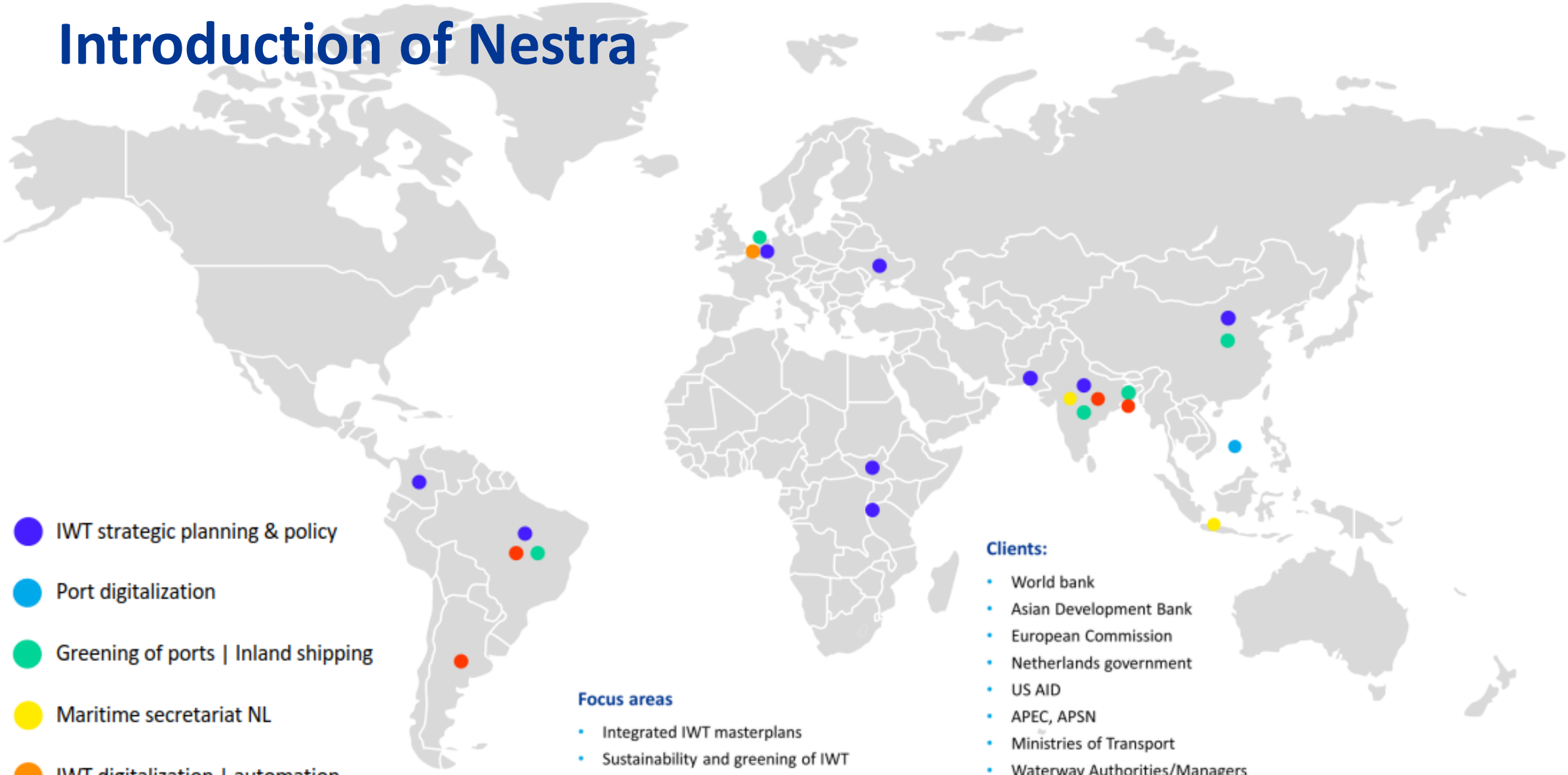
Green and Efficient Ports in the People's Republic of China

Connectivity and Investment Conference

Multilateral Cooperation center for Development Finance

Beijing, 5 December 2025

Introduction of Nestra



- IWT strategic planning & policy
- Port digitalization
- Greening of ports | Inland shipping
- Maritime secretariat NL
- IWT digitalization | automation
- IWT infrastructure

Focus areas

- Integrated IWT masterplans
- Sustainability and greening of IWT
- ICT applications and digitalization
- Feasibility projects
- Capacity building and training

Clients:

- World bank
- Asian Development Bank
- European Commission
- Netherlands government
- US AID
- APEC, APSN
- Ministries of Transport
- Waterway Authorities/Managers Port Authorities
- Private sector associations, Individual companies

China experiences Nestra

Projects for ADB:

- Research on Environmentally Sustainable Development; Technology Assessment and Innovation Path of the PRC's Coastal Ports (2025), Study on the Development of Green Ports and Shipping - Development of New Energy Applications in Ports and Shipping (2024)
- Shaanxi Transport and Logistics Port Plan, Hunan (Xiangjiang River), IWT report 13th 5-year plan; Strategy restructuring IWT & Multimodal logistics in Chongqing

Projects for World Bank:

- Publication - Blue routes to a new era: 40 years of IWT reform
- Hubei IWT project, 3 Gorges logistics zone, Anhui (Shaying River)

APSN/APEC: effect COVID on accelerated digitalization in APEC ports, Green port assessment (GPAS), Study on port digitalization in APEC ports

Waterborne Transportation Research Institute: support work and benchmark studies

Netherlands government entities like RVO, Min IenW: China Secretariat, Yangtze Project, LNG applications in IWT, Sino-Netherlands Platform

Introduction

Based on ADB projects:

- Overview of policy directions and initiatives from PRC ports and shipping industry
- Share experiences in port sustainability and new energy applications from PRC Ports

Key lessons:

- Conservation of Energy
- Insight in energy demand and supply
- Productive neighborhood principle → smart port micro-grids
- Electrification in port operations
- Efficiency and greening in port-hinterland connectivity
- Joint-Industry demonstration projects
- Green corridors

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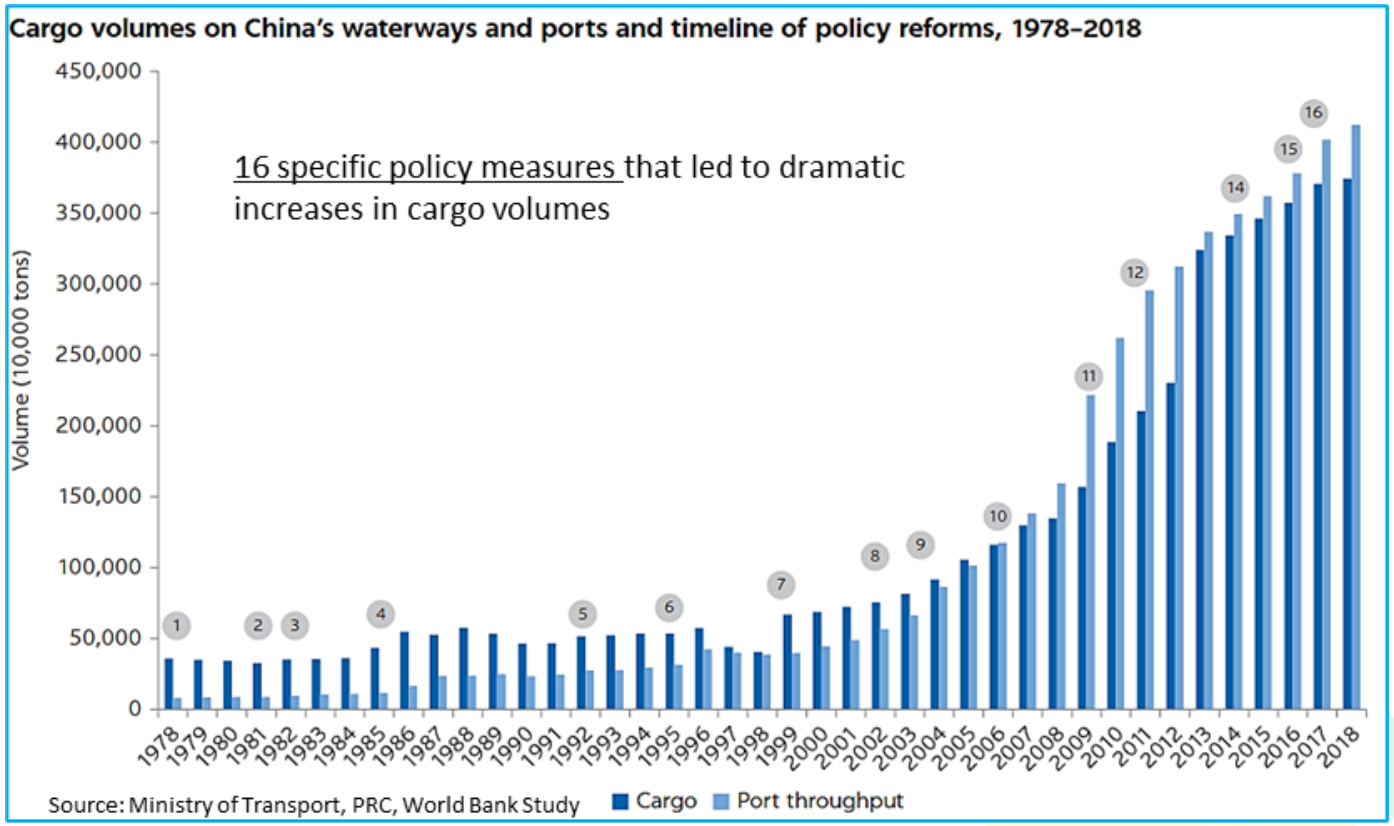
Overview Port Sector PRC

Some statistics on ports

- 16 out of 20 largest ports in the world in PRC
- Ningbo Zhoushan Port the world's largest port
- Total cargo throughput: 17.6 billion tons
- International trade: 5.4 billion tons
- Containers: 330 million TEUs



Some views on "greening ports"

- Long-standing reliance on fossil fuel
- World-class ports: "safe and convenient, intelligent and green, cost-effective and efficient, powerful and cutting edge"
- Renewable energy is gaining momentum; 60% of demand still from thermal power plants
- Latest: year-on-year CO2 emissions decreased

National level laws and regulations on green development

Legislative framework

- Four laws on environment protection, energy saving, circular economy and environment evaluation
- Five laws on pollution prevention, concerning with air, sea, water, solid waste and noise

Administrative regulations:

- Several Action Plans with respect on GHG emission, energy saving, air, water and soil pollution prevention, and
- A specific vessel pollution prevention regulation
- Guideline on transition from fuel to electricity

MoT level policies on green port development

Action plans

- The 12th Five-Year Plan on energy saving and GHG emission reduction
- The 14th Five-Year Plan on Green Transport
- Action plan on energy saving and GHG emission reduction during 12th Five Year Plan
- Opinion on Promoting Overall Green Transport Development
- Specific Implementation Plan on Vessel and Port Pollution Prevention 2015-2020
- Rail-water high quality development 2023-2025

Guidelines on

- Port Transformation and upgrading
- Yangtze River green shipping development
- Rail-water container transport

Reflection on policies and standards

绿色港口工作推进实施的一般过程

01
上位法
Legislation

02
发展规划
Development Project

03
指导意见
Guidelines

04
示范工程
Demonstration Project

05
行动计划
Action Plan

06
工作方案
Work Program

07
标准规范
Standards

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Reflection on policies and standards

PRC GREEN PORT POLICY FRAMEWORK

The PRC's green port policy framework targets several key dimensions of environmental performance: **emissions control, energy transition, waste management, dust and pollution reduction,** and operational efficiency

Water Resource Management & Pollution Control

- Water budgeting, metering, and recycling systems.
- Investments in waste water collection and treatment infrastructures
- Monitoring, laboratory testing, stringent discharge standards.
- Oil-water separation systems
- Stormwater interception networks

Waste Management & Circular Economy

- Waste reduction, segregation, and recycling are central to port operations.
- Collection and treatment of solid waste, oily residues, hazardous materials
- Efforts to promote resource recovery, recycling, conversion of organic waste into energy.

Air Quality Management

- Emission Control Areas
- Reduction of air pollutants around major port areas
- Dust suppression measures and enclosed conveyor systems
- Electrification and shore-power use
- "Oil-to-Electric"-scheme

Low-Carbon and Smart Port Development

- Automation and digitalization enhance operational efficiency and reduce idle time, thereby cutting emissions.
- Alternative and renewable energy integration (hydrogen, wind, solar,..)
- Modal shift initiatives

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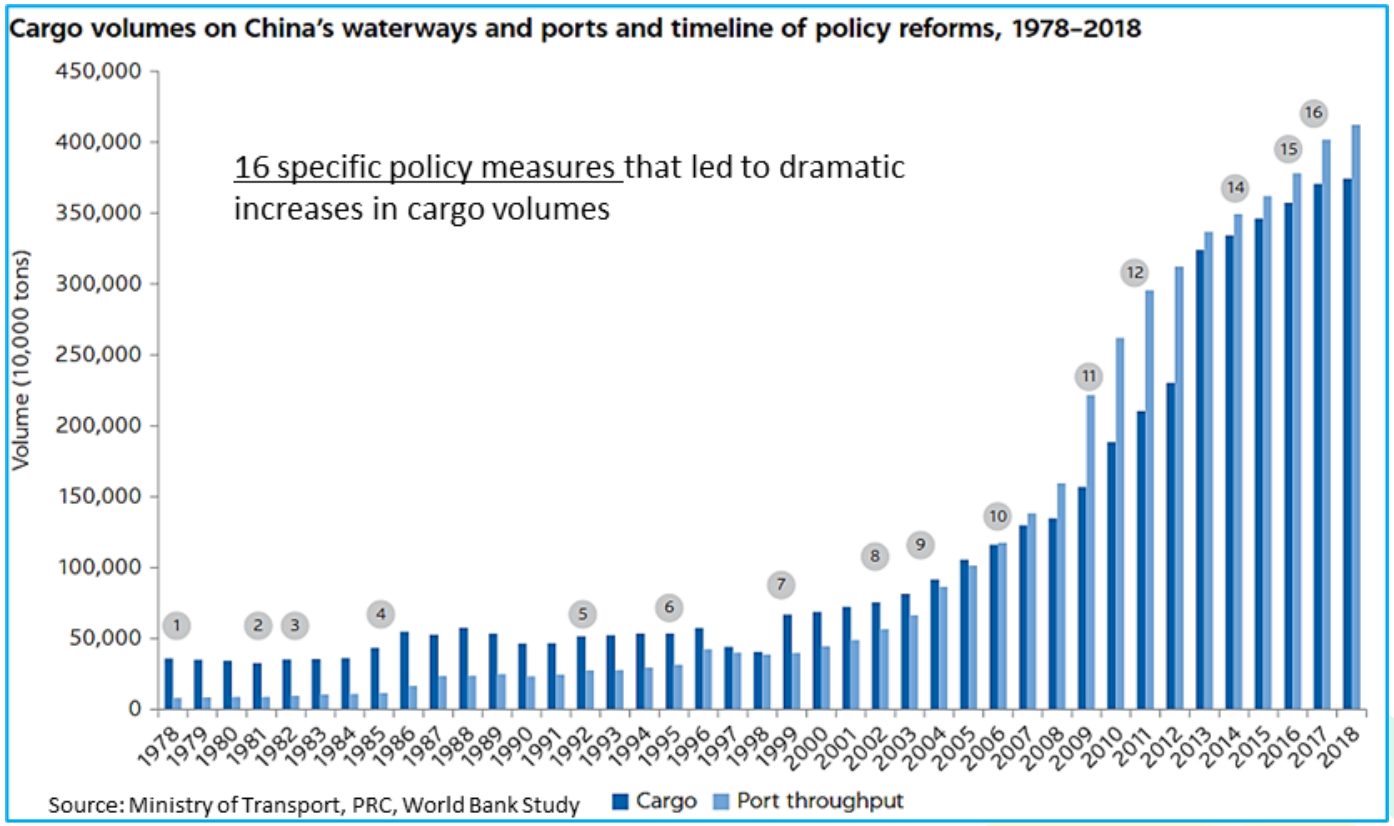

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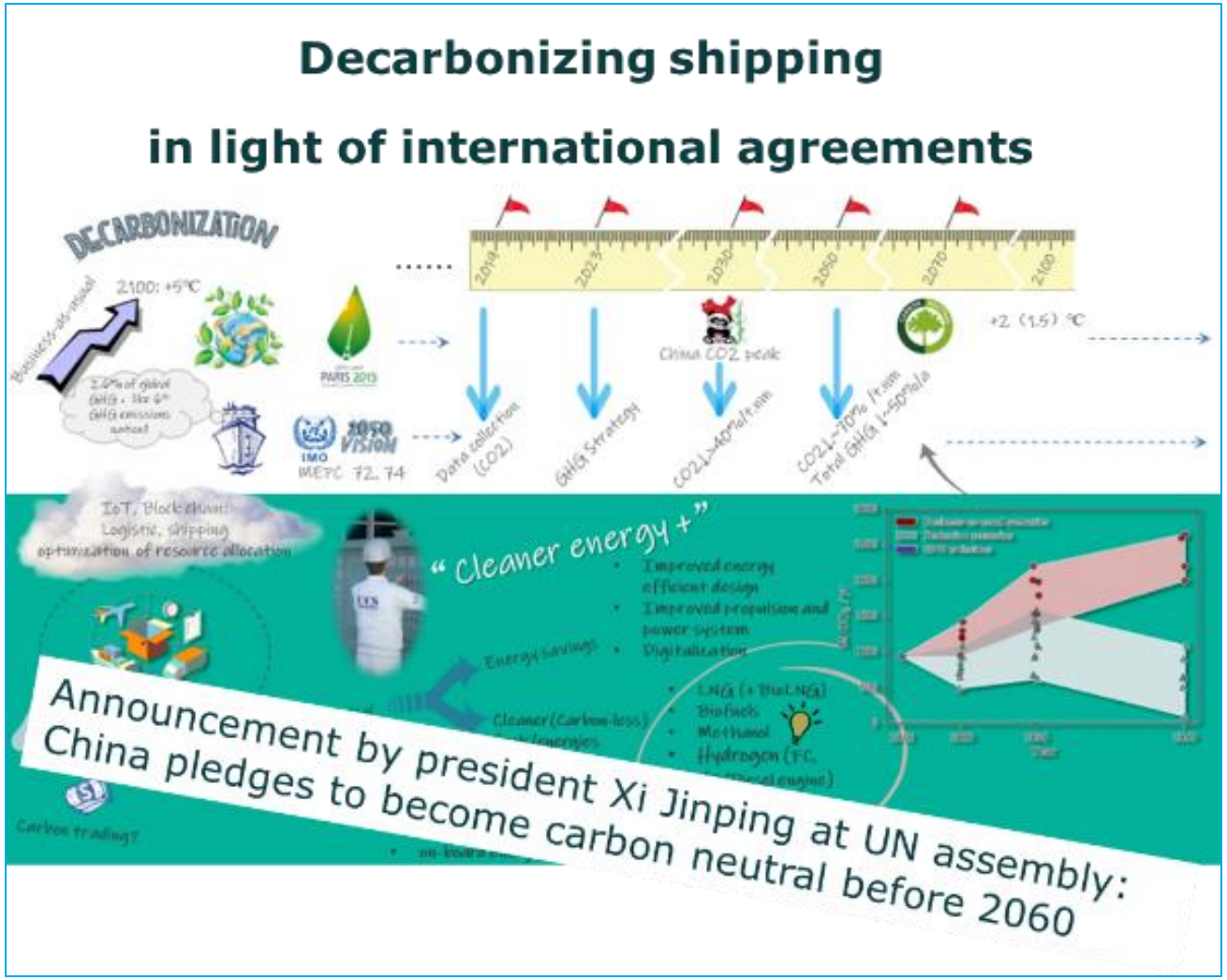
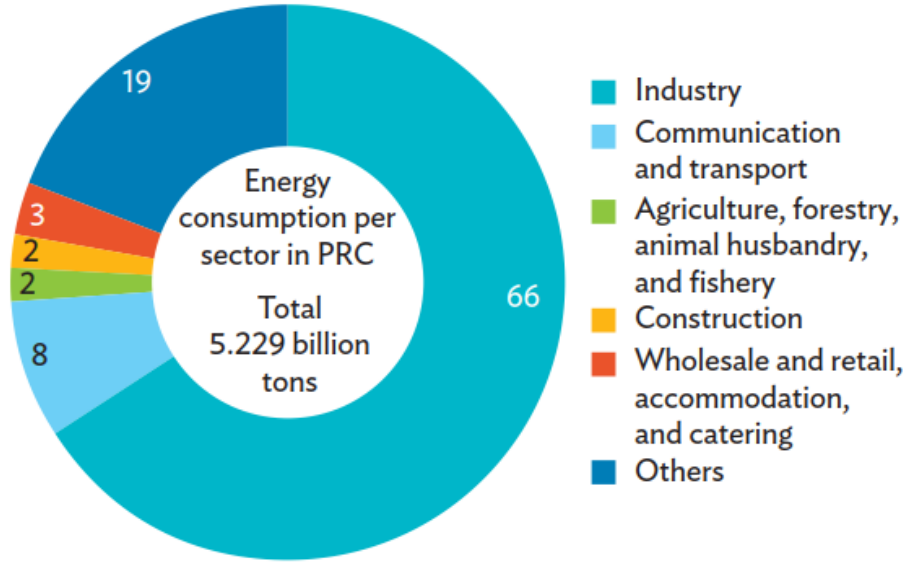
Decarbonization goal!



Proportions of Energy Consumption of Various sectors in the People's Republic of China (%)



PRC = People's Republic of China.

Notes:
1. Total energy consumption is presented in standard coal equivalent (SCE).
2. Consumption of coal, oil, natural gas and other energy source have been uniformly converted into SCE.

Source: Government of the People's Republic of China, National Bureau of Statistics. 2023. *China Energy Statistical Yearbook 2022*. Beijing: China Statistics Press.

New Energy in Ports

- Solar, wind, hydrogen, and tidal energy, bio-energy to power port industries and operations
- Multi-energy integration based on utilization of electric energy

Renewable energy for thousands. The PRC has constructed its first combined tidal and solar power station. Located in Zhejiang Province, the station will provide electricity to 30,000 homes (photo by Guodian United Power and Zhejiang University).

Estimated Costs of Energy from Renewable Sources

Technology	Investment Cost	Transport Cost	Energy Price
	660 MW installation: CNY2,500 million	CNY0.20–0.30/1,000 km	CNY0.30–0.40/kWh
	Distributed generation CNY8.10/W	Nearby used, short transmission lines, negligible	CNY0.36/kWh
	3 MW equipment: CNY9.30 million CNY~3,100/kW	CNY0.20–0.30/1,000 km	CNY0.27–0.35/kWh
H HYDROGEN	1,000 m^3/h installation: CNY13 million	CNY20 MPa: 21/500 km/kg CNY50 MPa: 9.64/500 km/kg	Gray: CNY12.80/kg Green: CNY24.40/kg CNY0.38–0.73/kWh
TIDAL ENERGY	1 MW installation: CNY33 million	Nearby used, short transmission lines, negligible	CNY0.45–1.40/kWh

h = hour, kg = kilogram, km = kilometer, kW = kilowatt, kWh = kilowatt-hour, m^3 = cubic meter, MPa = megapascal, MW = megawatt, W = watt.

Notes:
1. This figure assumes that the lower heating value of hydrogen of 33.33 kWh/kg is applied.
2. A megapascal is a unit of pressure according to the International System of Units.

Sources: J. Cao et al. 2021. Current Status of Hydrogen Production in China. *Progress in Chemistry*. 33 (12). pp. 2215–2244; Carbon Commentary. Some Rules of Thumb of the Hydrogen Economy. https://www.carboncommentary.com/blog/2021/6/11/some-rules-of-thumb-of-the-hydrogen-economy; Government of the People's Republic of China, National Energy Administration. The LCOE of Photovoltaic Power Generation in China Has Dropped by 90% in 10 Years [in Chinese]. http://www.nea.gov.cn/2018-04/13/c_137108373.htm; H. Qing. 2023. China is Putting New Energy and Investment into Tidal Power. *The Maritime Executive*. 23 February. https://maritime-executive.com/editorials/china-is-putting-new-energy-and-investment-into-tidal-power; Xiamen Mibet New Energy Co., Ltd. 2021. *What Are the Aspects of Photovoltaic Power Generation Cost Calculation? How Are Costs Assessed?* [in Chinese]. 19 May. https://www.mbt-energy.cn/news/industry/2105192.html.

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New Energy Technology

- Zero-carbon terminals, electrification of (automated) port equipment, hydrogen fueled trucks and rail gantry crane, OPS

Zero-Carbon Terminal in Tianjin Port

KEY CHARACTERISTICS

Shore power

All berths equipped with shore power facilities; technically capable vessels can now be connected.

Electrification equipment

All terminal and handling equipment is electrified, with no fossil fuels or carbon emissions.

Renewable energy

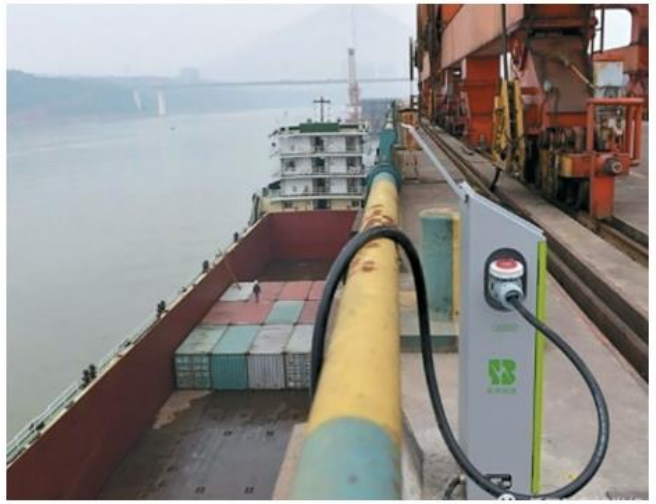
Wind and solar energy sources generate 50 million kWh per year (more than the total terminal consumption of 45 million kWh), with 70% self-consumed and 30% sent to the main grid, where it is used during downtimes.

Power-generation system

New (internal) energy power-generation system avoids long-distance transmission lines, and reduces utility costs and energy loss.

Equipment electrification. Electric automated guided vehicles are already operating in Qingdao Port (photo by Nestra).

Hydrogen fuel at Qingdao Port. Pictured above are pipes for pumping the hydrogen fuel into trucks, a refueling station (photo by Nestra).



Onshore power. This is a view of the onshore power facility in Luzhou Port, the first one completed in Sichuan Province (photo by Sohu, Inc.).

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New Energy Technology

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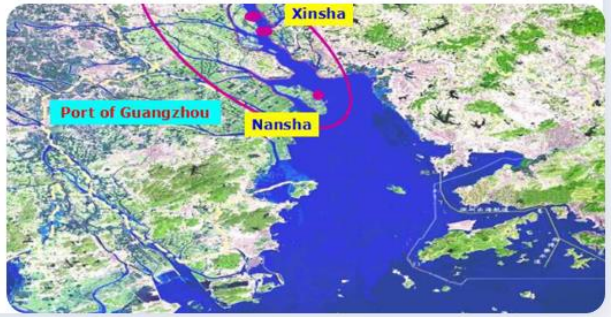
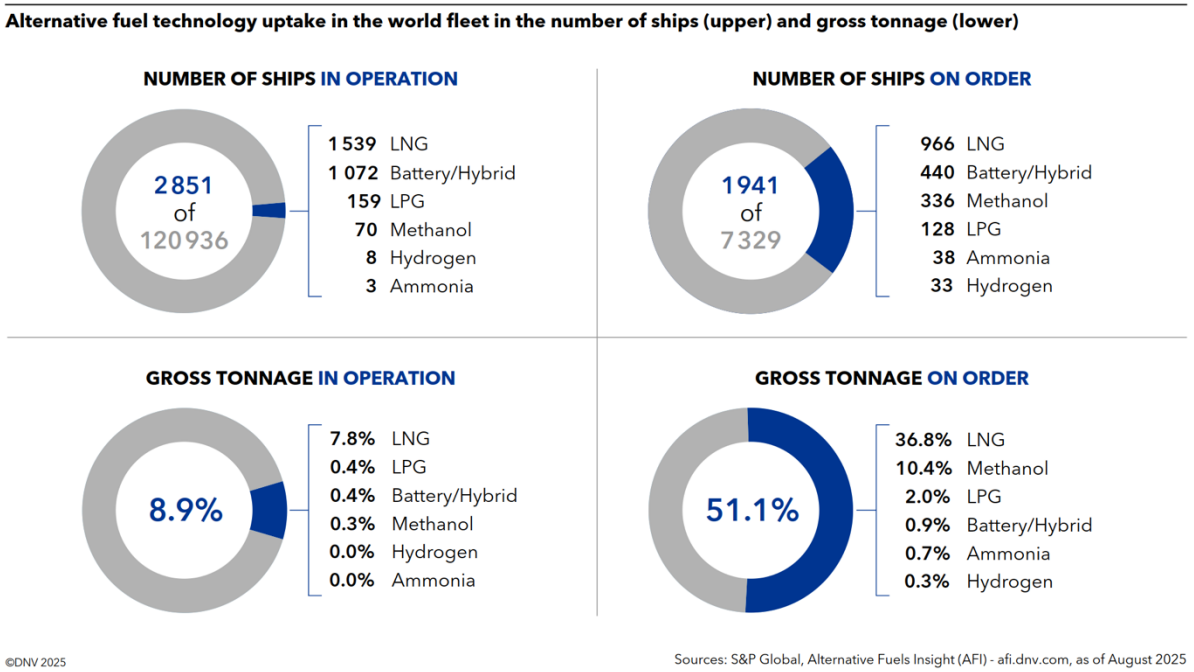
Sustainability in Coastal Ports: Xiamen, Beibu Gulf & Guangzhou

广州港 Guangzhou Port	北部湾港 Beibu Gulf Port	厦门港 Xiamen Port
珠三角核心港口，国际物流枢纽 Pearl River Delta Core Port, International Logistics Hub **5G、岸电系统、太阳能、氢能** 5G, Shore Power Systems, Solar Energy, Hydrogen Energy	**广西门户港，联通西部与东盟的枢纽** Guangxi Gateway Port, a Hub Connecting Western China and ASEAN **多式联运网络 + 自动化升级，引领绿色发展** Multi-Modal Transport Network + Automation Upgrades, Leading Green Development	**福建东南沿海，国家综合交通枢纽** Southeastern Coast of Fujian, National Comprehensive Transportation Hub **岸电系统、光伏发电、智慧港口** Shore Power Systems, Photovoltaic Power Generation, Smart Port,
		

Some challenges in ports with New Energy Application

- Port integrated energy systems: optimized energy exchange in port domain (heat, natural gas, hydrogen)
- PRC sea ports and inland ports have to adapt to future energy technology used to power vessels (LNG, Battery-Electric, Methanol, Hydrogen)

Green corridor initiatives



- Vessels and engine have a long lifetime; 9% of fleet has alternative energy source; zero emission <1%; 50% of new order still convention HFO, LFO, gasoil/diesel, almost 90% with LNG
- Onshore Power Supply challenges for further upscaling in PRC exist:
  - Safety (circuit breakers, high-voltage)
  - Power frequency not standardized for vessels
  - <u>Older vessels not able to connect to OPS</u>

OPS installations in PRC ports

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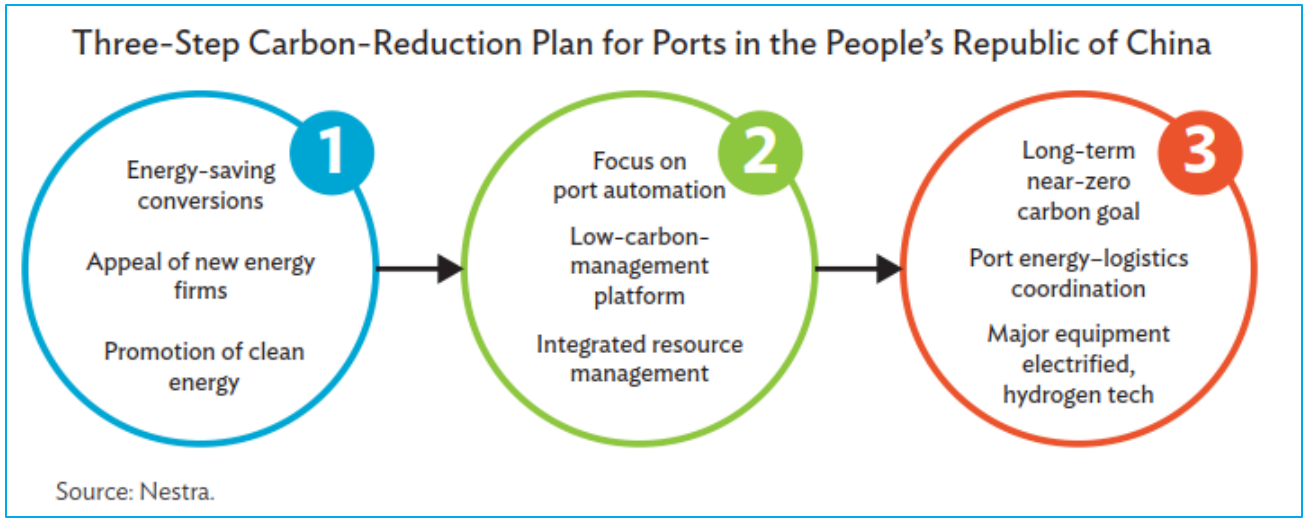
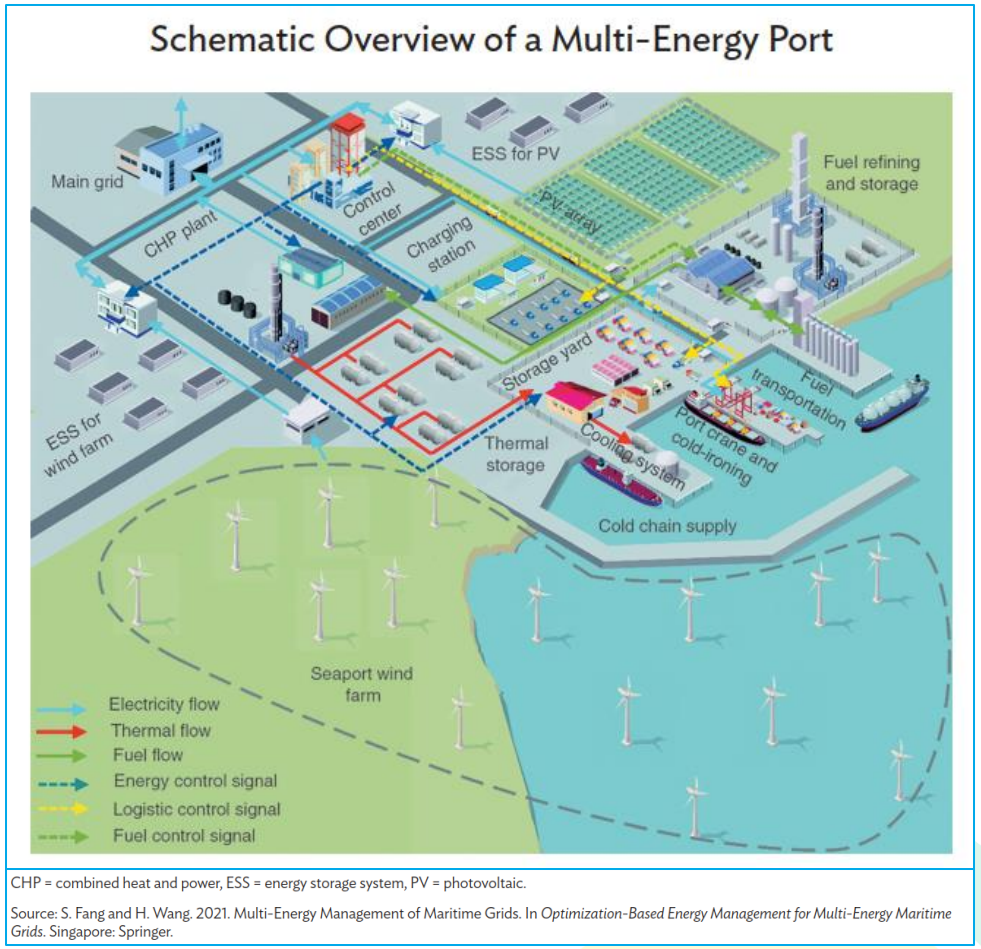
Reflection on policies and standards





CHP = combined heat and power, ESS = energy storage system, PV = photovoltaic.

Source: S. Fang and H. Wang. 2021. Multi-Energy Management of Maritime Grids. In *Optimization-Based Energy Management for Multi-Energy Maritime Grids*. Singapore: Springer.

Guiding, Organizational and Market Stimulation policies to support

- Port grid load layout optimization and new energy power system
- Promotion of green port technology in parallel with intelligent systems
- OPS and clean energy cutting direct emission of vessels
- Integrated port energy systems with hydrogen production and storage
- Microgrids in sea and inland ports
- Central-driven policy approach (long-term planning, unwavering support, public financing, research & development)
- Push for international cooperation (ISO, IMO, IPHA) and bilateral cooperation (digital and green corridors, green port certification), market development (green corridors) and standardization to reduce costs

THANK YOU

Nestra
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ADB Policy Brief – New Energy Applications for Ports and Inland Waterway Shipping in PRC
http://dx.doi.org/10.22617/BRF240009-2

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