

# Research on the Construction Method of Green Smart Port Indicator System

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**ABSTRACT:** Based on the analysis of domestic and foreign green and smart port construction experience, characterization indicators and construction in greening and intelligence, this project proposes a green smart port construction indicator system, mainly including planning and design, operation organization and production management. In order to improve the operability of the index system, each index system includes indicator connotation, indicator target value and Implementation path, so as to ensure the user's understanding of the indicator from the three aspects of the concept, goal and implementation path of the indicator, and effectively promote the construction of green smart port.

**Keywords:** Green smart port; Port indicator system.

## 1 INTRODUCTION

Green and smart is the development trend of future ports, this study according to the actual needs of port construction, to establish a future-oriented, in line with its own characteristics and development positioning, scientific, advanced and accessible, easy to measure and assess the indicator system, can effectively guide the construction of green smart ports, meet relevant policy requirements, improve the project construction and operation management system system, for the green development of the industry, intelligent development to provide reference and reference, and provide path guidance for the establishment of replicable and scalable models for the construction of green and smart ports in China. At present, the construction of green smart ports has begun across the country.

### 1.1 Green Port Rating Guidelines

In 2013, the Ministry of Transport issued the Green Port Equivalence Evaluation Standard..From the four directions of "concept, action, management and effect", nine major items and 25 specific indicators such as culture, environmental protection, energy conservation and system were proposed. On July 1, 2020, the Green Port Rating Evaluation Guidelines were released, revising some indicators, such as the use of shore power, the reception of pollutants from ships, and the supply of low-sulfur fuel oil.

## 1.2 Smart Port Rating Evaluation Guide

In January 2022, the China Port Association issued the "Smart Port Rating Evaluation Guide Container Terminals" (T/CPHA 2022-9), which proposed nine major items and 31 specific indicators in terms of intelligent management, facilities and equipment, information technology and digital intelligence services.

## 1.3 Guidance on building world-class ports

Issued in November 2019, it requires the establishment of a port development index system guided by high-quality development, and sets 16 indicators from five aspects: safe and convenient, smart and green, cost-effective, strong support, and world-advanced, giving play to the role of the baton.

## 1.4 Smart port demonstration project

Issued in February 2017, it requires the promotion of "Internet +" port applications through innovative port logistics operation models.

## 1.5 Guidance on the development of intelligent shipping

Released in May 2019, it proposes to strengthen top-level design and system planning to improve the level of informatization and intelligence of port terminals and shipping infrastructure.

## 2 Indicator system construction

This indicator system aims at the whole process of port planning, construction, operation and maintenance, runs the green smart concept through the whole life cycle of the terminal, and proposes a green smart port indicator system covering all parts of green smart terminal planning and design, operation organization and production management from the perspective of project feasibility study, preliminary design, construction and installation, completion acceptance, production and operation and other engineering construction project management processes.

The indicator system is divided into three first-level indicators: planning and design, operation organization and production management. Each first-level indicator has several second-level indicators. The second-level indicators include two parts: indicator connotation and indicator target value.

**Table 1.** Indicator system

order number	First-level indicator	Second-level indicator
1	Planning and design	Relevant development planning for green smart port construction
		Comparable comprehensive energy consumption per unit product of terminal operation
		Application of renewable energy technology
2	Operation	Coverage rate and utilization rate of ship shore power facilities

order number	First-level indicator	Second-level indicator
	organization	Classified collection and harmless treatment of solid waste
		Proportion of greening area to greening area
		Proportion of clean energy used by machinery and vehicles
		Construction of energy management and control platform
		Network facilities
		Intelligent new technology application
3	Production management	Green smart management organization
		Green smart capital investment
		Green Smart Goal Assessment
		Green and smart port training and education

## 2.1 Planning and design

### (1) Coverage rate and utilization rate of ship shore power

#### ①indicator connotation

The development plan is the relevant plan formulated for the green and intelligent construction and development of the port. It can be a special plan, and can also be included in the enterprise development strategy, development plan, and information development plan.

#### ②indicator target value

With reference to the relevant contents of the Green Port Grade Evaluation Guide and the Smart Port Grade Evaluation Guide, this indicator is set as that enterprises should organize the preparation of a green smart port development plan for more than 3 years (including), including objectives, assessment indicators, tasks, security measures, etc., and distribute them to the public, and adjust and revise them annually according to the implementation.

#### ③ Implementation path

Actively organize enterprise personnel to prepare development plans, including objectives, assessment indicators, tasks, safeguard measures, etc., and adjust and revise them annually according to the implementation situation.

### (2) Comparable comprehensive energy consumption per unit

#### ①indicator connotation

In the statistical period, the container terminal completed the comprehensive energy consumption of production per 10000 TEU of local cargo throughput (including the energy consumption of loading and unloading production and the energy consumption of auxiliary production)

During the statistical period, the dry bulk cargo terminal completed the comprehensive energy consumption of production per 10000 tons of local cargo throughput. Comprehensive energy consumption of production includes energy consumption of loading and unloading production and energy consumption of auxiliary production.

## ②indicator target value

The comparable comprehensive energy consumption index of the unit throughput of the container terminal shall be set to reach the level 1 index of 24.0 tce/10000 TEU in the "Energy Consumption Quota for Unit Product of Terminal Operations" GB31823.

The comparable comprehensive energy consumption index of unit throughput of dry bulk cargo terminal should reach the level 1 index of 1.8tce/10000 tons of throughput in the "Energy Consumption Quota for Unit Product of Terminal Operations" GB31823.

## ③Implementation path

A series of management and technical measures can be taken to reduce the energy consumption of the terminal, including the implementation of the port equipment energy management file system, the establishment of high energy consumption equipment account and elimination plan, the elimination of high emission non-road mobile machinery, and the deactivation of the own and agreed fleet of high emission heavy diesel trucks; Implement energy-saving transformation of loading and unloading equipment and facilities, upgrading and transformation of port power transformation and distribution equipment, motor frequency conversion transformation, and energy feedback transformation of lifting machinery, strengthen energy conservation management, and continue to promote energy efficiency quota assessment.

### (3) Application of renewable energy technology

#### ①indicator connotation

Renewable energy refers to wind energy, solar energy, water energy, biomass energy, geothermal energy and other non-fossil energy. Renewable energy is a green and low-carbon energy and an important part of China's multi-wheel drive energy supply system. It is of great significance to improve the energy structure, protect the ecological environment, cope with climate change and achieve sustainable economic and social development. Among them, wind power and photovoltaic power generation are widely used in the wharf.

#### ②indicator target value

The green smart specialized terminal should build wind power and distributed photovoltaic power generation projects, and strive to expand the proportion of renewable energy applications.

#### ③Implementation path

The port is rich in wind energy resources, which is conducive to the construction of wind power system; Distributed photovoltaic power generation can be implemented in large areas such as the roof of the waiting building.

## 2.2 Operation organization

### (1) Coverage rate and utilization rate of ship shore power

#### ①indicator connotation

Renewable energy refers to wind energy, solar energy, water energy, biomass energy,

geothermal energy and other non-fossil energy. Renewable energy is a green and low-carbon energy and an important part of China's multi-wheel drive energy supply system. It is of great significance to improve the energy structure, protect the ecological environment, cope with climate change and achieve sustainable economic and social development. Among them, wind power and photovoltaic power generation are widely used in the wharf.

②indicator target value

The electricity connection rate at major ports in China has also increased year by year. Therefore, this indicator is set to be 50% of the coverage rate of shore power facilities, and 100% in terminals with high demand for electricity. The shore power connection rate is 100% when the berthing ships meet the connection conditions.

③Implementation path

At present, China's port shore power construction is relatively complete, and low-voltage shore power facilities have basically been fully connected. Further improvement of high-voltage shore power facilities connection technology can achieve 100% connection of all shore power equipment.

(2) Classified collection and harmless treatment of solid waste

①indicator connotation

The main methods for harmless treatment of domestic waste include sanitary landfill, incineration and composting. The harmless treatment of domestic garbage refers to the process of using advanced technology and scientific technology to reduce the impact of garbage and its derivatives on the environment, reduce waste emissions and achieve resource recovery and utilization during the treatment of domestic garbage.

The calculation method is as follows:

$$\text{Rate} = \text{Amount} / \text{Tatal} \quad (1)$$

*Rate*: domestic waste classification treatment rate

*Amount*: domestic waste classification and harmless treatment amount

*Tatal*: tatal of garbage generated in the port area

②indicator target value

According to the requirements of the Green Port Grade Assessment Guide and the survey of the current situation of some terminals, it is set that the terminal enterprises should achieve 100% classified collection and storage of solid waste, or take harmless treatment measures for solid waste.

③Implementation path

At present, large coastal terminal enterprises can achieve 100% classified collection and storage of solid waste, or take harmless treatment measures for solid waste, which is relatively difficult to achieve.

### (3) Proportion of greening area to greening area

#### ①indicator connotation

Greenable area is the sum of the total area of the port area after removing the floor area of buildings and storage yards.

Proportion of greening area to greening area=greening area/greening area

#### ②indicator target value

According to the requirements of the Guide for Green Port Grade Assessment and the current situation of the terminal, the greening area shall be set to account for 100% of the greening area.

#### ③Implementation path

Improve the type and level of vegetation in the port area, and increase the greening area under the premise of ensuring operation.

### (4) Proportion of clean energy used by machinery and vehicles

#### ①indicator connotation

This indicator reflects the degree of clean energy utilization of port machinery and vehicles and the level of port cleaner production.

The calculation method is as follows:

$$\text{Rate} = \text{Amount} / \text{Tatal} \quad (2)$$

*Rate*: Proportion of port machinery and vehicles using clean energy

*Amount*: number of port machinery and vehicles using clean energt

*Tatal*: total port machinery and vehicles (excluding machinery that must use fuel, such as loaders)

#### ②indicator target value

At present, the newly-built and rebuilt specialized wharves are basically powered by electricity, so it is set that the specialized wharves should realize the use of clean energy for all the machinery and vehicles in port (except for the equipment that must use fuel oil).

#### ③Implementation path

Accelerate the elimination of old non-road mobile machinery, strengthen the maintenance of existing equipment, and increase the proportion of clean energy use in ports.

### (5) Construction of energy management and control platform

#### ①indicator connotation

A data platform for comprehensive monitoring and analysis of energy consumption in the enterprise to achieve refined energy consumption management.

## ②indicator target value

According to the construction status of the online monitoring system for energy consumption, the target value is set to build an energy control system covering the main energy consumption categories of the enterprise, with the main functions of early warning, energy consumption analysis, etc.

## ③Implementation path

In order to achieve the goal of "carbon peak, carbon neutral", it is imperative to carry out refined energy management. Building an energy management and control platform is an effective means to carry out refined energy consumption management.

## (6) Network facilities

### ①indicator connotation

Network construction is an important guarantee to realize the intelligent operation of the port, and is the basis for smooth communication between various intelligent systems, including wireless network and wired network. The network can be built by the port operator or by the superior company.

### ②indicator target value

Set the index value to achieve the coverage of the main areas of the port, such as the surrounding working roads and sites; Anchorage to approach channel; Ultra low altitude wireless coverage in the port area; Wireless coverage at the ship's sea side; The site and shoreline are not covered by the basic network of blind areas. Supporting the stable operation of smart port, key network equipment has redundant configuration.

### ③Implementation path

China's communication technology has been in the forefront of the world, and the construction of information network is relatively mature. Port managers should pay more attention to the construction of network, and create a high-speed and stable port network environment.

## (7) Intelligent new technology application

### ①indicator connotation

This indicator mainly includes the application of smart new technologies in various non-traditional port industries, such as 5G communication technology, digital twin technology, etc.

### ②indicator target value

The port should vigorously promote 5G communication technology, artificial intelligence technology, automatic driving technology, blockchain technology, digital twin technology, Beidou positioning technology and other new technologies.

### ③Implementation path

In recent years, China has continued to invest in science and technology, and has increasingly paid more attention to the field of science and technology. The port industry is also bound to

keep pace with the times, constantly strengthen scientific and technological innovation, and want to develop in the direction of intelligence and informatization.

## **2.3 Production management**

### **(1) Green smart management organization**

#### **①indicator connotation**

The management organization is a functional department set up to ensure the construction of green smart port, responsible for the planning, organization, implementation and supervision of relevant work, and is the specific organizer, planner and executor of the construction of green smart port.

The management organization can be specially set up by the port operator or attached to other functional departments, but it must have clear work responsibilities to people, or it can be uniformly set up by the superior company, but the work responsibilities and work scope must include the port operator.

#### **②indicator target value**

A special green and smart port construction functional department should be set up, or the relevant functional departments should concurrently serve, and there should be clear enterprise management leaders in charge.

#### **③Implementation path**

Port managers should pay more attention to the construction of green and smart ports, establish professional teams, and promote the construction of green and smart ports.

### **(2) Green smart capital investment**

#### **①indicator connotation**

To carry out the construction and related work of green smart wharf requires a large amount of financial support. The investment of enterprises in this work is also an important guarantee for construction.

#### **②indicator target value**

The port should have a fixed annual budget for the green and smart development of the port, and all the budget should be directly used to carry out the work related to the green and smart port construction according to the implementation schedule.

#### **③Implementation path**

The set indicator value is that the port should have a fixed annual budget for the green and smart development of the port, and all the budget should be directly used to carry out the work related to the green and smart port construction according to the implementation progress.

### **(3) Green Smart Goal Assessment**

#### **①indicator connotation**

Objective assessment is to complete the set objectives, decompose the objectives by levels,



and assess the responsibility units to complete the scheduled tasks and objectives within the agreed time limit. Objective assessment is a method of quota management, which is divided into assessment of principals, teams and operators at all levels according to different assessment objects.

②indicator target value

Formulate relevant systems for the construction of green and smart ports, involving energy consumption management, environmental protection, intelligent equipment and other relevant contents, and conduct the assessment on the work related to the construction of green and smart ports for principals, teams and operators at all levels.

③Implementation path

It is necessary to clarify the specific work objectives of all posts and personnel at all levels, and give full play to the potential and enthusiasm of employees through objective assessment, so as to better achieve the goal of building a green and smart port.

(4) Green and smart port training and education

①indicator connotation

Training and education refers to the training of port managers or practitioners on the concepts, skills and other aspects related to the construction of green smart ports. Education and training can take various forms, and the content is closely related to green smart ports.

②indicator target value

Formulate a comprehensive green smart port education and training plan and implement it effectively.

③Implementation path

Education and training is an important means to improve the green wisdom concept and skills of port managers and practitioners. It is imperative to improve the awareness and skills of relevant personnel through education and training.

### 3 CONCLUSIONS

Green development and smart development are the future development trend of the port industry<sup>[1-7]</sup>. Therefore, this study has developed a green and smart port indicator system based on the current development status and future development trend of the port industry. Through three primary indicators of planning and design, operation organization and production management, and 14 secondary indicators corresponding to the specific content, it has formulated the future port development goals, which can provide reference for the green and smart development of the port industry.

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