CASE STUDY

GLOBAL | MARITIME SUSTAINABILITY

Navigating the Future of Port Cities

As vital hubs for international transport, ports have rich histories of enabling commerce and connectivity. Six iconic port cities share with us how they are innovating to ensure adaptability, sustainability and climate resilience.

Tan Suan Jow has been the Dean of MPA Academy since 1 April 2017. He also holds the appointment of Chief Knowledge Officer. Prior to these appointments, Mr Tan was MPA's Director (Shipping Division) and Director of Marine as well as Director (Sustainability Office).

Port cities have long been vibrant hubs that play a crucial role in local and global trade, commerce and connectivity. Through the decades, port cities have withstood the test of time and continue to ride the waves of change in sustainability and integration, and face new challenges from climate change.

As a global hub port and leading international maritime centre, Singapore has been spearheading efforts in digitalisation and decarbonisation towards a more sustainable and low-carbon future for the global maritime industry. Singapore's port terminals will transit towards a low-carbon future, through the adoption of cleaner energy, automation and digitalisation. By 2030, our port terminal operators aim to collectively achieve a reduction of at least 60% of total emissions from port operations compared with 2005 levels, and to reach net zero emissions by 2050.

Singapore is also fostering a culture of innovation and sustainability across the maritime ecosystem. The Maritime and Port Authority of Singapore (MPA) has been relentless in driving initiatives to promote green shipping. At the international front, Singapore has been actively establishing green and digital shipping corridors with like-minded partners to pilot digital solutions and decarbonisation initiatives along trade routes. The port city is committed to leading the charge towards a greener, more sustainable maritime future.

> Each city's journey serves as a testament to the resilience and adaptability of port cities in an ever-changing world.

Driving Maritime Innovation and Sustainability

In the face of new global challenges and opportunities, the visionary transformation of five other iconic port cities offers a glimpse into the evolving landscape of urban maritime integration and sustainability. We take a look at how the unique history, challenges, and aspirations of Antwerp, Barcelona, Cape Town, Shanghai and Yokohama are shaping their efforts to ensure future resilience.

Antwerp's ambitious riverbank renewal and visionary infrastructure projects like The Big Link illustrates how climate adaptation can harmonise with urban liveability. Barcelona's exemplary efforts towards synergising port activities with urban life and fostering blue economy innovation showcase how a strategic vision can lead to sustainable growth and environmental stewardship.

Steeped in maritime history, Cape Town is embracing the blue economy with initiatives like the Blue Cape that catalyse economic growth while preserving marine ecosystems. Shanghai's relentless pursuit of port infrastructure excellence, exemplified by the Yangshan Deep Water Port Phase IV, shows its dedication to advancing efficiency and connectivity in global trade. Meanwhile, Yokohama is spearheading initiatives like its carbon-neutral port and international collaborations, leading the charge towards a greener and more sustainable future for port operations.

From urban renewal to environmental conservation, from economic growth to technological innovation, each city's journey serves as a testament to the resilience and adaptability of port cities in an ever-changing world.

Let us draw inspiration from the collective vision and ingenuity of these port cities, to chart a course towards a more sustainable, connected, and resilient future for urban maritime integration.

Advancing Tuas Port's Digitalisation and Decarbonisation

Tan Suan Jow has been the Dean of MPA Academy since 1 April 2017. He also holds the appointment of Chief Knowledge Officer. Prior to these appointments, Mr Tan was MPA's Director (Shipping Division) and Director of Marine as well as Director (Sustainability Office).

Singapore's Tuas Port will be developed in four phases and was officially opened on 1 September 2022. When completed in the 2040s, Tuas Port will be automated, intelligent and sustainable, with a handling capacity of 65 million twenty-foot equivalent units (TEUs), almost double the volume handled in 2021.

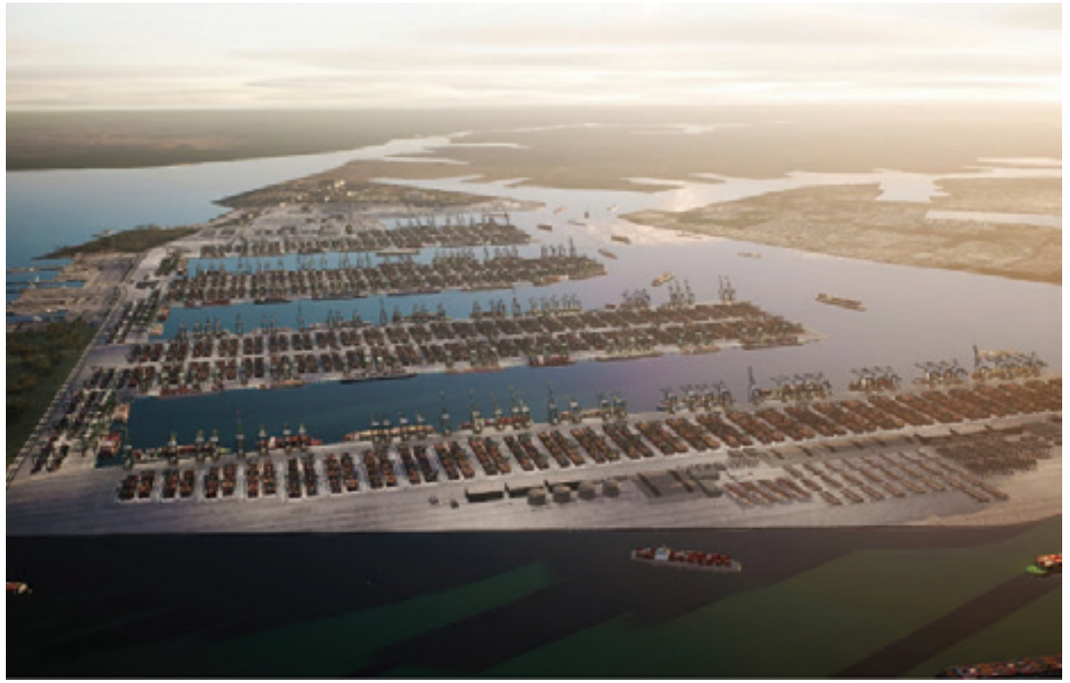
Sustainability is integral to Tuas Port's design, planning and construction. For instance, excavated earth from other land construction projects and dredged materials were reused as reclamation fill for the port. In addition, the port operator, PSA, aims to achieve net-zero carbon emissions by 2050. To that end, PSA has constructed green buildings such as the Administrative Building at Tuas Maintenance Base, which uses 58% less energy compared to other similarly-sized buildings and is Tuas Port's first super low-energy building. Moreover, PSA will rely on electrified equipment for port operations and implement smart grid solutions and battery energy storage systems to optimise energy use.

Tuas Port is envisioned to be the world's largest fully automated port when completed.
Image: PSA Singapore

Automation and Digitalisation

The port will feature smart technology to make it more efficient, productive and sustainable. Automated yard cranes, drones, and electric and driverless automated guided vehicles, which reduce carbon emission by about 50% compared to current diesel prime movers, will be deployed to enable safer and more efficient transport of containers between the berth and yard. Furthermore, terminal operations are remotely controlled and monitored by smart computer systems, improving labour productivity and creating better jobs for port workers.

Predictive analytics provide real-time information to better coordinate, plan and allocate resources under the Just-In-Time initiative while minimising the ships' idling time and emissions in the port. Tuas Port will be digitally integrated within the supply chain, improving the coordination of cargo flows in a secure and intelligent manner, and helping supply chain players save costs, and time, and enjoy greater convenience. Digitalisation offers immense potential to help vessels access various marine services such as bunkering, supplies and repairs, more efficiently. The port is also exploring the use of drones for maritime applications like remote ship inspections and ship supply deliveries.



Artist's impression of the future Tuas Port—targeted to be completed in the 2040s.
Image: Maritime and Port Authority of Singapore

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> **Tuas Port will feature smart technology to make it more efficient, productive and sustainable... Terminal operations are remotely controlled and monitored by smart computer systems.**

Singapore is the first port in the world to implement electronic bunker delivery notes, boosting efficiency and transparency during the bunkering process. This can save close to 40,000 man-days a year and enhance crew safety by eliminating the need for physical transfers for bunker documents between vessels.

Cybersecurity and Decarbonisation

In addition, Tuas Port is using digitalisation to enhance safety in the port. MPA established the Maritime Cyber Assurance and Operations Centre (MCAOC) to assist our agencies, research institutes, shipping community and industry to collectively secure the cyber domain against emerging and sophisticated cyber threats. Through collaboration with maritime stakeholders, the MCAOC provides real-time cybersecurity monitoring and disseminates information on cyber threats and systems recovery measures. On top of that, the MCAOC identifies possible vulnerabilities including onboard ships in due course, to strengthen incident prevention and response measures.

Tuas port will feature smart technologies such as automated yard cranes, drones, and electric and driverless automated guided vehicles.
Image: PSA Singapore

Automated guided vehicles are capable of moving cargo efficiently and securely while being greener and more sustainable compared to diesel prime movers.
Image: PSA Singapore

MPA is also actively supporting and driving maritime decarbonisation through several key initiatives. These include the Maritime Singapore Green Initiatives, transitioning to electric harbour craft, and developing multi-pathways for future marine fuels like ammonia and methanol. Additionally, MPA is driving international collaboration for climate action and promoting carbon awareness, accounting, and green financing for maritime companies.

A Future-Ready Port

Tuas Port is set to revolutionise port operations through the implementation of automation, predictive analytics, and smart technologies to make it more efficient, productive and sustainable.

Representing the future of Maritime Singapore, Tuas Port will be the nexus of a well-integrated ecosystem comprising the business and industrial districts in the western region of Singapore, such as the Jurong Lake District, Jurong Innovation District and the Tuas Industrial District. By co-locating complementary sectors that have synergies with the port, relevant industries can tap on Tuas Port's global connectivity with greater ease and efficiency.

River Scheldt Right Bank Renewal: Combining Climate Adaptation with Liveability

Koen Kennis is the Vice Mayor for Mobility for the City of Antwerp.

Tom Verbelen is the Director of External Relations and International Affairs for the City of Antwerp.

To reconnect the city with the river, the city of Antwerp drafted a masterplan for the large-scale renewal of the right bank quays of River Scheldt. The plan comprises customised solutions for seven sub-areas that include the raising of flood defences to prevent fluvial flooding and create space for residents. This entire process will take 15 years to complete.

Recreation area on the renewed Sint-Andries and Zuid quay.
Image: © AG Vespa, Sigrid Spinnox

Reviving the Historical Link with Water

In the North, the right bank quays lead to the Droogdokkenpark, an 11-acre (44,515 m^2) area by River Scheldt, combining green space with a maritime experience based on the history of the Antwerp port. The first part of this soon-to-be developed park—The Bélvedère—was completed in 2019 and features a 2-acre (8,094 m^2) hexagonal vantage point with spectacular views over the river and the port.

The southern sub-areas that have already been completed–the Sint-Andries and Zuid quay area—include a large, open floodplain with two sports fields, a skate park and playgrounds with expansive views over the river and a green linear park on the city side. The Zuid quay is connected to the recently developed Zuidpark–a three-tier park where the old shipping docks used to be, thereby reinstating the historical link to the city's port activity and creating an enormous green climate adaptive space with integrated water retention measures.

A render of the future Ringpark Groenendaal on top of the covered ring road.
Image: © BUUR part of Sweco – Latz + Partner – Bureau Greisch – Studio\Woodroffe\Papa

> Increased liveability and climate preparedness go hand in hand on the Antwerp waterfront.

The Big Link: Reconnecting the City with its People

Like the River Scheldt renewal plan, the Big Link project aims to create green space and enhance the liveability of the city of Antwerp, while significantly improving the mobility in and around Antwerp by partially covering the Ring Road.

Known as the largest infrastructure project of this century in Europe, the Big Link seeks to reconnect its people and communities with the city. This far-reaching plan for a complete redesign of the ring road area was the result of a massive co-creation process involving citizens, stakeholders, interest groups and representatives at different government levels.

The project aims to meet diverse future needs through its reclamation of hundreds of acres of space and partial transformation of the heavily congested Antwerp ring road area. For example, the creation of an extensive green-blue landscape will create new ecosystems and provide recreational services, substantially reduce the impact of Ring Road traffic, improve air quality and lower noise levels while reconnecting the inner and outer city districts.

Scheduled for completion in 2030, the Big Link project is unparalleled in size, complexity and impact. The development of seven ring parks and a bridge for pedestrians and cyclists across the River Scheldt will fundamentally improve the spatial structure and functioning of the city.

Barcelona's Visionary Transformation: Leading the Way in Port-City Integration, Sustainability, and Innovation

Javier Garrido Salsas is the Innovation Manager at the Port of Barcelona. He has pursued a PhD focused on studying the impacts of major trends in the port sector and the transition towards a new generation of green and digital ports, including a case study on the Port of Barcelona Vision 2040.

Barcelona's journey towards an integrated, sustainable, and innovative port-city landscape began in the 1980s, gaining significant momentum as the city prepared for the 1992 Olympic Games. This visionary initiative by the Port Authority of Barcelona, in partnership with local, regional, and national authorities, marked a pivotal shift. By relocating port activities away from urban centres, the port authority enhanced the synergy between the port and the city, improving urban liveability while preserving Barcelona's maritime heritage and setting a new standard for urban maritime integration globally.

"Your Port Opens Up Again"

The foundation laid during the early years paved the way for the port's 2021-2025 Strategic Plan, known as "Your Port Opens Up Again". The ambitious project aims to deepen the relationship between the historic port and Barcelona. This initiative focuses on reorganising passenger traffic and moving ferry and cruise terminals to a dedicated passenger wharf in the commercial port.

This move will not only streamline operations, but will also play a crucial role in reducing the port's environmental footprint. In addition, the project envisions the transformation of the northern end of the port into a vibrant hub for leisure, education, innovation, and research on the blue economy, dramatically reducing the port's environmental footprint.

BlueTech Port

At the heart of this strategic vision is the BlueTech Port project, designed to establish the port as a leading centre for maritime technology and research. The initiative focuses on fostering the development of the blue economy by supporting startups and established companies across various sectors. These sectors include:

- Marine renewable energies
- Sustainable maritime navigation
- Marine biotechnology
- Sustainable aquaculture
- Sustainable coastal and marine tourism

By developing an ecosystem that encourages innovation and collaboration, the BlueTech Port project aims to create forward-thinking solutions to meet global maritime challenges, demonstrating Barcelona's commitment to combining economic growth with environmental sustainability.

BlueTech Port's future lies in the Naus Sant Bertran, a complex of six interconnected former port warehouses located near the Drassanes square. These warehouses, which will occupy a total area of 23,000 m², are strategically positioned to support Barcelona's growth and to advance the global blue economy. The location is part of a broader plan to establish a comprehensive ecosystemic campus dedicated to blue economy innovation, which will also serve as the headquarters for the new BCN Port Innovation Foundation.

Such strategic and architectural planning highlights the Port of Barcelona's commitment to innovation, sustainability, and the promotion of the global blue economy. By creating a dedicated space for companies, startups, and research initiatives focused on marine and maritime technologies, BlueTech Port is poised to become a cornerstone in the development of sustainable economic models that attract global investors and hub management specialists.

Aerial view of the port city area and the cruise wharf.
Image: Port of Barcelona

> By fostering a symbiotic relationship between marine activities and urban life, the city sets a global benchmark for innovative, sustainable, and inclusive urban maritime integration.

Barcelona, the Port City

This collaborative and strategic approach not only reinforces Barcelona's position as a global leader in the blue economy, but also emphasises the city's dedication to sustainable growth, environmental stewardship, and technological advancement.

Barcelona's port-city transformation journey illustrates a holistic approach to urban development, sustainability, and innovation. By fostering a symbiotic relationship between marine activities and urban life, the city sets a global benchmark for innovative, sustainable, and inclusive urban maritime integration.

This initiative not only reaffirms Barcelona's rich maritime heritage, but also highlights its future as a leader in maritime innovation and sustainability. Through these strategic efforts, Barcelona demonstrates how cities can embrace their historical ties to the sea while paving the way for a sustainable and innovative future, thus serving as a model for port cities worldwide.

The Cape of Storms

Mayor Geordin Hill-Lewis has been the Executive Mayor of Cape Town since November 2021. Prior to this role, he served as a member of the National Assembly for the official opposition, the Democratic Alliance, for more than a decade.

Cape Town boasts a beautiful harbour with a rich maritime history that spans centuries. Situated in the Cape of Storms, the harbour was established in 1652 as a victualing (food-supplying) station for the Dutch East India Company. It has since transformed into a multifaceted port that is critical to the region's export industry, serving as a vital junction for cargo moving between Europe and the Western Hemisphere, as well as the Middle East and Australia.

The Cape Town Port is run nationally through the Transnet National Ports Authority (TNPA) and enjoys good rail and road connections inland to many other South African cities.

Cape Town's Blue Economy

According to estimates from the African Union, the blue or ocean economy presently brings in close to US$300 billion for the continent and supports 49 million employment opportunities. In 2019, the City of Cape Town, in partnership with the V&A Waterfront, officially launched Blue Cape, a non-profit organisation and strategic business partner to maximise the economic contribution of the blue economy for the city.

The rise of Cape Town as a leading catamaran producer and a cost-effective supplier to global markets has spurred demand for skilled professionals in the yacht and boat-building industry. This growth has favourably positioned the city to enhance economic returns within the supply chain, particularly in supporting visits by superyachts, by providing high-quality berthing, victualling, maintenance, and entertainment services.

A Busy Harbour

The vision for the Cape Town harbour aligns with the city's broader objectives of sustainable development, economic growth, and job creation. To achieve this, the port authorities are focusing on modernising infrastructure, enhancing stakeholder engagement, and operational efficiency.

During the past cruise season, Cape Town welcomed 70 ships, with 145,000 passengers and 42,000 crew passing through the Cape Town Cruise Terminal. The Cape Town Cruise Terminal, a dedicated cruise terminal developed in 2018, was funded by the V&A Waterfront which has proven to be a worthwhile venture that is already showing a massive return on investment.

Although there has been a 30% global reduction in ocean freight rates since 2021, Cape Town did not experience a similar decline. The City of Cape Town, together with the Western Cape Government and TNPA, are actively engaging stakeholders, including the private sector, to enhance port efficiency and hold the national government accountable.

Aerial view of Port of Cape Town.
Image: City of Cape Town

Drive to Increase Efficiency

To improve freight movement efficiency and alleviate port congestion, the TNPA has identified several measures. These include:

- Traffic impact assessments and engagement with key stakeholders within the maritime transport logistics chain to establish a truck holding area and enhance enforcement against illegally parked trucks.
- Investments in improved software to optimise the traffic flow between the port and terminal gates.
- Piloting and scaling up of technical equipment to stabilise vessels during adverse weather conditions and reduce operational inefficiencies caused by wind disruptions.
- In-depth research to develop a more accurate predictive model for wind, to mitigate the impact of strong winds and improve the overall operational efficiency of the port.
- Spearheading of the development of the precinct and the land adjacent to the port to integrate the port, road and rail logistics and back-of-port facilities, to enhance storage capacity, and enable more effective movement of cargo in and out of the port.

Looking Ahead

The City of Cape Town has an urban planning mandate and is highly invested in improving the urban design of the port precinct, as well as assessing alternative sites for the current in-land intermodal terminal.

As the current location of the terminal in a key economic node for the city is hampering urban regeneration, TNPA together with the City of Cape Town is assessing sites on the city's periphery where there is good road access to the port as feasible alternatives. The City of Cape Town is also conducting research, including analysis of freight movement and the logistics economy, to enhance efficiency of back-of-port operations.

Shanghai Port

The Shanghai Municipal Transportation Commission is in charge of the planning, construction, development and management of transportation in Shanghai, China.

Shanghai Port is committed to enhancing its capacity, promoting green shipping, and embracing digital transformation to maintain its position as a world-class port city of the future.

After a hiatus due to the COVID-19 pandemic, Shanghai Port became the first port in China to resume international cruise transportation.

In 2023, Shanghai Port's container throughput exceeded 49 million TEUs, making Shanghai the top container port in the world for the 14th consecutive year—container routes in Shanghai cover over 700 ports in more than 200 countries and regions around the world.

To ensure its quality standards as a world-class port city of the future, Shanghai Port focuses on three key areas.

On the ground at the world's busiest container port.
Image: Shanghai Municipal Transportation Commission

Enhancing the Capability of the Port Hub

To increase the capacity of its port infrastructure, Shanghai Port is optimising the functional layout and intelligent upgrade of the port areas. In addition, it is supporting the development of the north side of the Xiaoyangshan area. It also aims to play a more active role in regional economic development and ensure the stable and smooth operations of industrial and supply chains.

Aerial view of the Port of Shanghai's new terminal.
Image: Shanghai Municipal Transportation Commission

Strengthening Cooperation in Green Shipping

Shanghai has always integrated sustainable development into all aspects of its port and logistics and is committed to becoming a leader in the ecological development of global ports.

In 2023, the Port of Shanghai and the Port of Los Angeles Green Shipping Corridor combined efforts to drive maritime sustainability through voluntary cooperation under the framework of emission reduction established by the International Maritime Organization.

The jointly-released Port of Shanghai-Port of Los Angeles Green Shipping Corridor Implementation Plan Outline will showcase:

- Advanced logistics technology
- Decarbonisation applications
- Best management practices
- Creation of a model of global cooperation for sustainable development in the shipping industry

Building a Digital and Intelligent Port

Shanghai is actively promoting the digital and intelligent transformation of its port, such as the use of new technologies like 5G (fifth-generation technology standard for cellular networks), IoT, cloud computing, big data, artificial intelligence and blockchain.

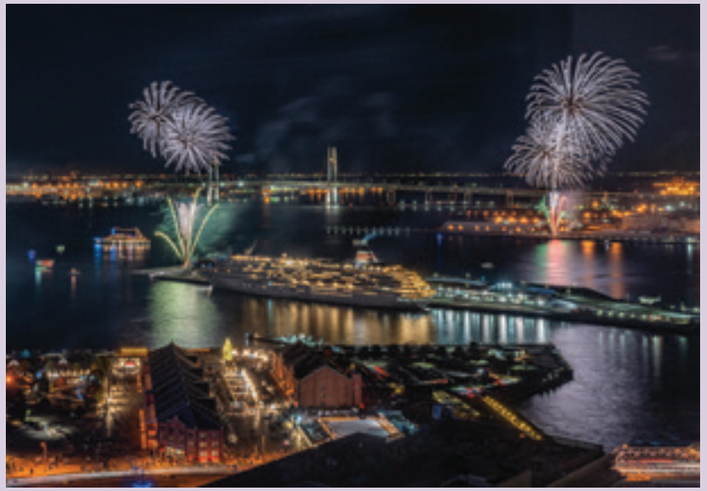
As part of its future efforts, the Yangshan Deep Water Port Phase IV—the largest and most automated container terminal in the world—will focus on building the digital twin system of a port and the Shanghai International Container Transportation Service Platform. It will also explore public data sharing and interaction to realise the digital integration of its port, shipping and trade, and create a leading digital service platform for international shipping.

The Port of Yokohama—Towards Carbon Neutrality

The International Affairs Bureau handles the general coordination of the City of Yokohama's international affairs, promotes mutual exchange and collaboration, and actively supports the development of municipal diplomacy.

In the face of complex world issues including climate change, cities must create unique solutions and share ideas through networking and collaboration. As the traditional gateway for people, new technologies, products and ideas, ports play a more significant role than ever in an uncertain future.

Yokohama, a global city with a diverse population of 3.77 million, has been one of Japan's earliest international hubs since 1859. Home to the largest logistics port in Japan, Yokohama aims to lead as a decarbonisation model for major cities. To this end, the Port of Yokohama has identified carbon-neutral initiatives that promote collaboration among civil society, the private sector, and other Asian cities.



Night view of Yokohama Port.
Image: Port of Yokohama Cruise Ship Photo Contest

Carbon-Neutral Port

To transform the Port of Yokohama into a carbon neutral port, the port authorities are introducing the use of next-generation energy sources. This includes the creation of a supply chain for hydrogen and its derivatives, such as methanol and ammonia. At the same time, the private sector, academia, and government are working together to promote the decarbonisation of electricity supply and actively implement hydrogen and other next-generation energy sources.

In December 2023, the City of Yokohama Port and Harbor Bureau and the Ministry of Land, Infrastructure, Transport and Tourism of Japan signed a Memorandum of Understanding to establish a Green Digital Shipping Corridor with the Maritime and Port Authority of Singapore.

View of Yokohama.
Image: © Hideo Mori

Local and International Collaboration

As a port city, it is crucial for Yokohama to consider carbon dioxide absorption in the waterfront area. In 2014, Yokohama was one of the first municipalities in Japan to start a blue carbon[1] project which it is promoting in collaboration with residents. Yokohama will continue to act as a leader for blue carbon in Japan.

As an innovator of urban solutions, the city is sharing ideas and technologies with other Asian cities to realise carbon neutrality through platforms such as the Y-PORT (Yokohama Partnership of Resources and Technologies) programme as well as conferences and exhibitions that attract a global audience.

For instance, last November, Yokohama hosted Y-SHIP 2023, an international convention that aims to achieve open innovation by inviting professionals and businesses involved in green transformations. At the convention, Yokohama shared its urban solutions for carbon neutrality, including port-oriented ones, with a wide global audience. Furthermore, at the 12th Asia Smart City Conference, which was held concurrently with Y-SHIP with the cooperation of the World Bank, Asian Development Bank, and other international organisations, the City of Yokohama declared its solidarity to co-create a sustainable and resilient zero-carbon future together with 44 overseas cities and government organisations, including the Bangkok Metropolitan Administration.

In three years' time, Yokohama will host the GREEN × EXPO 2027 (International Horticultural Expo 2027, Yokohama, Japan), a world-class expo. The expo focuses on sustainability and well-being, and how the natural environment and biodiversity can coexist with humans' social and economic activities. Held in the verdant setting of Kamiseya in Yokohama's suburbs, the GREEN × EXPO will also showcase green transformation and nature-based solutions to achieve carbon neutrality.

[1] Coined in a 2009 report by the United Nations Environment Programme, blue carbon refers to the carbon captured by living organisms in oceans and stored in the form of sediments from mangroves, salt marshes and seagrasses.