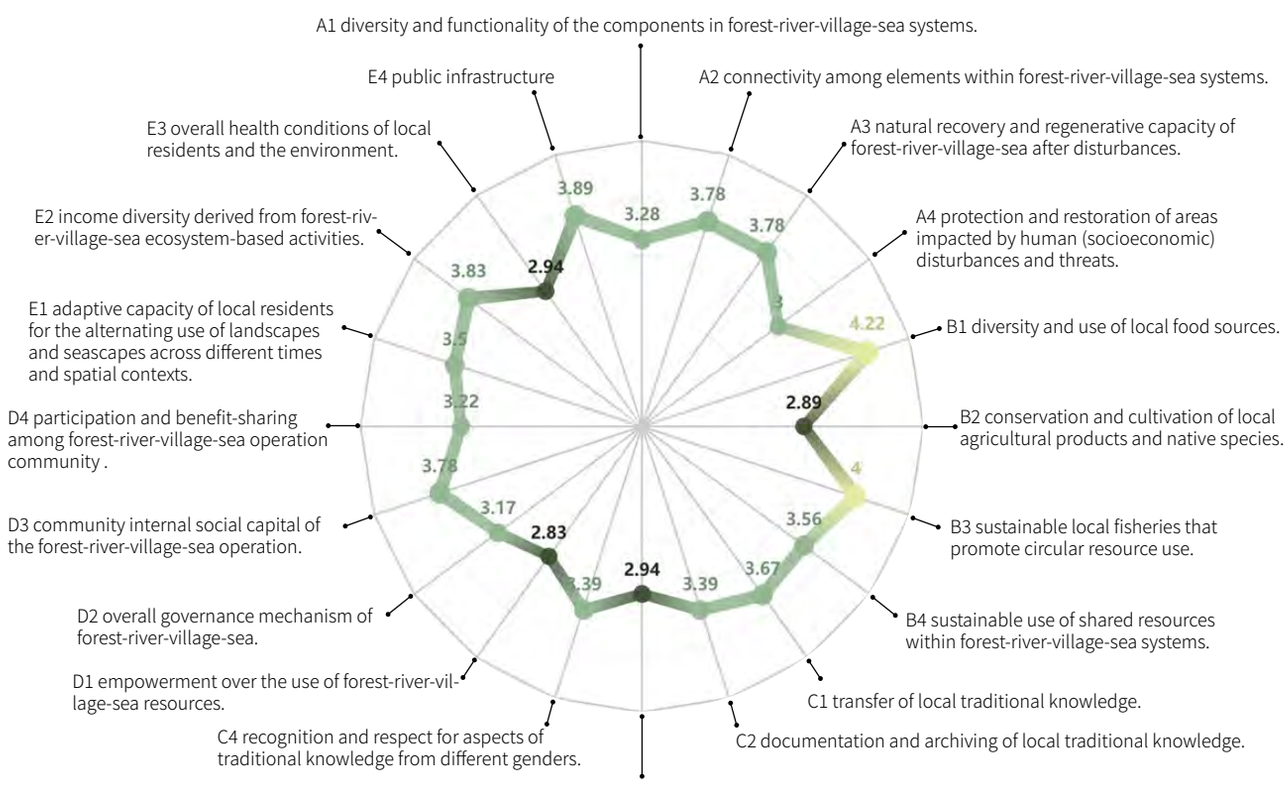


Figure 2. Results of the SEPLS Resilience Assessment for Dong'ao Community, Yilan
Photo credit:Yao-Jen Hsiao

blue economy through bottom-up communication among diverse stakeholders, facilitating consensus on the governance improvements needed for the future. It helps governments and blue economy stakeholders identify strengths, weaknesses, and opportunities for improvement, thereby guiding development strategies and supporting the blue economy with RISC resilience.

The RISC assessment consists of three parts. First, local governments evaluate the resilience, inclusiveness, sustainability, and circularity of the blue economy within their city or region. The second part is for local governments to assess the level of enabling governance conditions within their cities or regions for implementing a RISC-certified blue economy. This part of the assessment includes nine key questions that cover policy formulation, policy coherence, and policy implementation. Local and regional governments incorporate water security into discussions on blue economy systems as a means to stimulate multi-stakeholder dialogue, build consensus, and encourage broad-based input. The results have indicated that to effectively implement blue economy requires comprehensive policies, ensured policy consistence, and enabling conditions for policy execution to achieve the sustainable development of ocean industries. Examples of the RISC assessment outcomes are shown in Figure 4.

Advancing a Sustainable Blue Economy through Satoumi Practices

In recent years, the global development of marine industries has impacted the ecosystem services, thereby undermining sustainable development. Satoumi, by focusing on the relationship between humans and nature, respects local knowledge and has trusts in humanity's capacity for wise use. It also considers the harmony between society and ecosystems, laying an essential foundation for realizing the blue economy and sustainable development. However, the marine economy has diversified. It has gone beyond traditional fisheries, shipping, and marine recreation. To include rapidly growing sectors such as renewable energy and biotechnology, there is now a need to establish clear metrics for ecosystem services as well as their spatial interactions and synergies (Rui et al., 2024).

Figure 3. RISC Assessment Framework
Photo credit:Yao-Jen Hsiao

On the other hand, the definitions used in international frameworks regarding the ocean economy often lack comprehensive information on or fail to consider the non-market products and services (OECD, 2016). Thus, ecosystem services should be incorporated when implementing a blue economy. For example, marine sectors should integrate biodiversity strategies and measure environmental depletion, degradation, as well as the non-market benefits provided by ecosystems in order to enhance resilience (Mulazzani & Malorgio, 2017). Meanwhile, climate change adaptation strategies should also be included, with consideration for Nature-based Solutions (NbS), to advance carbon reduction and towards the net-zero goals.

Through Resilience Assessment Workshops (RAWs) and stakeholder platform meetings, Satoumi can promotes communication among diverse stakeholders in coastal communities, evaluates actions plans that enhance resilience, and increases adaptive capacity. This aligns with the objectives of the blue economy's RISC-proof approach. Therefore, through leveraging Satoumi to boost local's actions, it fosters peer learning and advances ocean governance from coastal communities to regional, even national levels. It can thereby contribute to the advancement of the blue economy.

Finally, beyond sustained attention and advocacy for the blue economy, national governments and the international community should also advance the for-

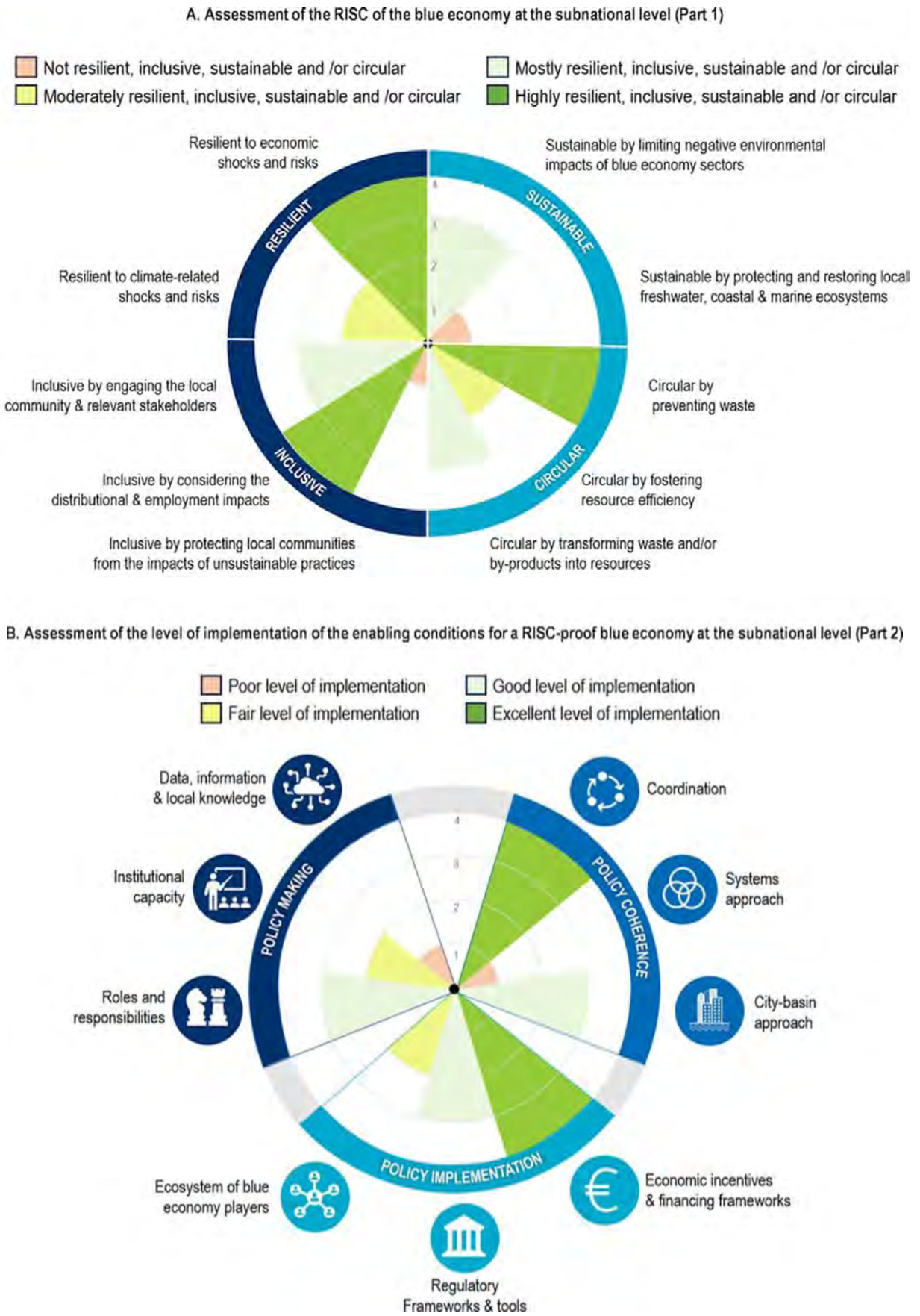


Figure 4&5. Sample Results from the RISC Assessment
Photo credit:Yao-Jen Hsiao

mulation of legally binding policies for plastic management, so is it importance to expand collection on ocean-related data such as carbon emissions, trade, and investment. The global society should also eliminate harmful subsidies, improve management mechanisms for exclusive economic zones and the high seas, and promote investment in marine technology and digital transformation. Only through these efforts can the synergistic benefits of ocean governance be realized, ultimately achieving a sustainable blue economy.

Reference

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change, 26*, 152–158.

Díaz, S., Settele, J., Brondízio, E., et al. (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Dublin, D. R., & Natori, Y. (2020). Community-based project assessment using the indicators of resilience in SEPLS: Lessons from the GEF-Satoyama Project. *Current Research in Environmental Sustainability*, 2.

Ford, J. D., King, N., Galappaththi, E. K., Pearce, T., McDowell, G., & Harper, S. L. (2020). The resilience of Indigenous peoples to environmental change. *One Earth*, 2(6), 532–543.

Kozar, R., Galang, E., Sedhain, J., Alip, A., Subramanian, S. M., & Saito, O. (2020). Place-based solutions for conservation and restoration of social-ecological production landscapes and seascapes in Asia. In O. Saito, S. M. Subramanian, S. Hashimoto, & K. Takeuchi (Eds.), *Managing socio-ecological production landscapes and seascapes for sustainable communities in Asia: Mapping and navigating stakeholders, policy and action* (pp. 117–146).

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Synthesis*. Island Press.

Mulazzani, L., & Malorgio, G. (2017). Blue growth and ecosystem services. *Marine Policy*, 85, 17–24.

OECD. (2016). *The ocean economy in 2030*. OECD Publishing.

OECD. (2024). *The Blue Economy in Cities and Regions: A Territorial Approach*. OECD Urban Studies. OECD Publishing. https://doi.org/10.1787/bd929b7d-en

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, 325(5939), 419–422.

Rui, D., Liu, B., Zhou, C., & Min, X. (2024). Exploring the multiscale island terrestrial ecosystem service relationships and coastal vulnerability under the influence of coastal ecosystems. *Ocean & Coastal Management*, 256, 107267.

Satoyama Initiative. (2024). GEF-Satoyama Project.

Steffen, W., Rockström, J., Richardson, K., Lenton, T. M., Folke, C., Liverman, D., & Donges, J. F. (2018). Trajectories of the Earth System in the Anthropocene. *Proceedings of the National Academy of Sciences of the United States of America*, 115, 8252–8259.

UNU-IAS, Bioversity International, IGES, & UNDP. (2014). *Toolkit for the indicators of resilience in socio-ecological production landscapes and seascapes (SEPLS)*.

Yanagi, T. (2011). Present situation of Satoumi creation. *Global Environmental Research*, 16(1), 3–8.

Yanagi, T. (1998). Establishment of Sato-Umi in the coastal sea. *Journal of Japan Society of Water Environment*, 21, 703.

Sun, H.-T., Yen, C.-Y., & Li, K.-C. (2020). Building resilience across "Forest-River-Village-Sea": Localizing resilience indicators and integrating them into the adaptive management of socio-ecological production landscapes and seascapes in Xinshe Village, Hualien. *Taiwan Forestry Journal*, 46(6), 59–80.

Li, K.-C., & Wang, X. (2015). Learning from the experiences of the International Partnership for the Satoyama Initiative. *Taiwan Forestry Journal*, 41(1), 24–37.

Can Blue Economy Development Drive the Global South to Win Leadership on the World Stage?

Dr. Rokhmin Dahuri
Member of the People's Representative Council of the Republic of Indonesia

Keywords:
Blue Economy, Blue Finance, Ocean Governance, South-South Cooperation, Maritime Geopolitics

Professor Rokhmin Dahuri serves as a member of Indonesia's House of Representatives. He has extensive experience in marine and fisheries, specializing in coastal and ocean management, aquaculture, and sustainable development. He served as Indonesia's Minister of Marine Affairs and Fisheries from 2001–2004 and is President of the Indonesian Aquaculture Society.

Abstract

Marine waters consisting of seas and oceans cover more than 70% of the Earth's surface and holds untapped potential for economic development and human prosperity, particularly for the Global South—regions rich in marine resources but historically underrepresented in global governance. The concept of a blue economy offers a transformative path for these nations to harness ocean wealth responsibly

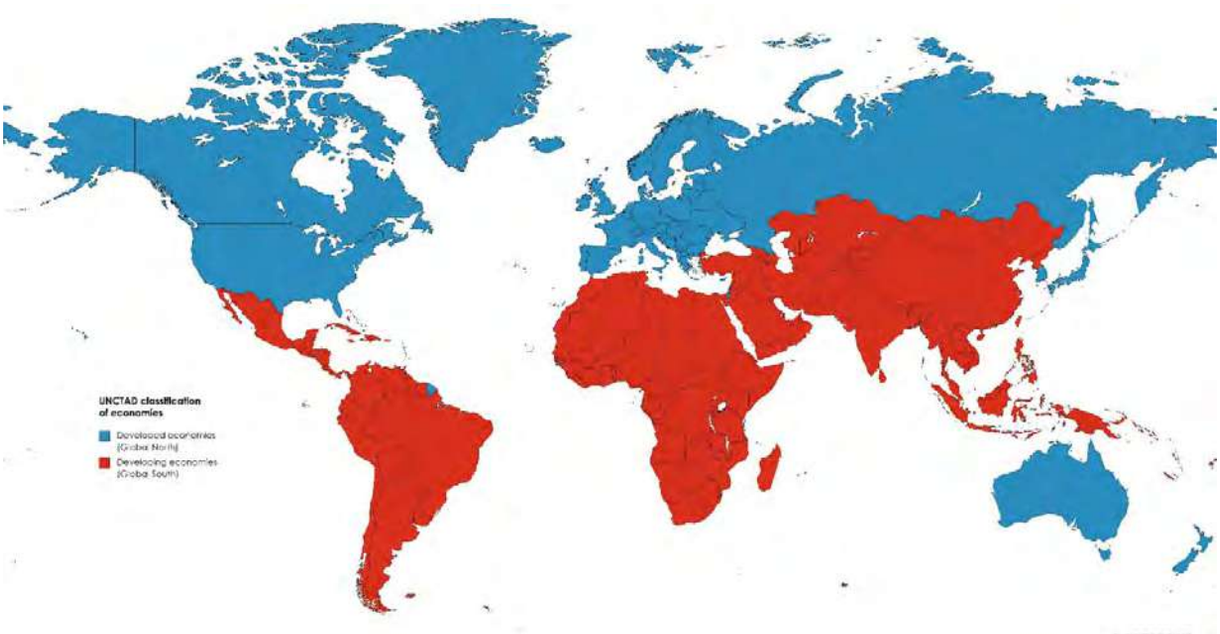


Figure 1. Global North (Blue) and Global South (Red)
Photo credit: Specialgst – Blank map: mapchart.net; UNCTADstat – Classifications. UN Trade and Development. Handbook of Statistics 2023, unctad.org. CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=139254470

for their advancement, job creation, and prosperity; and at the same time enhancing resilience, equity, and ecological sustainability. This paper explores how strategic development and investment in the blue economy can reposition the Global South from a mere resource exploiter and provider to a global leader in environmentally-friendly technological innovations, industrial and economic development; climate actions; and multilateral diplomacy for a better, prosperous, inclusive, peaceful, and sustainable world.

Introduction

The "blue economy" refers to the sustainable use of coastal and marine resources for economic growth, improved livelihoods, and coastal and ocean ecosystem health. For countries in the Global South—encompassing much of Africa, Asia, the Pacific, and Latin America—the blue economy represents both a necessity and an opportunity. With rich marine biodiversity (renewable resources); non-renewable resources (oil and gas, minerals, and construction materials); environmental services (media for maritime transportation and coastal and marine tourism, and life-supporting functions); and extensive coastlines, these regions are uniquely positioned to lead a new global paradigm in sustainable development, innovations, ocean governance, and climate resilience.

However, the question remains: can blue economy development catalyze the Global South's rise to leadership on the world stage? This paper argues yes, and provides an analysis through economic, geopolitical, environmental, and institutional lenses.

The Strategic Value of the Blue Economy for the Global South

Natural Resource Endowment

The Global South is home to vast marine waters, Exclusive Economic Zones (EEZs), coastal and ocean resources, and marine biodiversity hotspots. From Indonesia and the Philippines, Mozambique and the Caribbean nations, Seychelles and Maldives, to Palau and Fiji, these countries have sovereign access to a huge blue economy potentials covering at least eleven economic sectors: (1) capture fisheries (fishing), (2) coastal - and marine - aquaculture, (3) fish and seafood processing, (4) marine biotechnology industry, (5) energy and mineral resources, (6) coastal and marine tourism, (7) maritime (sea) transportation, (8) coastal forestry (mangroves), (9) maritime industry and services, (10) small island resources, and (11) non-conventional resources seabed. In this context, the maritime industry and services sector includes, among others: ship yards and dockyards, ship engines and spare parts, submarine cables and fiber optics, fishing gears, pedal wheels for shrimp ponds, coastal and ocean engineering, and digital technologies (such as Big Data, Blockchain, IoT, AI, robotics, and drones) for blue economy development.

Economic Diversification and Resilience

Sustainable blue economy strategies—such as capture fisheries, aquaculture, marine biotechnology, and eco-tourism—can reduce overreliance on terrestrial sectors and increase economic resilience, especially in the face of climate-induced shocks and trade disruptions.

Figure 2. Capture Fisheries
Photo credit: Shutterstock

Figure 3. Maritime Transport
Photo credit: Shutterstock

Employment and Inclusive Growth

According to the FAO and UNCTAD, sustainable ocean industries can generate millions of jobs, particularly for youth and coastal communities, while promoting gender equity through targeted programs in fisheries, and maritime industries and services (Food and Agriculture Organization of the United Nations, 2022; United Nations Conference on Trade and Development, 2023).

Leadership Potential Through the Blue Economy

Climate Action and Environmental Stewardship

Global South nations are among the most vulnerable to climate change impacts such as sea-level rise and ocean acidification. By pioneering ocean-based climate solutions—like blue carbon ecosystems, mangrove restoration, and marine protected areas—they can lead by example and gain moral authority in climate diplomacy.

Knowledge and Technological Innovation

With increasing investments in marine science and technology—supported by South-South cooperation and multilateral organizations—developing countries are beginning to generate their own data, IP, and innovations in areas such as offshore energy and climate-resilient aquaculture.

Multilateral Diplomacy and Governance

As the ocean becomes a new frontier of geopolitical competition, Global South nations can unify their voices through coalitions like the Indian Ocean Rim Association (IORA), the Pacific Islands Forum, and the 2050 Africa's Integrated Maritime Strategy (2050 AIM Strategy), offering leadership in shaping fair and sustainable ocean governance rules (African Union, 2020).

Key Enablers for Leadership

To unlock the leadership potential of the Global South through the blue economy, several enabling conditions must be met:

Policy Coherence and Institutional Strengthening

Strong ocean governance frameworks and integrated coastal zone management are essential. National Ocean Policies aligned with the SDGs, the Paris Agreement, and the Kunming-Montreal Global Biodiversity Framework will build credibility and attract investment (World Bank, 2021; United Nations Environment Programme Finance Initiative, 2022).

Sustainable Financing and Investment

Innovative financing mechanisms—such as blue bonds, debt-for-nature swaps, and blended finance—can bridge capital gaps. Public-private partnerships (PPPs) and regional development banks must prioritize blue economy projects with high impact and low ecological risk.

Capacity Building and Education

Human capital development is critical. Maritime education, vocational training, and research collaboration will ensure a new generation of skilled ocean professionals and policy leaders from the Global South.

Challenges and Mitigation Strategies

While the promise is great, significant challenges persist:

- Illegal, Unreported, and Unregulated (IUU) Fishing: Requires robust maritime security and cooperation.
- Technology Transfer Barriers: Need for fair intellectual property regimes and joint ventures.
- Power Imbalances in Global Institutions: Advocacy for reform and equitable representation is essential.

Strategic diplomacy, regional coalitions, and alliances with progressive partners in the Global North can help mitigate these challenges.

Case Examples

These examples show how Global South countries are already demonstrating thought leadership and innovation through the blue economy, as illustrated by the following cases.

A Indonesia's Archipelagic and Blue Economy Vision: Integrating ocean sustainability with economic transformation, marine spatial planning, and coastal community empowerment.

B Seychelles' Blue Bonds: Pioneering sustainable finance for ocean conservation and sustainable fisheries.

C African Union's Blue Economy Strategy: Positioning the continent as a maritime power through coordinated development and security frameworks.

Conclusion

The sustainable blue economy presents a rare convergence of environmental necessity, economic opportunity, and geopolitical strategy. For the Global South, it is not merely a path to development—it is a vehicle for global leadership in an era defined by ecological crisis and institutional realignment.

By embracing sustainable ocean governance, investing in marine innovation, and strengthening regional and global coalitions, the Global South can not only uplift its people but also shape a more equitable and sustainable global order.

References

African Union. (2020). *2050 Africa's integrated maritime strategy*. African Union. https://au.int/sites/default/files/documents/30929-doc-2050_aim_strategy_eng_0.pdf

Food and Agriculture Organization of the United Nations (FAO). (2022). *The state of world fisheries and aquaculture 2022: Towards blue transformation*. FAO. https://doi.org/10.4060/cc0461en

United Nations Conference on Trade and Development (UNCTAD). (2023). *Trade and environment review 2023: Building a sustainable and resilient ocean economy beyond 2030* (UNCTAD/DITC/TED/2023/1). United Nations. https://unctad.org/system/files/official-document/ditcted2023d1_en.pdf

United Nations Environment Programme Finance Initiative (UNEP FI). (2022). *Sustainable blue economy finance initiative progress report 2022*. https://hma.com.cy/wp-content/uploads/2023/06/Sustainable-Blue-Economy-Finance-Initiative-Report-2022.pdf

World Bank. (2021). *Riding the blue wave: Applying the blue economy approach to World Bank operations*. World Bank. https://documents1.worldbank.org/curated/en/099655003182224941/pdf/P16729802d9ba60170940500fc7f7d02655.pdf

Driving Ocean Innovation Investment Ecosystem with Ocean Impact Navigator (OIN)

Michael C. Huang, Ph.D.
Senior Researcher, Ocean Policy Research Institute (OPRI), Sasakawa Peace Foundation

Keywords:
Blue Economy, Blue Finance, Marine Innovation, Ocean Impact Navigation, Japan

Dr. Michael C. Huang serves as Senior Research Fellow at the Ocean Policy Research Institute (OPRI), specializing in blue economy, blue finance, and STI policy assessment. Since joining in 2018, he has been dedicated to connecting ocean and social systems analysis, and serves as Advisory Board Member of the World Economic Forum's 1000 Ocean Startups Coalition since 2025.

Ocean Health is Human Health

The ocean plays a critical role in sustaining life on Earth. It produces more than half of the oxygen we breathe, regulates the global climate, and absorbs a significant share of the planet's carbon dioxide and excess heat. It is also a major food source for over 3 billion people, supports natural coastal defenses like coral reefs and mangroves, and holds immense cultural, spiritual, and medicinal value. As the global population rises and ecological pressures mount, maintaining ocean health is not merely an environmental issue—it is a human imperative. The COVID-19 pandemic was a stark reminder of how fragile global well-being can be—and how deeply human health is intertwined with the health of the planet. Scientific evidence has long warned that biodiversity loss and environmental degradation increase the risk of pandemics. In a similar way, the ongoing decline in ocean health poses a growing threat to our collective future.

Equally important are the ocean's economic contributions. According to OCED's estimate at year 2016, the ocean economy is valued at over USD 1.5 trillion

Figure 1. Amami Ōshima, Japan, with Potential for Tourism and Blue Carbon Storage
(Left: Estimation of seagrass blue carbon stock using underwater and aerial drones / Right: Aerial drone image of a humpback whale mother and calf along the coast)
Photo credit: Michael C. Huang

and provides livelihoods for hundreds of millions, especially in developing nations. Women are central to this workforce, making up the majority in seafood processing and trade (OECD, 2016). Moreover, the ocean's vast, largely unexplored biodiversity holds immense promise for breakthroughs in medicine and technology. Yet, these benefits are not guaranteed. Safeguarding them demands urgent, coordinated action. A healthy ocean underpins a healthy planet—and must be prioritized with the same urgency and global commitment shown in response to public health emergencies.

The Ecosystem of Ocean Investment

Ocean-impact investment—often called Blue Impact Finance—occupies the middle ground between mainstream ESG investing and traditional philanthropy. Like philanthropy, it is driven by the desire to generate measurable environmental and social benefits; like ESG, it expects financial discipline and market-rate returns. The difference lies in its focus and risk appetite: whereas ESG investing concentrates on avoiding harm through screening and risk mitigation, Blue Impact Finance intentionally channels capital into solutions that tackle systemic ocean challenges—restoring ecosystems, decarbonizing maritime industries, and strengthening coastal economies. At the same time, it differs from philanthropy by seeking positive financial outcomes, accepting higher risk but not treating capital loss as inevitable. A robust ocean-investment ecosystem is therefore essential to mobilize capital at scale for innovations that deliver both impact and profit.

As ocean-focused start-ups proliferate, investors and financial institutions increasingly demand clear, comparable data on how their capital affects ocean health. Existing guidance—such as UNEP's Sustainable Blue Economy Finance Principles (United Nations Environment Programme Finance Initiative, 2018) and the frameworks of World Bank's Blue Finance Guidance—has established a foundation for large development projects, yet a gap remains for community-based, scientific-led ventures (Huang, Juang, & Jin, 2025). To close this gap, the Ocean Impact Navigator (OIN) was developed by the 1000 Ocean Startups coalition (1000 Ocean Startups, 2022, June). OIN is the first science-based, harmonized toolkit covering the entire Ocean Impact Innovation ecosystem: investors, research institutions, and startups.1 By standardizing impact metrics, it gives stakeholders the transparency they need to allocate resources confidently, unlock new capital flows, and accelerate the transition to a truly sustainable ocean economy.

Measuring Ocean Impact with the Ocean Impact Navigator (OIN)

OIN is a science-based, comprehensive framework designed to meet the growing need for consistent and credible measurement of impact in the ocean innovation space. Developed for startups, venture capital firms, and financial institutions, OIN brings together multiple global standards—including the SDGs (Sustainable Development Goals), IRIS+2, IFC, and GRI (Global Reporting Initiative)—into a unified tool featuring 34 actionable KPIs across six core impact areas. First introduced at the 2022 United Nations

Figure 2. Kelp Aquaculture in Hakodate, Hokkaido, Japan, with Value for Food Production and Increasing Blue Carbon Stock
Photo credit: Michael C. Huang

Figure 3. Oyster Farming in Toyama Prefecture, Japan, Using Deep Seawater for Safe and High-Value Seafood Production
Photo credit: Michael C. Huang

Ocean Conference, OIN has since been adopted internationally as a benchmark for measuring real progress toward a sustainable ocean economy. The six impact areas of OIN are as follows:

A. Sustainably Managed Ocean Resources

Measures biomass restoration, seafood waste reduction, marine life welfare, and sustainable production of seaweed and bivalves.

B. A Clean Ocean

Assesses efforts to reduce plastic pollution, chemical and nutrient runoff, invasive species, and airborne emissions like NOx, SOx, and particulates.

C. Thriving and Restored Marine Habitats

Focuses on the protection and restoration of vital ecosystems, including coral reefs, mangroves, seagrasses, salt marshes, kelp forests, and others.

D. Towards 1.5° C

Captures contributions to climate mitigation through reduced or avoided GHG emissions and carbon sequestration.

E. Climate-Resilient Coastal Communities

Tracks coastline protection, use of ocean data for adaptation, and the number of people supported in climate resilience efforts.

F. Positive Socio-Economic Outcomes

Includes job creation, education and training, gender and diversity inclusion, fair wages, food security, and economic opportunities in coastal communities.

OIN helps investors and intermediaries move beyond superficial metrics and identify interventions that truly improve ocean health and coastal well-being. Many existing KPIs either incentivize harmful practices or focus on business performance disconnected from environmental outcomes. OIN fills this gap by enabling multidimensional impact reporting (World Economic Forum, 2022), guiding investors through more rigorous due diligence and helping to focus resources on high-impact, scalable innovations.

In addition to supporting individual organizations, OIN serves as a shared framework for the broader ocean innovation ecosystem. Its standardized metrics enable performance aggregation, foster transparent impact communication, and support the development of credible, evidence-based transformation

Figure 4. Ecotourism in Palau with Small Groups (Under 10 People) to Reduce Environmental Pressure
(Left: Local guide introducing local beliefs and traditional sites / Right: Ecotourism lunch fostering interaction with local residents, with locally sourced food and utensils)
Photo credit: Michael C. Huang

Figure 5. Ocean Impact Navigation (OIN) – International and Japan Versions for Seafood
Photo credit: Michael C. Huang

narratives. These insights are vital for attracting both public and private investment and for enhancing ecosystem-wide coordination by highlighting strengths, gaps, and areas of strategic alignment. In doing so, OIN helps to catalyze a truly inclusive and sustainable blue economy.

Enabling Shared Progress across the Ecosystem

While various ocean-related indicators—including those aligned with the SDGs—existed prior to the development of the Ocean Impact Navigator (OIN), they were often fragmented, sector-specific, and inconsistent in scope. In response, the World Economic Forum (WEF) initiated the creation of OIN, convening a broad coalition of stakeholders with a shared commitment to ocean sustainability. This collaborative effort, informed by external experts and rigorous review, resulted in a unified, science-based framework designed to streamline and standardize impact measurement across the ocean innovation ecosystem.

OIN supports more effective impact due diligence, reduces the reporting burden on startups and investors, enables consistent portfolio-level reporting, and informs ecosystem-wide strategic decision-making. For startups in particular—often operating with limited resources—the complexity and duplication of reporting frameworks pose a serious barrier. OIN addresses this by offering a coherent structure that allows these organizations to focus on delivering high-impact solutions rather than navigating redundant reporting requirements. However, for OIN to realize its full value, it must be integrated into broader impact strategies, governance systems, and ESG disclosure practices. Rather than functioning as a standalone tool, OIN should be embedded as a foundational component of a holistic impact infrastructure.

Adaptability and Localization Toward a Broader Socioeconomic Perspective

Achieving a sustainable blue economy requires innovations that are rooted in local culture, values, and regional realities. Impact evaluation frameworks must therefore be adaptable to national and cultural contexts. The Ocean Impact Navigator (OIN) was designed with this flexibility in mind, making it highly conducive to localization efforts. In this spirit, the Ocean Policy Research Institute (OPRI), as a knowledge partner of the 1000 Ocean Startups coalition, collaborated with the Social Innovation and Investment Foundation (SIIF) to develop OIN Japan—the first localized version of the framework. Released in March 2025, OIN Japan is more than a direct translation; it is a contextual adaptation that reflects the unique social, environmental, and economic characteristics of Japan's ocean sectors (Ocean Policy Research Institute, 2025, March 6). Additional language versions, including French, Spanish, and Mandarin, are in development to support broader global adoption and enable more community-based, research-validated approaches to ocean impact assessment.

By evaluating Japan's ocean-linked industries and initiatives through OIN, innovative and sustainable practices can gain the visibility and credibility needed to attract investment. As international interest in Japan's ocean economy grows, applying a globally recognized yet locally tailored framework is both timely and strategic. Ideally, this movement will catalyze the expansion of blue impact finance not only within Japan, but across the wider Asia-Pacific region and beyond. However, for OIN to remain relevant and robust, it must continue evolving to include socio-economic dimensions and community perspectives, which are currently underrepresented. One notable gap is the absence of indicators that capture food culture and heritage, which are central to ocean-linked livelihoods and local identity.

Examples illustrate how these dimensions differ across regions. In parts of Europe, oysters are cultivated to demonstrate environmental benefits through water purification. In Japan, however, efforts focus more on social impact—for instance, the use of deep-sea water for inland Atlantic salmon aquaculture, highlighted by Maruha Nichiro's blue bond issuance in 2022, or initiatives that use deep-sea water to grow safe oysters that promote food education and elevate the value of aquaculture. In addition to evaluating ocean startups, OIN holds potential for assessing the impact of nonprofit and cooperative initiatives. A standout case is "Kaachan no Mise" (Mother's Store) in Ibaraki Prefecture, a community-run restaurant and market led by women from the local fisheries cooperative. This initiative not only strengthens local economies but also promotes gender equality by expanding women's roles in business and decision-making within the fisheries sector.

Looking ahead, it is essential to develop evaluation frameworks that reflect a broader range of cultural, economic, and social factors—including culinary traditions, coastal heritage, employment dynamics, and ecotourism. These elements add critical depth and high-value differentiation to local impact strategies. In support of this, OPRI has launched the "Blue Impact Finance Initiative (BIFI)" website to showcase leading ocean startups evaluated through OIN (Ocean Policy Research Institute, 2025, September). As we continue refining OIN Japan, our goal is to ensure the framework captures the full richness of Japan's fisheries, cultural practices, and societal challenges, while also offering a scalable model for other countries across the Asia-Pacific region.

Future Perspective: Enriching the Ocean Investment Ecosystem Through Blended Finance

The development of the Ocean Impact Navigator (OIN) has significantly empowered ocean-focused startups by providing a credible framework for measuring both environmental and socio-economic impact through a combination of quantitative and qualitative indicators. This has encouraged not only startups but also cooperatives and non-profit organizations to engage in voluntary impact reporting, enhancing their visibility and appeal to international

organizations, investors, and the broader public. The 1000 Ocean Startups Coalition plays a critical role in this process, serving as a hub for knowledge exchange and a bridge between ocean innovators and financial institutions.

Given that over 70% of the Earth is covered by ocean—and much of it remains unexplored—the scope for innovation in ocean sustainability, livelihoods, and climate resilience is vast. Many promising ideas and practices are still emerging, and tools like OIN are key to validating and scaling these solutions. To truly enrich and sustain the ocean investment ecosystem, it is vital to go beyond traditional sources of capital. Alongside venture capital and impact investors, official development cooperation agencies and philanthropic funds must be engaged to create a blended finance model. This approach enables risk sharing, resource pooling, and the acceleration of high-impact investment at scale. By aligning diverse financial actors under a shared commitment to measurable impact, we can build a robust and resilient blue economy—and collectively restore the health and promise of our ocean.

Reference

United Nations Environment Programme Finance Initiative. (2018). *The principles for sustainable blue finance*. https://www.unepfi.org/blue-finance/the-principles/

Huang, J., Juang, M., & Jin, Y. (2025). *Innovative social practice and community-based approach to the ocean: Implications for blue impact finance*. Springer Nature. https://link.springer.com/book/9789819691036

1000 Ocean Startups. (2022, June). *Ocean Impact Navigator*. https://www.1000oceanstartups.org/navigator

World Economic Forum. (2022). *Ocean impact navigator digital tools*. World Economic Forum. https://uplink.weforum.org/uplink/s/ocean-impact-navigator/

Ocean Policy Research Institute. (2025, March 6). 日本での OIN 記者発表(*Japan Press Release*). https://www.spf.org/opri/news/20250306.html

Ocean Policy Research Institute. (2025, September). *Blue Impact Finance Initiative (BIFI)*. https://www.spf.org/opri/projects/2025-09_bifi.html

OECD (2016), The Ocean Economy in 2030, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264251724-en

A Coherent Ocean Future: The Implementation of Sustainable Ocean Planning (SOPs) as Integrated Governance Tools.

Cynthia Barzuna
Global Deputy Director, Oceans Program, World Resources Institute (WRI)

Keywords:
Sustainable Ocean Economy, Sustainable Ocean Planning, Blue Economy, Blue Finance, Ocean Governance

Cynthia Barzuna serves as Global Deputy Director of the Ocean Program at the World Resources Institute (WRI), specializing in sustainable ocean planning and marine protected area management. She previously served as Costa Rica's Vice Minister of Water and Oceans, leading the expansion of Cocos Island National Park to achieve protection of 31% of the country's exclusive economic zone by 2021.

The ocean is the world's largest natural asset and underpins the livelihoods of over three billion people globally. However, the health of the ocean is increasingly under threat due to climate change, pollution, and unsustainable exploitation. Delivering a Sustainable Ocean Economy (SOE) is essential to restore ocean health and support economic and social prosperity.

A Sustainable Ocean Economy is not merely defined by extraction or productivity—it is built upon the conditions we create for long-term prosperity, security, and equity. At the center of this enabling environment is coherence: coherence in governance, finance, diplomacy, and human inclusion. Sustainable Ocean Plans (SOPs) offer this integrative foundation.

Maritime Security as a Development Enabler

Historically siloed, maritime security is now recognized as a prerequisite for sustainable ocean development. Illegal, unreported, and unregulated (Illegal, Unreported and Unregulated Fishing, IUU) fishing, piracy, trafficking, and port vulnerabilities all undermine ocean economies. According to the Our Ocean Conference 10-Year Progress Report, maritime security received the fewest number of commitments (215) but boasts the second-highest implementation rate (47%), with $2.3 billion delivered as of January 2025 (Lee-Emery, Cuddy and Pickerell, 2025). This marks the maritime security sector as one with clear growth opportunity and potential to support national and global security objectives while simultaneously addressing urgent needs of ocean-reliant communities.

Countries like Taiwan and Japan have made strategic investments in coast guard capacity and surveillance not as isolated security measures, but as enablers of blue economy growth. These investments protect fisheries, reduce risk, and increase investor confidence—highlighting that maritime domain awareness and cross-agency coordination are essential to unlocking ocean-based prosperity.

SOPs: Catalysts for Integration

SOPs are national strategies to manage 100% of a country's ocean space sustainably—ecologically, economically, and socially. They offer a unifying policy umbrella across ministries of fisheries, environment, finance, and defense, intergovernmental agencies and all of the stakeholders of the ocean. They institutionalize tools such as marine spatial planning, ISPS/SSAS compliance, early warning systems, and crisis coordination protocols. They provide clear investment signals and de-risk ocean sectors for both public and private investors.

The High Level Panel for a Sustainable Ocean Economy (Ocean Panel) is a unique initiative that brings together 18 world leaders—Presidents and Prime Ministers—who are committed to catalyzing bold, science-based action for ocean protection and sustainable use. The Ocean Panel aims to build momentum for a sustainable ocean economy that benefits people, nature, and climate. Its headline commitment is that 100% of the ocean areas under national jurisdiction of Panel members will be sustainably managed, through the development and implementation of Sustainable Ocean Plans (SOPs). This groundbreaking pledge sets a global precedent and serves as a call to action for other countries to follow suit in aligning ocean governance with economic, social, and environmental goals.

To support countries in achieving this goal, the Ocean Panel helped establish Ocean Action 2030, a coalition of expert institutions that provides technical assistance, knowledge sharing, and capacity-building to governments developing SOPs. Building on this momentum, the 100% Alliance was launched to encourage all coastal and ocean states—not just Panel members—to commit to sustainably managing 100% of their national ocean area. The Alliance aims to advance global action and peer learning toward achieving ocean sustainability worldwide by 2030.

As the High Level Panel for a Sustainable Ocean Economy emphasizes, a Sustainable Ocean Economy cannot be built without a Sustainable Ocean Plan. Yet only nine countries have adopted SOPs to date. The 100% Alliance—launched by France and Chile—invites more nations to join this political commitment to manage 100% of their ocean areas sustainably by 2030.

Finance: The $550 Billion Gap

The current state of blue finance is dire. SDG14 remains the least funded of all goals. Between 2015 and 2019, only 0.01% of total SDG-linked development finance was allocated to the ocean.

Ocean finance is insufficient and misaligned, Ocean Panel's Ocean finance for the sustainable ocean economy report, estimates current financial flows fall short of the estimated a $550 billion annual finance gap needed annually to support the SOE, with a significant investment still supporting harmful subsidies and unsustainable activities.

Critical ocean sectors are underfunded, including marine conservation, marine renewable energy, sustainable fisheries and tourism, nature-based solutions, and data innovation. Barriers include lack of standardized frameworks, limited disclosure and transparency, high transaction costs, low returns, and weak enabling environments, especially in LDCs and SIDS.

The report also highlights that less than 1% of official development assistance and philanthropic funding is directed toward ocean sustainability. SOPs can help change this by embedding sustainability into national investment strategies, improving bankability, and aligning with climate and biodiversity goals. The establishment of new instruments like blue bonds, debt-for-nature swaps, and performance-based financing tied to ecological and social outcomes are essential next steps.

To advance a sustainable ocean economy, the report outlines several key pathways and recommendations. First, it calls for aligning ocean finance with global climate, biodiversity, and Sustainable Development Goals (SDGs) by embedding ocean sustainability into

national financial strategies and business operations. Creating enabling environments through stronger policy, regulation, and governance—particularly in support of coastal communities and small-scale actors—is essential. Additionally, strengthening financial infrastructure by scaling seed funding, improving data systems, promoting blue bonds, and supporting Sustainable Ocean Plans (SOPs) aligned with national climate priorities can help unlock investment. Finally, the report urges the redirection of capital away from harmful practices by reforming subsidies, introducing ocean user fees, and incentivizing private sector participation in regenerative ocean sectors.

A People-Centered Ocean: Inclusion and Equity

Today, more than 133 million people work in ocean sectors—mostly in fisheries and aquaculture. However, many work informally and with limited protections.

Today, the ocean economy is a vital global resource supporting over 133 million formal jobs across sectors like fisheries, tourism, marine transport, and energy. Including informal and subsistence employment, this number could be significantly higher. However, climate change, technological shifts, and growing sustainability imperatives are reshaping employment dynamics. Ocean Panel's Blue Paper The future of the workforce in a sustainable ocean economy explores the current status and future trends in ocean-related jobs, identifying both risks and opportunities as the world transitions toward a sustainable ocean economy. By 2050, the sustainable ocean economy could generate an additional 51 million jobs.

The report warns of substantial skills gaps, particularly in developing countries and coastal communities, and highlights challenges like regional disparities, limited access to education, infrastructure gaps, and social inequities—especially for women and Indigenous peoples. Still, there are major job creation opportunities in marine renewable energy, sustainable aquaculture, biotechnology, and conservation, especially if investment is paired with workforce training and digital innovation.

Key recommendations include the development of Sustainable Ocean Plans (SOPs), creation of national blue skills strategies, improvements in data systems, and stronger public-private partnerships. Governments, the private sector, financial institutions, and academia all have roles to play in building an inclusive, adaptive, and skilled workforce. With coordinated action, the transition to a sustainable ocean economy can create millions of new jobs while protecting ocean ecosystems and promoting social equity.

SOPs must be explicit about inclusion. The Ocean Panel calls for blue workforce development plans, inclusive skills training, formalization of labor, and gender-responsive governance. If we want to enable blue jobs and dignity, we must center people—particularly Indigenous Peoples, women, and youth—in ocean governance frameworks.

Conclusion: Turning the Tide with Coherent Action

The ocean knows no borders—its currents, ecosystems, and crises are deeply interconnected. To protect this vast shared resource and unlock its full potential, we must reject fragmented approaches and embrace coherence across governance, finance, security, and equity. Sustainable Ocean Plans (SOPs), supported by frameworks like the 100% Alliance and Ocean Action 2030, offer a powerful pathway to do just that.

This is not only about policy—it is about purpose. It is about placing people, particularly coastal communities, Indigenous Peoples, women, and youth, at the heart of decision-making. It is about aligning public and private investments with the long-term health of our planet. And it is about ensuring that maritime security, economic opportunity, and environmental protection work together—not in isolation.

The time for siloed action is over. The tools are in our hands. If we act with clarity, commitment, and col-

laboration, we can shape a future where the ocean is secure, sustainably managed, and fully integrated into national priorities for climate, biodiversity, and inclusive growth.

References

Thiele, T., A. Pouponneau, A. Swift, L. Arnaud, D. Barrowclough, Y. Batista, C.L. Carpentier, D. Vivas Eugui, L. Heaps, S. Johnson, C. Jolly, S. Koirala, S. Ockenden, A. Peltola, R.D. Tirumala, K. Sack, M. Walsh, and T. Wang.2025. *Ocean Finance for the Sustainable Ocean Economy*. Washington, DC: High Level Panel for a Sustainable Ocean Economy. https://oceanpanel.org/publication/finance-for-the-sustainable-ocean-economy/

Ben Hassen, L., C.S. Colgan, M.J. Spalding, O.S. Ashford, A. Castelletto, H. Ding, M. Grasso, P.A.S. James, K. Narula, A. Pouponneau, T. Slingsby and T. Smanis. 2025. The Future of the Workforce in a Sustainable Ocean Economy. Washington, DC: World Resources Institute. https://oceanpanel.org/publication/oceanemployment/ DOI: https://doi.org/10.69902/64d6259f

Lee-Emery, A., M.Cuddy, and T. Pickerell. 2025. "Assessing 10 years of international commitments to sustainable ocean action: A global stocktake of the Our Ocean Conference." Working Paper. Washington, DC: World Resources Institute. DOI: 10.46830/wriwp.24.00134.

From Science to Scale: Making Sustainability Real in the Blue Economy

Photo credit: Orly Eyal Levie

Hila Ehrenreich
CEO, Israel National Center for the Blue Economy

Keywords:
Blue Economy, Marine Innovation, Sustainable Ocean Economy, Marine

Hila Ehrenreich is the CEO of Israel's National Blue Economy and Innovation Center. She has extensive experience in environmental and infrastructure sectors, specializing in blue economy and innovative technology. She previously served as VP of Business Development at a technology incubator and CEO of a maritime government company, with over 15 years dedicated to advancing ocean economic innovation.

The ocean is the heartbeat of our planet. It covers over 70% of the Earth's surface, regulates the climate by absorbing more carbon than any other system on Earth, transports over 90% of global trade, and provides a primary source of animal protein for more than 3.3 billion people. Without a healthy ocean, there is no climate stability, no food security, and no sustainable economy. The ocean is not just an ecosystem - it is a life-support system.

This is the essence of the Blue Economy: an economic framework grounded in the understanding that the health of the ocean and the health of our societies are inseparable.

As the National Center for the Blue Economy, our mission is twofold: First, to identify, invest in, support, and accelerate startups and innovations that protect marine ecosystems and address the climate crisis. Second, to explore whether the ocean itself can offer more sustainable alternatives to critical human needs - in energy, food, infrastructure, and more.

With the right innovation and investment, the ocean can become a source of cleaner energy, healthier food, more efficient transportation, and stronger economic resilience. But this opportunity depends on our ability to strike a delicate balance - between preservation and utilization, between impact and investment, between urgency and responsibility.

That is the central challenge of sustainability in the blue economy: building growth engines that do not destroy the very ecosystems they rely on.

Figure 1. Israel National Center for the Blue Economy
Photo credit: Israel National Center for the Blue Economy | Hila Ehrenreich

Startups as Stewards of a New Era

Achieving this balance requires bold, visionary entrepreneurs. We need startup founders who are not only technologists or scientists - but leaders. People who are committed to creating solutions that deliver both environmental impact and economic value.

For this mission to succeed, we need excellent startups that generate measurable environmental impact while maintaining strong, scalable business models. These businesses must not only survive the difficult early stages of development - they must also endure, grow, and ultimately replace polluting systems in key sectors such as shipping, ports, energy, and aquaculture.

Startups must be both innovative and investable!

As someone who sees hundreds of startups a year, I witness brilliant technologies that never reach a pilot stage - and even when they do, those that manage to raise capital and secure a potential first customer often hit a wall: regulation.

A private investor evaluating a sustainability-focused solution often perceives regulation as one of the highest risks. And this is where promising technologies can fail. Instead of choosing innovation, investors retreat to familiar, legacy systems - even if they are clearly more polluting - simply because they are known, approved, and predictable.

A clear example is in the field of energy storage - widely considered the holy grail of the clean energy transition. There are dozens of proven, cost-effective, and environmentally superior alternatives to lithium-ion batteries and fossil-based systems. Yet many of them remain stuck in limbo, unable to proceed because regulators subject them to prolonged approval processes that can last decades.

This is not to say we should compromise on safety or environmental assessments. These are essential. But the outcome of today's system is that we entrench legacy infrastructure - solutions that we already know are insufficient or harmful, simply because they are easier to permit. And so, we fail to break the loop.

Innovation in the Blue Economy

The Blue Economy is no longer limited to traditional maritime sectors like shipping or fisheries. Today, it's a powerful arena for innovation, where startups are developing technologies that both preserve marine ecosystems and generate real economic value. These ventures operate at the intersection of science, environmental responsibility, and business scalability, and they demonstrate how the ocean can be a platform for meaningful, measurable climate solutions.

At the National Center for the Blue Economy, we invest in and support startups that exemplify this intersection. These companies aren't just reducing pollution - they're redesigning how maritime industries operate. They tackle some of the most pressing ecological challenges at sea while building scalable, investable businesses.

Below are several examples from our portfolio that illustrate the essence of the blue economy in action, where sustainability and innovation converge to transform harmful practices or ecological threats into opportunities for resilience and renewal.

Figure 2. Concept of Offshore Hydrogen Production via Hydrogen Platform
Photo credit: Shutterstock

Bio-Inspired Anti-Biofouling Technology

One startup in our portfolio has developed a breakthrough solution to combat biofouling - the buildup of bacteria, algae, and other organisms on marine and industrial surfaces. Instead of using toxic coatings or harsh chemicals, their approach leverages a naturally derived peptide that prevents bacterial adhesion by triggering a dispersal mechanism. The result is a non-toxic, biodegradable coating that reduces operational downtime, improves system efficiency, and extends the lifespan of critical infrastructure such as desalination plants and offshore platforms.

Waste Heat-to-Energy Conversion in Marine Environments

A pioneering technology in our portfolio is transforming low-grade waste heat into clean electricity using an innovative thermoacoustic process. This system converts residual thermal energy, often released from ship engines, industrial exhausts, or port operations, into usable electricity without any moving parts, combustion, or chemical refrigerants. It works by converting heat into sound waves, which are then transformed into electrical power through a phase-change mechanism. This allows for the efficient utilization of low-temperature heat sources, previously considered non-recoverable. The technology is silent, emission-free, and highly efficient, offering a substantial reduction in operational costs and carbon emissions.

Figure 3. Biofouling Caused by Barnacles
Photo credit: Shutterstock

Eco-Safe Management of Harmful Algal Blooms

Climate-driven increases in harmful algal blooms (HABs) have created urgent environmental and economic threats across aquaculture, tourism, and marine ecosystems. One of our portfolio companies has developed an advanced monitoring and

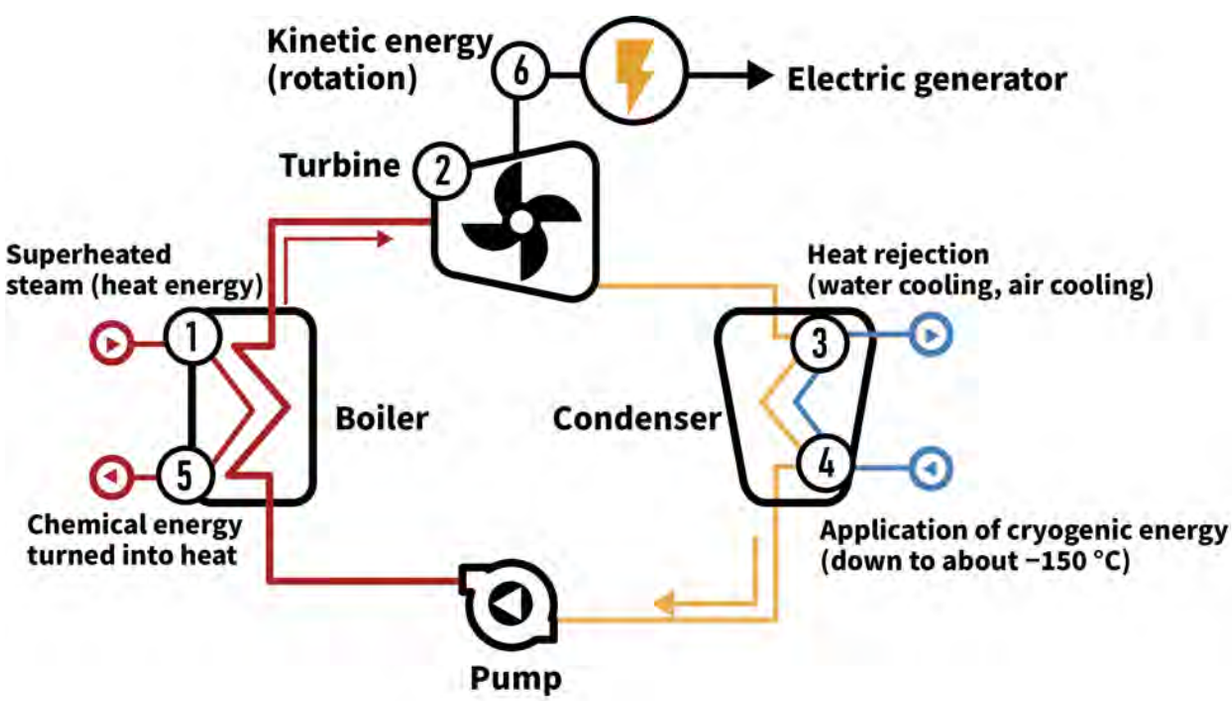


Figure 4. Rankine Cycle – A closed-loop system that converts thermal energy to electricity, including an expander and generator. The Organic Rankine Cycle (ORC) follows the same schematic but replaces water with another organic working fluid.
Photo credit: Illustration by the Editorial Team

Photo credit: Hila Ehrenreich

mitigation platform that combines remote sensing, autonomous detection units, and eco-friendly neutralization agents to stop blooms before they spread. The technology is specifically designed for the smart and efficient removal of toxic cyanobacteria (blue-green algae) from freshwater bodies, pollutants that disrupt ecosystems, endanger public health, and compromise water quality. By triggering the algae to sink naturally to the bottom, along with the carbon they've absorbed, the system delivers a dual benefit: effective water purification and scalable carbon sequestration. This field-deployable, non-invasive approach offers a powerful solution to one of today's most pressing aquatic challenges - all without introducing harmful chemicals or damaging surrounding environments.

In conclusion

The Blue Economy is not just an economic trend. It is a responsibility and an opportunity. It asks us to rethink how we grow, how we consume, and how we live in partnership with the planet's most vital system.

We all understand the importance of the ocean as the heart of the Earth and the basis for our lives. We need to harness innovation to preserve the ocean and learn how to use it sustainably to replace old and polluting industries. For this to succeed, we need excellent companies that are both sustainable and investable - companies that can scale, create value for investors, and serve the public good. And our role, as civil society, as environmental organizations, and as governments, is to enable them to develop and reach the market responsibly, but with a more reasonable time to market.

The path forward demands courage, clarity, and commitment. Because without a healthy ocean, there is no sustainable future. It's as simple - and as urgent - as that.

Seaweed as Infrastructure: A New Framework for Ocean and Environmental Policy

Efrat Landau-Lev
CEO, Seakura

Keywords:
Ulva -Based Infrastructure, Sustainable Ocean Governance, Nature-Based Solutions, Sustainable Marine Management

Efrat Landau-Lev is the CEO of Seakura, specializing in business development and strategic communication with a focus on advancing land-based seaweed cultivation technology. With over 20 years of experience, she leads Seakura's mission to establish Ulva seaweed as part of global strategies for climate resilience, ocean health, and water management.

As climate challenges intensify and marine ecosystems face growing stress, almost all areas of life on Earth are being challenged. From water scarcity to food security, agricultural runoffs, polluting ground fertilization, environmental accountability and even human health, are forming an understanding that an “old world” structural method of operations must change.

As an effort to tackle almost all challenges, this article argues that seaweed cultivation should be reimagined not as food or biomass production alone, but as a core component of each country and state’s infrastructure. We will explore the concept of “Seaweed as Infrastructure,” using the case of Seakura’s land-based Ulva farms in Israel to illustrate how algae systems can be deployed at scale to absorb nutrient pollution, restore ecological balance, and deliver long-term value through environmental services. The model positions seaweed cultivation as a foundational tool for sustainable ocean governance and climate resilience.

Rethinking Infrastructure in the Age of Environmental Accountability

Modern infrastructure is traditionally defined as physical systems that support economic activity: roads, water supply, energy grids, and waste management. But in the Anthropocene, where environmental degradation threatens human and planetary health, infrastructure must be redefined to include natural systems that protect, regulate, and regenerate ecological balance.

Seaweed — and specifically, green macroalgae like Ulva — has a unique biological capacity to absorb excess nutrients such as nitrates and phosphates. When grown deliberately near pollution sources, seaweed acts as a living biofilter, capable of cleaning discharged wastewater, capturing carbon, and enabling environmental services that are not only measurable but highly scalable. From this perspective, seaweed becomes a tool for remediation, for food production, for carbon sequestration, and for resilience.

The Ancient Role of Seaweed: Nature's First Infrastructure

Seaweed has existed for over 1.6 billion years, predating not only flowering plants but also most multicellular life. As some of Earth's earliest photosynthetic organisms, seaweeds were instrumental in producing the oxygen-rich atmosphere that made complex life possible. They played a foundational role in the emergence of ecological systems — forming the first food webs, absorbing minerals, and stabilizing the marine environment. In this sense, seaweed has always been infrastructure: the original infrastructure of life on Earth.

By returning to this ancient wisdom and re-integrating seaweed into modern infrastructure systems — especially those connected to water and nutrient cycles — we are not introducing something new. We are restoring something essential. In the face of climate instability and rising environmental costs, the future may well depend on ancient lifeforms doing what they were always meant to do: balance, regenerate, and sustain.

The Seakura Model: Land-Based Seaweed Systems for Utility Integration

At Seakura (2004), we developed and patented a land-based seaweed farming system designed to treat brine wastewater rich in nutrients, particularly from desalination plants. Our flagship species, Ulva (commonly known as Sea Lettuce), is cultivated in shallow raceways or ponds that receive a controlled flow of wastewater, allowing the algae to absorb excess nitrates and phosphates before the water is released into the sea. In this system, Ulva transforms pollution into biomass.

What makes this infrastructure-oriented model especially powerful is its integration into existing utilities. In Israel, desalination has become a national water solution — providing over 70% of the country's drinking water. However, brine discharge remains an environmental concern due to its high salinity and nutrient concentrations, especially nitrates. By incorporating seaweed farms into the end-of-pipe infrastructure of desalination and wastewater treatment plants, we are addressing this challenge directly and sustainably.

Seakura's first industrial-scale project will launch near Eilat, southern Israel, in 2027. Once operational, it will be capable of removing 10 tons of nitrates annually from a desalination facility's discharge stream. This is a measurable and scalable environmental service with far-reaching ripple effects: reducing marine pollution, increasing the capacity of desalination plants to operate sustainably, and contributing to Israel's food and water security policies.

Proof of Concept: Seakura's Pilot in Eilat

To validate the "Seaweed as Infrastructure" model in real-world conditions, Seakura conducted a successful proof-of-concept pilot in collaboration with Israel's Water Authority, Israel's Ministry of Environmental Protection, and Mekorot – the Israeli national desalination company in its southern desalination plant in Eilat. The objective was to demonstrate the feasibility and impact of using land-based Ulva cultivation systems to absorb nitrate pollution from desalination brine before discharge into the Gulf of Eilat, a sensitive marine environment under strict regulatory oversight. The pilot focused on nutrient removal, system stability, and scalability.

Over the course of 2 years, Seakura's engineered cultivation pools were supplied with nutrient-rich brine water directly from the desalination plant. The Ulva species demonstrated exceptional performance, with measured nitrate uptake rates reaching up to 1 gram of nitrogen per 1 square meter per day ($N/m^2/day$), enabling effective nutrient recovery from effluent previously destined for the sea. The system operated with high stability, minimal energy input, and no chemical intervention. As a land-based solution, it presented zero risk of species escape or habitat disruption, while functioning as a biofiltration "buffer" between industrial infrastructure and the marine environment.

The POC confirmed the viability of expanding to full commercial scale. In the next implementation phase,

Seakura will deploy a 100-dunam (10-hectare) Ulva farm that is projected to remove 10 tons of nitrates annually from desalination brine. This will be the world's first large-scale environmental service farms integrated into a desalination system, demonstrating that seaweed infrastructure can be a high-value addition to national water strategies.

Seaweed for Climate, Agriculture, and Ocean Health

By deploying seaweed as infrastructure, the environmental and social benefits are manifold. Here are a few domains in which algae-based systems can create systemic value:

1. Water and Ocean Health: Seaweed absorbs excess nutrients, improving the quality of coastal waters, reducing eutrophication, and supporting biodiversity.
2. Food and Agricultural Systems: Clean brine discharge allows for more desalinated water to be recycled for agricultural use. Simultaneously, the Ulva biomass can be processed into biostimulants and feed additives, reducing dependency on synthetic fertilizers and antibiotics.
3. Carbon Sequestration and Climate Goals: Seaweed captures CO_2 during photosynthesis. Large-scale cultivation offers a natural carbon sink that supports national net-zero targets. In the Eilat project, over 5 tons of carbon will be absorbed annually.
4. Resilience and Regulation: As water utilities and industries face growing regulatory pressure, algae systems offer a cost-effective and nature-based compliance pathway, turning liabilities into assets.

Taiwan: A Strategic Partner in Marine Innovation

Taiwan, with its advanced marine research institutions, high dependency on desalinated and recycled water, and visionary Blue Economy strategies, is uniquely positioned to lead the adoption of seaweed infrastructure.

The coastal city of Taoyuan, for example, is home to significant ocean innovation programs and a growing need for integrated water management solutions. With Taiwan's increasing focus on environmental sustainability, local implementation of land-based Ulva systems — similar to Seakura's Eilat model — could deliver concrete benefits:

- Nitrate Reduction: Removing nutrient pollution from both industrial and agricultural sources before it reaches fragile marine ecosystems.
- Increased Water Reuse: Cleaner brine means more capacity for reusing desalinated and treated wastewater for agriculture and urban needs.
- Climate and Environmental Credits: Algae systems generate measurable environmental services that may be translated into carbon and nitrogen credits, aligning with Taiwan's broader decarbonization agenda.

By treating Ulva as a tool for environmental services rather than merely biomass production, Taiwan could gain a sustainable and scalable way to manage its ocean interface, support food security, and enable compliance with emerging ESG standards. Seakura is currently exploring collaborations in Taiwan and welcomes joint innovation projects that demonstrate the power of seaweed as living, climate-aligned infrastructure.

ESG, Job Creation, and Maritime Security: Expanding the Value of Seaweed Infrastructure

While environmental remediation and climate resilience are essential benefits of algae systems, seaweed infrastructure also aligns directly with the Environmental, Social, and Governance (ESG) framework increasingly used by governments, investors, and international institutions to evaluate impact and sustainability. Ulva farms offer not only ecological services but also broad-based socioeconomic value—particularly in the areas of job creation, community resilience, and maritime security.

Environmental Services as a New Employment Engine

One of the major advantages of Seakura's model is its labor-generating potential. Unlike fully automated facilities, land-based Ulva systems rely on a balanced integration of human labor and ecological automation. At commercial scale, each Ulva farm employs multidisciplinary teams: marine biologists, water engineers, technicians, logistics personnel, and administrative staff. This creates a stable and skilled workforce that can be localized, trained, and scaled in tandem with environmental objectives. For example, Seakura's upcoming Eilat farm—spanning 100 dunams—will create over 25 direct jobs in its first operational year, with potential for doubling that figure as biomass harvesting, product development, and export channels expand. Additional indirect employment will arise through partnerships with local transportation, agriculture, biostimulant processing, and R&D sectors.

This employment model is inherently inclusive: youth and women can participate in entry-level roles, while local universities and technical colleges can collaborate on workforce development. In regions with limited industrial presence, Ulva cultivation can serve as a green job anchor, providing long-term employment tied to sustainability metrics and measurable ecosystem services.

Figure 1. Large Ulva
Photo credit: Alamy

Figure 2. The Laomei Green Stone Trough is located in Shimen District on the North Coast, Every April and May, because the northeast monsoon slowly weakens, the local rock trough scientific name: tidal trench and sea erosion trench is covered with a large green seaweed
Photo credit: Alamy - Panther Media Global

Social Impact in Underdeveloped Coastal and Island Regions

Remote islands and coastal zones often suffer from declining populations, reduced public services, and limited access to meaningful work. By strategically situating Ulva infrastructure in such areas, countries can reinvigorate coastal economies, attract new residents, and stabilize fragile communities.

In Taiwan—where multiple islands lie at the intersection of strategic geography and environmental sensitivity—this opportunity is particularly timely. Deploying seaweed farms on underutilized islands could create a dual-impact solution: restoring marine ecosystems while reactivating local economies.

Among the most feasible and promising locations are Penghu and Matsu:

- Penghu Archipelago (澎湖群島) consists of dozens of islets, many with small populations and marine-oriented economies. These islands have already attracted interest in wind energy and ocean conservation programs. Ulva farms could complement these efforts by generating green jobs, improving water quality, and integrating with marine innovation initiatives.

- Matsu Islands (馬祖列島), closer to mainland China, are geopolitically sensitive but also targeted for regional revitalization. Civilian-based seaweed infrastructure projects would support population retention, promote sustainable development, and add a layer of peaceful strategic presence in a region where Taiwan has a clear interest in maintaining influence.

Ocean Security: Civil Infrastructure as Strategic Deterrence

A key theme raised during the Ocean Affairs Council forum in Taiwan was maritime security, especially in light of ongoing geopolitical tensions in the South China Sea and Taiwan Strait. In this context, seaweed infrastructure offers an unexpected yet powerful advantage: civilian-led strategic presence. Ulva farms located on remote or contested islands provide

non-militarized anchors for national presence. These are peaceful, internationally legitimate facilities that demonstrate responsible environmental stewardship while simultaneously contributing to territorial sovereignty and ocean monitoring.

These farms can also integrate marine sensors, environmental data stations, and even autonomous drone docks for maritime surveillance—creating a hybrid infrastructure that supports both ecological and security goals. Countries like Taiwan—facing complex diplomatic environments—can leverage this model as a soft power tool: investing in peaceful ocean regeneration projects that carry embedded security value.

ESG at the Intersection of Climate and National Strategy

By blending E (Environmental Services), S (Social Equity and Employment), and G (Governance and Strategic Positioning), seaweed infrastructure stands as a high-performing, ESG-aligned intervention. Investors and governments are increasingly looking for infrastructure that delivers multi-layered ROI—and Ulva farms meet that criteria with clarity.

Conclusion: A Blueprint for the Future

"Seaweed as Infrastructure" is not a metaphor—it is a blueprint. A scalable, science-based, economically viable solution to some of the most pressing challenges facing ocean governance and climate resilience. With the right policy, investment, and cross-sector collaboration, seaweed cultivation can become a new pillar of green infrastructure, unlocking co-benefits for nature, society, and future generations. Seakura's globally unique experience demonstrates that when seaweed is no longer treated as a commodity alone, but as a biological service platform, the value it provides multiplies. It is time for coastal nations—Taiwan among them—to reimagine seaweed not as a supplement to policy, but as a structural foundation of a new, ocean-centered economy.

Efrat Landau-Lev is the CEO of Seakura, a pioneering Israeli company specializing in land-based seaweed cultivation systems that deliver environmental services through nitrate absorption and sustainable biomass production. Efrat holds a BSC degree in Political Communications and Law from the prestigious American college "Emerson" located in Boston, MA. Over the past 20 years Efrat Landau – Lev has mastered massive experience in business development and strategic communication, that transform ideas into solid businesses and global companies. Efrat leads Seakura's mission to position Ulva seaweed as a vital component of global environmental infrastructure. Her work focuses on integrating seaweed cultivation into national strategies for climate resilience, ocean health, and water resource management, for the benefit of many generations to come.

Empower Women, Empower the Blue Economy

Orina Chang
Chair professor and Associate Dean, School of Banking and Finance, National Sun Yat-sen University

Keywords:
Somaliland, Blue Economy, Women Empowerment, South-South Cooperation

Chi-Chen Chang serves as Senior Portfolio Manager and Head of Alternative Investments. She has extensive experience in financial investment, specializing in alternative assets such as private equity, hedge funds, and real estate. Since joining Morgan Stanley in 2016, she has managed diversified investment strategies, consistently delivering steady growth and excellent risk-adjusted performance for clients.

Introduction

Somaliland is a self-declared republic in the Horn of Africa, bordered by Djibouti to the west, Ethiopia to the south, and Somalia to the east. Roughly the size of England and Wales, it spans about 137,600 km² and has an estimated population of around 4-5 million people. The population is almost entirely ethnically Somali and predominantly Sunni Muslim, with Islam declared the state religion. It's economy today remains heavily dependent on livestock and diaspora remittances. Livestock (primarily camels, sheep, goats, and cattle) contributes about 60% of GDP and 85% of export earnings, employing the majority of the workforce. Meanwhile, remittances from abroad inject roughly $1 billion annually, making Somaliland one of the most remittance-dependent economies in Africa. This narrow economic base leaves Somaliland vulnerable to shocks (like droughts that devastate herds) and underscores the need for diversification.

In recent years, Somaliland has forged a unique partnership since 2020 with Taiwan as it seeks both investment and international partnerships. Under the leadership of the current Ambassador from Taiwan, Allen C. Lou (羅振華), Taiwan has supported Somaliland in sectors like education, health, energy,

Figure 1. Geographic Location of Somaliland
Photo credit: Shutterstock

and minerals. In Education, dozens of Somaliland students have received scholarships to Taiwanese universities in fields such as public health, agriculture, and engineering. Taiwan's International Cooperation and Development Fund (ICDF) has also launched vocational training – for example, a new Innovation Zone in Hargeisa that trained a cohort of women in digital skills and ICT literacy. In healthcare, Taiwan has donated equipment (such as COVID-19 aid and hospital supplies) and dispatched medical missions. On the

energy front, Taiwan's state-owned CPC Corporation entered a joint venture to explore oil and gas in Somaliland's onshore block SL10B/13. In the minerals sector, Somaliland has discovered potential deposit of lithium – a critical mineral for batteries. To this front, a U.S. congressional hearing highlighted that a U.S.-Taiwan company (The Chang Development Company 張氏開發) is interested in exploring these lithium reserves.

With the potential of rare earth minerals that could help drive the Somaliland's economy, Somaliland's strategic coast on the Gulf of Aden offers another avenue for economic expansion. The Port of Berbera, long a regional trade hub, is undergoing a major upgrade through a partnership with DP World (Dubai). A new container terminal completed in 2021 expanded Berbera's capacity from 150,000 TEUs to 500,000 TEUs (twenty-foot equivalent units) per year. DP World has invested $442 million in a phased expansion that extend the berth to 1,000m and ultimately enable 2 million TEU annual throughput. This modernized port, plus a new Berbera Corridor highway to Ethiopia, positions Somaliland to capture transit trade and develop logistics services. Berbera's growth is crucial for diversification, as it can reduce over-reliance on livestock by turning Somaliland into a gateway for regional commerce.

Already, around 80% of commodities imported into Somaliland are re-exported to Ethiopia and beyond, highlighting the port's regional importance. With further investment, Berbera can anchor a broader "blue economy" – leveraging ocean resources and maritime industries for growth. The blue economy concept encompasses sustainable fisheries, aquaculture, maritime transport, coastal tourism, and marine energy. For Somaliland, developing its blue economy could unlock new jobs and revenue streams from its 850 km coastline and rich marine waters (which are currently underutilized, with fisheries contributing <2% of GDP). However, success in this sector will depend on inclusive human capital development – in particular, empowering women to participate and lead.

Female Labor Participation and Taiwan's Human Capital Role

To date, Somaliland's gender gaps in education and employment remain significant. Literacy and

Figure 2. Berbera Port
Photo credit: Shutterstock

schooling reflect a disparity that roughly 44% of Somaliland's women (15+ years) can read and write, versus 52% of men. In rural areas the female literacy rate is much lower, barely 10% in some pastoral communities. Cultural norms, domestic responsibilities, and limited school access have historically kept many women out of the workforce. Paradoxically, although fewer women have formal jobs, Somali society often relies on women in practice to keep families and businesses running – especially when men are absent or distracted. This phenomenon is mainly due to the widespread habit of qat (khat) chewing among men. Qat is a mild narcotic leaf that occupies many Somaliland men for hours each afternoon, leaving them unproductive. It's estimated 90% of adult males chew qat daily in Somaliland. The financial and social toll of this addiction is high – Somaliland spends over $500 million a year (about 30% of GDP) importing qat. This dynamic suggests that empowering women with skills and opportunities could have an outsized impact on Somaliland's economy.

As previously mentioned, Taiwan's engagement in Somaliland has placed strong emphasis on human capital development, benefiting both genders but with potential to especially uplift women. Through scholarship programs, Taiwan has funded Somaliland's brightest students (male and female) to pursue higher education in Taiwan's universities. In 2024 alone, 32 Somaliland students received Taiwan scholarships (through MOFA and ICDF), and over 130 Somalilanders have studied in Taiwan since ties were established. Many scholarship recipients are women entering STEM fields, medicine, and public health, which helps chip away at the gender gap in advanced skills. Additionally, Taiwan has supported vocational training and technical education within Somaliland. A notable initiative is the Somaliland Innovation Zone (SIZ) launched in 2021 with Taiwan's support . Through SIZ, the Taiwan Technical Mission ran a five-week ICT course exclusively for women, training 32 female government and private sector employees in computer skills (from word processing to digital graphic design). Courses like this not only improve women's employment prospects in an increasingly digital economy, but also empower them to start businesses (some trainees used their new skills to design logos and plan entrepreneurial ventures).

Figure 3. Outstanding Somaliland Female Students Studying Higher Education in Taiwan
Photo credit: Taipei Representative Office in Somaliland

Taiwan has experience leveraging its own human capital for economic growth – its "economic miracle" was built in part on educating women and integrating them into export manufacturing and services. In sectors directly relevant to the blue economy, Taiwan offers a wealth of expertise that Somaliland can tap into. For example, Taiwan is a global leader in aquaculture and fisheries science; its distant-water fishing fleet is among the world's largest, and it has pioneered sustainable aquaculture techniques for species like grouper and milkfish. Taiwanese academia and industry include many female scientists, technicians, and business owners in marine industries . This experience could be shared through training programs for Somaliland's aspiring "fishpreneurs" – teaching women how to farm fish or sea cucumbers, how to process and package seafood, and how to manage co-ops and supply chains. Likewise, Taiwan's advanced port logistics and shipping industries (where women now hold many management roles) can provide mentorship as Somaliland trains a new workforce for Berbera Port operations. The Somaliland-Taiwan partnership, while still young, has the potential to deliberately cultivate a female-driven blue economy workforce. By channeling scholarships and technical assistance towards maritime subjects – e.g. marine biology, coastal engineering, fisheries management – Taiwan can help Somaliland build a cadre of educated women ready to lead in fisheries,

port administration, marine tourism, and related fields.

Kenya - A Case Study: Women's Fish Processing Cooperatives

To visualize what a women-empowered blue economy could look like for Somaliland, we could examine successes elsewhere in Africa. To this end, Kenya offers a case study demonstrating how empowering women in the blue economy can transform communities.

In coastal Kenya (as well as around Lake Victoria), women have long been the unsung heroes of the fishing industry. While men usually dominate fishing at sea, women dominate the post-harvest sector – they purchase fish at the landing sites and handle processing (sun-drying, smoking, salting, or frying the fish) and marketing in local markets. These female fish processors, often called "mama karanga" (fish frying mothers) at the coast, typically operate informally with very small capital. In the past, lack of access to credit and cold storage meant women had little choice but to accept whatever price the middlemen offered, leading to slim profits. However, in the last decade, Kenya has seen the rise of women's cooperatives and micro-finance support in the fisheries sector that are transforming these livelihoods. By organizing into cooperatives or beach management units (community fisheries organizations) and pooling resources, women have been able to invest in better technology, such as acquiring energy-efficient smoking kilns and solar fish dryers that reduce spoilage and improve product quality.

Micro-finance institutions, sometimes in partnership with NGOs, have started offering equipment leasing or low-interest loans tailored for women fish processors . In some fishing communities, women's groups have obtained freezers and ice boxes through grants, allowing them to store fish and sell when prices are favorable rather than rush to sell at low prices. As a result, women are capturing more value from the fish trade. A World Bank-supported program in East Africa noted that when women received training plus improved processing technology (like solar tents), their incomes and asset ownership rose significantly.

Beyond income, these cooperatives also give women a stronger voice in fisheries management that was historically male-dominated. In Kenya's South Coast, for example, women-led cooperatives now participate in co-managing marine resources, ensuring sustainable

Figure 4. Outstanding Somaliland Students Studying Higher Education in Taiwan
Photo credit: Taipei Representative Office in Somaliland

practices (such as observing closed seasons and protecting mangrove nurseries) in exchange for microcredit and marketing support from government agencies. The transformation of informal female fishmongers into organized entrepreneurs has had ripple effects: families have more stable year-round income; communities get improved food security through reduced post-harvest losses; and the women gain social recognition as equal contributors to the household.

Conclusion

A gender-inclusive blue economy is not a lofty ideal for Somaliland – it is a practical strategy to achieve the country's development aspirations. By actively involving women in new maritime industries, Somaliland can double its talent pool and ensure the benefits of growth reach all citizens. The World Economic Forum estimates that closing gender gaps in labor markets could add 26% to global GDP. In Somaliland's context, empowering women in the blue economy will help tackle several national goals – reducing unemployment to increase household incomes and diversify its economy.

Taiwan's role as a development partner remains pivotal in this journey. Through continued support in education and technical know-how, Taiwan can help ensure that Somaliland's women have the skills and confidence to captain fishing boats, run fish processing plants, or launch startups in seafood export and marine tourism. The friendship between Taiwan and

Figure 5. Mama Karanga and the Fish Product Processing to Sale Process
Photo credit: Shutterstock

Somaliland is built on mutual values of self-reliance and democracy; by extending that ethos to include women's empowerment, the partnership can become a model of inclusive South-South cooperation. Already, Taiwan's training programs (like the women-in-tech initiative and scholarships) are planting seeds for a future cohort of female leaders in Somaliland's economy. Going forward, targeted programs – perhaps a "Women in Blue Economy" initiative funded jointly by Taiwan and international donors – could fast-track the integration of women into fisheries and port logistics jobs via internships, seed grants, and exchange programs with Taiwanese experts in aquaculture and marine management.

The Habibie Center

habibiecenter.or.id

The Habibie Center (THC) is an independent think-tank committed to advancing democratic values in Indonesia and beyond. Founded in November 1999 by the third President of Indonesia, B.J. Habibie and his family, THC champions the establishment of a democratic society that respects, protects, and promotes human rights.

THC operates based on three foundational principles: decision-making that reflects the voice of the people, equal before the law, and transparent and accountable governance.

Building on Habibie's legacy as the President who led Indonesia through its democratic transition, THC supports reforms that institutionalize democracy in Indonesia. These include lifting restrictions on political parties and civil associations, conducting free and fair elections, promoting freedom of press, advancing regional autonomy for equitable development, and reforming national armed forces to allow for democratic civilian control.

Currently, THC implements three core programs. In politics, media, and governance, THC promotes democratic norms through the Habibie Democracy Forum and regular public dialogue Dialog Demokrasi. With The ASEAN Studies Program, THC fosters academic-government collaboration and public awareness on regional integration, notably through the Talking ASEAN seminar series. In the areas of social inclusion, THC has developed a national database on violence, conflict, and terrorism. Furthermore, THC has successfully implemented a program to reintegrate the former terrorist convicts and their followers into their community in Poso, Central Sulawesi. In its effort to support JustEnergy Transition, THC promotes democratization by ensuring meaningful public participation in the transformation process through policy research, publications, capacity building, and multi-stakeholder dialogues.

In 2025, THC continues to explore the intersection of democracy with politics, social inclusion, and energy transition. Planned activities include hosting the annual Habibie Democracy Forum, promoting people to people connection to strengthen social cohesion in Indonesia and ASEAN, and advocating for an inclusive energy transition through institutional strengthening and international partnerships.

THC believes that collaboration is crucial for achieving sustainable and impactful outcomes. In partnership with multiple stakeholders, both domestic and international, THC has worked with many agencies including The Indonesian Ministry of Foreign Affairs, Coordinating Ministry for Human Development, National Counter Terrorism Agency, Bank Indonesia, The World Bank, USAID, UNDP, UN Women, Ford Foundation, Sasakawa Peace Foundation, Korea Foundation, The Asia Foundation, Taipei Economic and Trade Office, Konrad-Adenauer-Stiftung, foreign embassies and diplomatic missions in Indonesia, and many more.

ORF began its journey in 1990 at the juncture of ideation tempered by pragmatism.

During the period of India's transition to a new engagement with the international economic order, several challenges emerged, evoking a need for an independent forum that could critically examine the problems facing the country and help develop coherent policy responses. ORF was thus formed, and brought together, for the first time, leading Indian economists and policymakers to present the agenda for India's economic reforms.

As a premier public policy think tank in India, Maritime Studies remains a core area of focus for the Observer Research Foundation (ORF). The maritime character of India's geography has made it imperative for stakeholders engaged in public policy conversations to weigh in on the potential of oceans to shape a resilient future securing our interests and compulsions.

By way of research, ORF engages in rigorous research by way of frequently publishing short-form as well as long-form articles which cater to a vast network of readership. Through this endeavor, ORF's research provides vital input in informing policy conversations, fostering debate and dialogue on key issues pertaining to the maritime domain. Apart from research, ORF also engages in policy conversations by way of hosting and participating in global policy dialogues.

Sagarmanthan: The Great Oceans Dialogue, an annual convening on maritime global economy is one of ORF's key contributions in informing policy debates on the maritime domain. This dialogue brings together key voices including policy makers, scholars, and practitioners of various aspects of the Blue Economy, Shipping, Maritime Connectivity, amongst others, to debate and discuss actionable pathways, which will be crucial in determining strategies to herald a common blue future. As India undergoes a vital transition in embracing its maritime identity, ORF's priority areas are shaped by the need to harness the opportunities that appear to emerge and guide India's role in shaping the global maritime future.

2025 serves as a crucial for India's maritime engagement. By way of its location at the heart of the Indian Ocean, and as a key pillar of the Indo-Pacific strategic geography, India's role in maritime norm-making is indeed critical. This year, India is poised to host the Quad Leaders' Summit, assume the chair-ship of the Indian Ocean Rim Association, as well as the Indian Ocean Naval Symposium. These will remain key priority areas for ORF as a vital actor in shaping policy conversations on the maritime.

ORF's vast repository of maritime research can be found

2024 Sagarmanthan Summit, South Asia's Largest Maritime Dialogue, Opens in Delhi
The "Sagarmanthan: The Great Oceans Dialogue" was jointly organized by India's Ministry of Ports, Shipping and Waterways (MoPSW) and the Observer Research Foundation (ORF), a leading global think tank based in Delhi.
Pictured from right to left: Greek Minister for Maritime Affairs and Insular Policy Christos Stylianides; Maldives Minister of State for Fisheries and Ocean Resources Amzath Ahmed; National Representative for Rio Negro Province, Argentina Maria Lorena Villaverde; India's Union Minister of Ports, Shipping and Waterways Sarbananda Sonowal; India's Union Minister of State for Ports, Shipping and Waterways Shantanu Thakur; MoPSW Secretary T.K. Ramachandran; and ORF President Samir Saran.

Photo credit: Observer Research Foundation (ORF)

2025 Taiwan International Ocean Forum

Department of International Development, Ocean Affairs Council

Hosted by the Ocean Affairs Council, the "2025 Taiwan International Ocean Forum" (TIOF) was organized this July at the National Taiwan University Hospital International Convention Center. Focusing on two main themes—maritime security and the blue economy—the forum explored the increasingly complex global geopolitical landscape and emerging security challenges. On the day before the forum, the TIOF speaker delegation was received by President Lai. The President noted that the "Taiwan International Ocean Forum," established in 2020, has become an important platform for Taiwan to deepen cooperation with various countries. He expressed hopes that the visiting guests would have fruitful outcomes from this year's forum and that their visits would enhance friendship between Taiwan and international ocean partners, working together to promote marine prosperity and sustainable development for future generations.

Figure 1: The President poses with the delegation at the "2025 Taiwan International Ocean Forum."
Photo credit: Office of the President, Republic of China (Taiwan)

Day 1 | Building Maritime Security and Harmony Together in the Indo-Pacific

High-Level Dialogues

The first day of the forum spotlighted the High-Level Dialogues, moderated by Thomas P. McDevitt, President of The Washington Times. Panelists included Bi-Ling Kuan, Minister of the Ocean Affairs Council; Fei-Fan Lin, Deputy Secretary-General of Taiwan's National Security Council; and Gavin Williamson, Member of the UK Parliament and former Secretary of State for Defence; and Yamato Aoyama, Member of the House of Representatives of Japan from the Constitutional Democratic Party.

Minister Kuan emphasized that Taiwan, situated on the frontlines of the First Island Chain, has long faced China's military exercises, gray-zone incursions, and the persistent threat of "cognitive warfare." As Taiwan's top ocean policy authority, the Ocean Affairs Council is tasked with safeguarding national security, maritime law enforcement, public safety, and environmental sustainability. This broad mandate enables Taiwan to engage the international community across multiple fronts, fostering resilient and enduring partnerships that transcend political shifts.

Deputy Secretary-General Lin warned that Taiwan is not China's only target, stressing that the democratic camp must stand united in confronting Beijing's challenge to Indo-Pacific security. "This is a contest between democracy and authoritarianism, and global democratic partners must stand together," he said, adding that strengthening technological defense and building whole-of-society resilience are essential.

Former UK Defence Secretary Gavin Williamson expressed strong support for Taiwan, remarking that Taiwan has been "too modest" on the world stage and should more actively seek international attention and backing. Sharing the UK's experience, he recalled that after a British warship transited the Taiwan Strait, Beijing lodged protests, yet London did not back down. Instead, the action encouraged France and Australia to take similar steps. He stressed: "Taiwan's freedom is not Taiwan's issue alone—it is the shared responsibility of the entire democratic world. We must show our resolve through action and ensure that dictators do not prevail."

Expert Insights

Beyond the High-Level Dialogue, Philippine maritime security expert Jay Tarriela highlighted in his keynote address that China's provocations in the South China Sea pose a grave threat to regional stability. He argued that Beijing's actions have exceeded the bounds of lawful jurisdiction, undermined the international norm of respecting sovereignty and territorial integrity, and violated the principles of the United Nations Convention on the Law of the Sea (UNCLOS).

Figure 2 (left): Thomas P. McDevitt, President of The Washington Times, moderated the "High-Level Dialogue," with panelists including Kuan Bi-ling, Chairperson of the Ocean Affairs Council (center); Lin Fei-fan, Deputy Secretary-General of the National Security Council (far left); Gavin Williamson, former UK Secretary of Defence and current Member of Parliament (second from right); and Aoyama Taito, Member of Japan's Constitutional Democratic Party (far right).
Photo credit: Ocean Affairs Council

Figure 3: On the first day of the forum, discussions highlighted security challenges in the Indo-Pacific maritime region, including gray zone operations, maritime militias, submarine cable protection, and quasi-blockade measures. Experiences in the South China Sea provided a basis for examining regional cooperation mechanisms. In the afternoon, the forum shifted focus to a free and open Indo-Pacific strategy, emphasizing multinational joint law enforcement, humanitarian assistance, and maritime domain awareness sharing.
Photo credit: Ocean Affairs Council

Day 2 | Resilience Through the Blue Economy

Whereas the first day of the forum focused on security and resilience, the second day turned to the blue economy, with speakers from Korea, Israel, Japan, Taiwan, Malaysia, and India sharing diverse perspectives on innovation, policy, and inclusive governance.

In a keynote address, Diane Faith Figueroa, Director for Innovative Finance at RARE's Indo-Pacific Program, noted that the global funding gap for ocean conservation exceeds USD 100 billion annually. She highlighted innovative financial instruments such as Indonesia's small-scale fisheries impact bonds and the Philippines' coral reef insurance schemes, demonstrating that cross-sector collaboration can generate scalable funding models for conservation.

On building industrial momentum and strategic resilience, Jungchul Bae, President of the Korea Marine Equipment Research Institute, and Hila Ehrenreich, CEO of Israel's National Blue Economy Center, presented technology-driven initiatives, including eco-friendly ship design, ammonia fuel testing facilities, and seaweed-based carbon sequestration projects. Both emphasized that technological progress must advance in conjunction with regulatory and policy frameworks to drive low-carbon industrial transformation.

Turning to synergies between economic development and nature, Efrat Lev, CEO of Israel's SEAKURA, and Alita Sangalang, Senior Specialist at the Philippines' Department of Environment and Natural Resources, shared experiences in advancing seaweed cultivation, mangrove restoration, and coral reef rehabilitation. They underscored the need to integrate these cost-effective solutions into coastal governance and ESG metrics.

At the policy advocacy level, M. Hasan Ansori, Executive Director of the Habibie Center in Indonesia, stressed the importance of the "triple helix" model of government, business, and civil society collaboration as the foundation for advancing blue ESG governance. Minako Inoue, Chair of Sailors for the Sea Japan, called for expanding the WTO Fisheries Subsidies Agreement and strengthening the "Blue Seafood Guide" to promote sustainable consumption and marine conservation.

Younger Generations: The Key to a Sustainable Future

This year's forum featured a special session moderated by Jasmine Lee, Co-Founder of US Taiwan Watch, bringing together young ocean advocates from Taiwan, the United States, Japan, and India to showcase the diverse capacities of the next generation in driving ocean action through technology, local knowledge, and satoumi-based approaches.

Szu-Ying Chen, Executive Director of the Azure Alliance in Taiwan, highlighted how integrating artificial intelligence with local knowledge systems can broaden the application of marine sustainability policies, while also sharing her experiences at COP28 and the UN Human Rights Council. Chia-Lin Huang, a Taiwanese writer on sustainable marine tourism, showcased how emotional narratives can drive advocacy efforts through ocean stories, local conservation, and citizen science.

Aya Matsuda, International Affairs Advisor to Japan's Whaling Association, introduced the concept of "marine ranching" as an alternative to traditional energy-intensive aquaculture, underscoring the importance of island communities in food security and ocean sustainability. Bhavesh Jain, an awardee of India's National Youth Challenge, presented his glass-bottle reuse entrepreneurship initiative, illustrating how young leaders can generate both environmental and social impact through community-based action.

Outlook

The 2025 Taiwan International Ocean Forum, through its themes of maritime security and the blue econo-

my, forged consensus among democratic partners in confronting gray-zone threats while exploring viable pathways toward blue sustainability through innovative finance, low-carbon technology, and community action. By deepening regional cooperation, the forum also infused sustained policy resilience and momentum into global ocean governance. Taiwan will continue to advance a new maritime paradigm where security and sustainability converge, leveraging on solid partnerships and forward-looking visions.

Figure 4: On the second day, the forum focused on "Blue Economy and ESG Transformation," starting from supply chain restructuring and net-zero transition, with in-depth discussions on blue carbon markets, ocean green finance, smart monitoring, and sustainable fisheries. Participants included experts and think tanks from The Economist, Israel, South Korea, Japan, and other countries, jointly exploring strategies for aligning Asia-Pacific blue innovation with Taiwan's blue economy practices.
Photo credit: Ocean Affairs Council

Ocean lab -The Global Plastics Treaty

Department of International Development, Ocean Affairs Council

From the Convenience of Plastics to a Marine Crisis

Plastics were once hailed as the most convenient material—lightweight, inexpensive, and durable. Yet precisely because of their durability, plastics have become one of the greatest hidden threats to our environment. Did you know that more than 14 million tons of plastic waste enters the ocean each year (UNEP, 2021)—the equivalent of one truckload every single minute?

These plastics do not simply float on the sea surface. Large debris, such as discarded fishing nets and plastic bags, can entangle turtles and whales, sometimes suffocating them. Once broken down, microplastics are ingested by fish and shellfish, eventually returning to our dining tables. Even more subtle yet threatening are the chemical additives in plastics, such as phthalates and bisphenol A (BPA), which can disrupt reproductive systems in marine life and pose risks to human health.

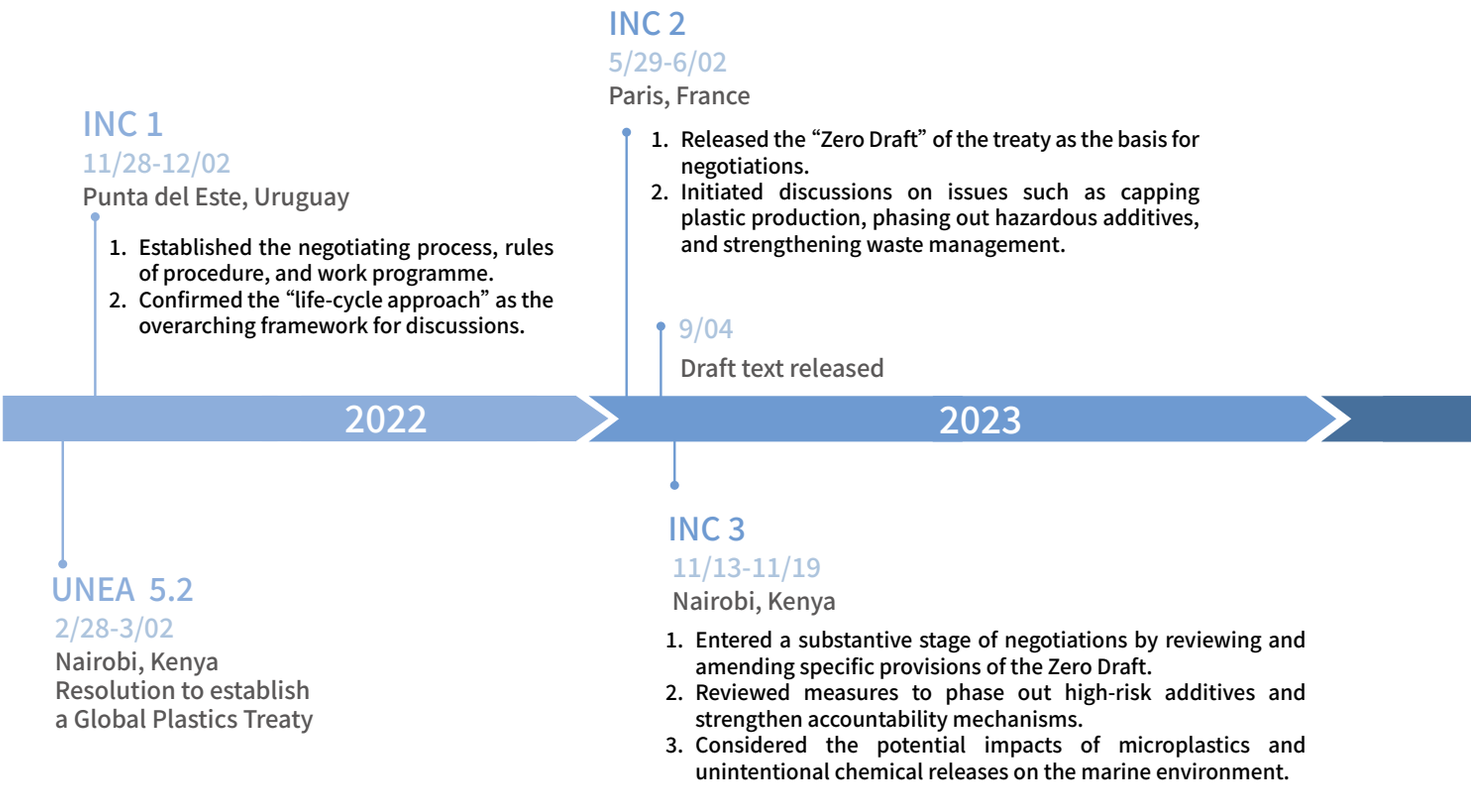


Figure 1: The Negotiation Process: INC-1 to INC-5.2
Since 2022, the Intergovernmental Negotiating Committee (INC) has convened five sessions, progressively advancing the development of the Global Plastics Treaty
Photo credit: Ocean Affairs Council

Background and Objectives of the Global Plastics Treaty

Background

Because marine litter and plastic pollution transcend national borders and affect the global commons, unilateral actions by individual countries cannot effectively address the problem. In March 2022, 175 countries adopted a historic resolution at the United Nations Environment Assembly (UNEA, 2022), launching negotiations toward a legally binding international agreement to comprehensively tackle plastic pollution. This agreement has been described as the "Paris Agreement moment" for plastics governance—intended, like the Paris Agreement on climate change, to serve as a decisive global framework for confronting plastic pollution (hereafter referred to as the "Global Plastics Treaty").

Objectives of the Global Plastics Treaty

Objective 1: Reducing Plastic Pollution

The Treaty's foremost objective is to significantly reduce plastic pollution and prevent plastics from entering the marine environment. From abandoned fishing gear that entangles turtles and whales to microplastics that infiltrate the food chain and harm both ecosystems and human health, plastics pose pervasive risks. By addressing the entire life cycle of plastics—from product design and consumption to end-of-life management—the Treaty seeks to minimize plastic leakage and allow the ocean to recover.

INC 4
4/23-4/29
Ottawa, Canada

1. Advanced into negotiations on the legal architecture and detailed treaty provisions.
2. Discussed the establishment of mandatory plastic reduction targets and financial support mechanisms.
3. Deliberations on production limits and product design requirements became increasingly contentious.

INC 5.1
11/25-12/01
Busan, Korea

1. Originally planned as the final negotiating session, but member states failed to reach consensus on several critical issues.
2. The session concluded with agreement to use the Chair' s revised text as the basis for further negotiations.
3. Decided to reconvene in Geneva, Switzerland, on 5–14 August 2025 (INC-5.2), aiming to finalize the treaty.

2024 | 2025

INC5.1
Chair' s text of the Global Plastics Treaty (Draft)

INC 5.2
8/05-8/14
Geneva, Switzerland

1. Due to sharp divisions over plastic production reduction and restrictions on toxic chemicals, the session produced only a non-binding draft text.
2. The Chair' s two proposed draft texts excluded references to the full life cycle of plastics and removed provisions on health and product phase-outs. As a result, no country supported the drafts, with many states calling for negotiations to resume based on the INC-5.1 text.
3. Even with a one-day extension, no consensus was reached. The timing and venue for the next round of negotiations remain undecided. Civil society groups criticized the consensus-based decision-making process, arguing that it was exploited by oil-producing countries to further delay progress.

Divergence on key issues, no consensus was reached in the end

INC 5.2
the Global Plastics Treaty (Final Draft Treaty)

Objective 2: Enhancing Recycling and Reuse

Plastics should not be treated as "single-use and disposable," but rather as resources within a circular economy framework. The Treaty promotes strengthened systems for recycling, reuse, and the development of sustainable alternatives—for example, reprocessing discarded fishing nets into new products. By advancing circularity, countries can reduce the flow of plastics into the ocean, safeguard marine ecosystems, and stimulate green industries.

Objective 3: Regulating Hazardous Chemicals

Many plastics contain harmful chemical additives such as phthalates and bisphenol A (BPA), which enter the marine environment through waste and threaten reproductive and developmental health in living organisms. One of the Treaty's objectives is to regulate, restrict, or phase out high-risk additives, thereby preventing their accumulation through microplastics in the food chain and protecting both ecological and human health.

Objective 4: Supporting a Just Transition

While plastic pollution affects everyone, countries vary greatly in their capacity to respond. The Treaty promotes equity through financial aid, technology transfer, and capacity-building for developing nations. This inclusive approach ensures that waste management improvements and plastic reduction efforts can be genuinely implemented worldwide and in the oceans.

Key Controversial Issues

Since the mandate to negotiate a legally binding Global Plastics Treaty was adopted in 2022, the process has faced persistent challenges. Diverging national interests have prevented consensus, and as of the INC-5.2 session in August 2025, critical disagreements remain unresolved. The negotiations have split into two opposing camps:

Countries Advocating Strong Plastic Reduction

Led by the European Union, the United Kingdom, and Canada, this group emphasizes the need to act at the source by restricting plastic production and establishing a comprehensive "full life-cycle tracking mechanism" to provide traceability across supply chains. They argue that only by reducing overall plastic volumes and ensuring product traceability can the world effectively curb the escalating plastic crisis.

Countries Opposing Production Caps, Favoring End-of-Pipe Solutions

Led by major petroleum exporters such as Saudi Arabia and India, this group strongly resists limits on production. They contend that the negotiations should instead focus on strengthening waste management regulations and improving recycling systems, thereby mitigating environmental impacts without imposing severe disruption on the petrochemical industry.

In addition to these core debates, further divisions have arisen in the area of ocean governance:

Managing Existing Pollution:

Small island developing states (SIDS) and coastal nations have called for the creation of an international fund and for producers to share responsibility for marine litter clean-up. However, some industrialized countries oppose overburdening companies with liability, leaving financing mechanisms unresolved.

Abandoned Fishing Gear and Shipping Waste:

Discarded fishing nets frequently cause "ghost fishing," posing long-term threats to fish stocks and marine ecosystems. Some countries have proposed including these under extended producer responsibility (EPR) schemes. Major fishing nations, however, have expressed reservations, concerned about imposing additional burdens on fishers.

Technology Transfer and Financing:

Developing countries broadly argue that without adequate international financial support and technology transfer, they cannot build effective recycling and monitoring systems, nor fully implement the treaty. The design of a fair and equitable mechanism for financing and burden-sharing remains a decisive factor for the success or failure of the negotiations.

Taiwan's Response to the Global Plastics Treaty

Although Taiwan is not a formal Party to the Global Plastics Treaty, it continues to closely monitor and actively engage in relevant developments. Domestically, Taiwan has anchored its efforts in the Resource Circulation Promotion Act and other environmental regulations, progressively strengthening marine plastic pollution governance. With ocean-related issues gaining prominence in the negotiations, Taiwan's Ocean Affairs Council (OAC) participated for the first time in the Geneva INC-5.2 session, ensuring timely awareness of negotiation dynamics.

Taiwan's existing policies on plastic reduction are closely aligned with the treaty's core principles, demonstrating both a comprehensive policy framework and a clear direction of action. Regardless of the outcome of international negotiations, Taiwan's determination to advance plastic reduction and the circular economy remains steadfast. Concrete measures by key agencies include:

Resource Circulation Administration:

Taiwan's circular economy policies mirror the treaty's four central pillars: reducing and substituting plastic products, promoting sustainable product design, advancing circular economic transformation, and managing legacy pollution. Measures include the implementation of multiple bans on single-use plastics, promotion of "4S Green Design" principles, the establishment of the efficient "Four-in-One Recycling System," and the Salute to the Sea program targeting legacy marine plastics.

Chemical Substances Administration:

Beyond plastics management, the treaty also addresses chemicals used in plastics. Taiwan has already regulated 18 substances across 7 categories identified in the negotiations. Operators are required to obtain permits and submit regular reports, aligning Taiwan with emerging global trends in chemical control.

Ocean Affairs Council:

On end-of-pipe management, the OAC has mobilized an "Environmental Fleet" and "Undersea Warriors" to remove floating and seabed litter. It has also launched the Marine Debris Recycling Alliance to promote resource recovery and circular reuse of ocean plastics. Through the Indo-Pacific Regional Marine Debris Cooperation Platform, Taiwan collaborates with international organizations and neighboring states, sharing expertise and technology, and demonstrating its commitment to global responsibility.

Through inter-ministerial collaboration and the effective implementation of existing policies, Taiwan continues to consolidate its achievements in plastic reduction while demonstrating proactive action to the international community. Going forward, Taiwan will deepen its plastic reduction and circular economy policies, contributing to global plastic pollution governance through knowledge-sharing and cooperative engagement.

References

United Nations Environment Assembly (UNEA). (2022). *Resolution to end plastic pollution: Towards an international legally binding instrument.* UNEP. https://www.unep.org/

United Nations Environment Programme (UNEP). (2021). *From pollution to solution: A global assessment of marine litter and plastic pollution.* UNEP. https://www.unep.org/

International Ocean Information

Quarterly | Vol.36

Published by	Ocean Affairs Council
Address	4F, No. 25, Chenggong 2nd Road, Qianzhen District, Kaohsiung City 806610, Taiwan.
Telephone	(07)338-1810
Website	https://www.oac.gov.tw/

Publisher	Bi-Ling Kuan
Editor-in-Chief	Hsiang-Wen Huang
Deputy Editor-in-Chief	Shan-Ying Lee
Editorial Consultant	Shih-Ming Kao, Yang-Chi ChanLiu, Yau-JrChuang, Ching-Ta, Ming-An Lee, Ting-Wei Chen
Planning and Editing	Jia-Bin Lin, Pei-Chuan Tsai, Hui Cheng, Xi Li, Shih-Ju Shao, Zhu-Yun Zheng, Chun- Hao Lin, Fan- Chin Shih

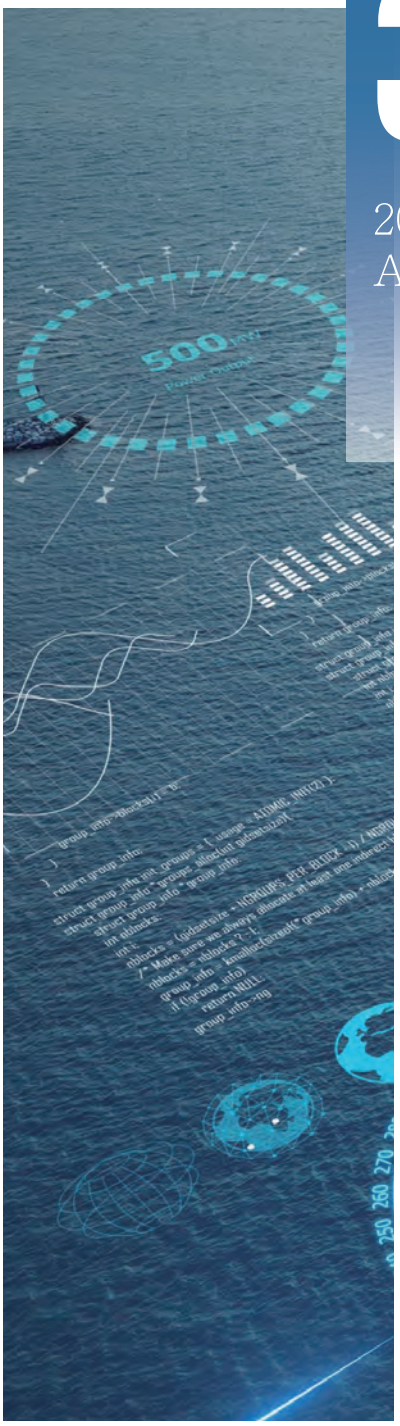
---

Executive	Taiwan Geographic Information Center
Address	6F, No. 7, Section 1, Roosevelt Road, Zhongzheng District, Taipei City 100215, Taiwan
Telephone	(02)2393-1122
Website	https://www.tgic.org.tw/

Executive Editor	Kun-Chi Lai
Administrative Editor	Yue-An Cian
Administrative Director	Meng-Ying Li
Art Editor	Yu-Chun Lin, Yue-An Cian
Proofreading	Meng-Ying Li, Yi-Jie Wang
Translation Team	Cathleen Lin, Kai-Hsuan Zhang
Image Source	Shutterstock, Alamy, Freepik.com

國際海洋資訊
International Ocean Information

Vol.
36
2025
AUTUMN



國際海洋資訊
International Ocean Information

線上全文

線上初期

中華民國114年9月出版（每季出版）
中華民國108年8月創刊
ISSN 2706-638X（紙本）
ISSN 2706-6398（電子）
中華郵政高雄雜字第236號執照登記為雜誌交寄

封面 / 封底
Front Cover / Back Cover
藍色經濟示意圖
Illustrative Diagram of a Blue Economy
資料來源:Shutterstock
Photo credit:Adobe Stock

發行 海洋委員會 Ocean Affairs Council

編印 Taiwan GIS Center 財團法人台灣地理資訊中心