

EXECUTIVE SUMMARY

A Study on Improving Cargo Handling Equipment Management Framework for Carbon-Neutral Port Transition

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1. Background and Purpose

1) Background

- Managing cargo handling equipment is essential as a practical starting point for achieving carbon neutrality in ports.
- Greenhouse gas (GHG) reduction and carbon neutrality implementation are now required across all industrial sectors, with decarbonization emerging as a key priority for ports as critical infrastructure for international logistics.
- Achieving carbon neutrality in ports requires a phased strategic approach that should begin with areas where both manageability and effectiveness can be simultaneously ensured.
- Cargo handling equipment should be a management priority because port operators can directly control it, activity data are

relatively accessible, and it accounts for the largest proportion of emissions within ports.

- Korea's policy discussions on reducing GHG emissions from cargo handling equipment have focused primarily on energy transition, limiting the effectiveness of emission reduction efforts.
- Current domestic policies for reducing GHG emissions from cargo handling equipment focus primarily on energy transition measures such as equipment electrification and renewable energy adoption. However, this approach alone is insufficient for continuously monitoring and managing reduction progress and ensuring the stable accumulation of emission reduction achievements.

2) Purpose

- This study aims to propose improvements to the management framework for cargo handling equipment to ensure the effective implementation of GHG reduction activities.
- The purpose of this study is to propose measures for improving the cargo handling equipment management framework to better address GHG emissions, along with institutional reforms to support these objectives.
- Specifically, this study (1) establishes the policy importance and urgency of managing GHG emissions from cargo handling equipment, (2) diagnoses limitations in the current management

framework, and (3) proposes improvement measures to ensure systematic and sustained implementation of emission reduction policies.

2. Methodology and Distinctive Features

1) Methodology

- This study employed literature analysis, case studies, stakeholder interviews, and expert consultations.
- The research methods included literature review of domestic and international studies, analysis of relevant legal systems and policy trends, examination of policy approaches in leading countries, case studies from other sectors, and stakeholder interviews with expert consultations.
- In particular, stakeholder interviews and expert consultations were conducted to reflect practical policy needs from the field and to develop effective and feasible policy recommendations.

2) Distinctive Features

- This study distinguishes itself from existing research in the following key aspects:
- First, it focuses on establishing the policy and institutional foundation necessary for sustained GHG reduction from cargo handling equipment.

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- Second, it adopts a novel approach to GHG management through advancing the administrative management framework for cargo handling equipment.
 - Third, it proposes implementable management measures grounded in field insights and policy perspectives of relevant stakeholders.

3. Result

1) Summary

- Improving the management framework for cargo handling equipment is required to achieve carbon-neutral ports.
- The “*2050 Carbon Neutrality Roadmap for the Maritime and Fisheries Sector*” officially established carbon neutrality targets for the port sector, making GHG reduction from cargo handling equipment, a major emission source in ports, a critical policy imperative.
- However, the current management framework for cargo handling equipment is designed primarily to ensure safety and reduce air pollutants, which limits its capacity to continuously induce and govern GHG reduction activities.
- Therefore, to achieve port carbon neutrality, it is necessary to improve the management framework to enable effective reduction of GHG emissions from cargo handling equipment.

- Major countries and other sectors in Korea have been strengthening their GHG management foundations.
 - Leading countries have strengthened GHG management foundations for cargo handling equipment. Beyond technological measures such as electrification, they are implementing complementary policy instruments including institutional arrangements, data and MRV frameworks, and mechanisms for sustaining emission reduction efforts.
 - Korea's building, industrial, and transport sectors have enhanced their GHG management foundations through policy instruments that comprehensively address emission management across operational processes.
 - These cases indicate that GHG reduction from cargo handling equipment should be pursued through approaches that enable the continuous identification and management of emissions across overall equipment operations.
- Improving the cargo handling equipment management framework is necessary to achieve effective and sustained GHG reduction.
 - To ensure that GHG reduction from cargo handling equipment is implemented and managed in a sustained manner, it is necessary to expand the scope of equipment management so that GHG considerations are explicitly incorporated into existing management practices.

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- Furthermore, the management framework should be reoriented to enable emissions to be identified and managed throughout the entire equipment management lifecycle, thereby enabling continuous and sustained emission reduction efforts by relevant stakeholders.

2) Policy Formulation Methods

- The cargo handling equipment registration format in the *Regulations on the Management of Port Facility Equipment* requires revision.
- To enable systematic management of GHG emissions from cargo handling equipment, it is necessary to secure basic specification data on prime movers that directly affect GHG emissions at the equipment registration stage.
- Accordingly, this study proposes revising the cargo handling equipment registration format in *Annex Form No. 2* of the ‘*Regulations on the Management of Port Facility Equipment*’ to reflect equipment types and prime mover characteristics.

〈Figure 1〉 Revision to the Equipment Registration Format

항만시설장비(컨테이너 크레인) 대장				항만시설장비(트랜스퍼 크레인) 대장					
시설장비명		관리번호		시설장비명		관리번호			
설치장소		부두		설치장소		부두			
용도(취급 화물)		소유자		용도(취급 화물)		소유자			
제조·설치감사일		관리자		제조·설치감사일		관리자			
검사감각번호		제작자		검사감각번호		제작자			
검사기관		가격 / 대당	백만원	검사기관		가격 / 대당	백만원		
주요 제 형				주요 제 형					
장격하중(스트레드 일)	톤	전 상 속도	장격하중	m/min	컨테이너 적재 단위/물수	단	일	무부하	m/min
바다측 도달거리	m	무부하	바다측 도달거리	m/min	인양고도	m	트롤리 횡행 속도	m/min	
(바다측 제일중심 기준)	m		(바다측 제일중심 기준)	m	타이어 휠 간격	m	컨트롤 주행 속도	m/min	
육지측 도달거리	m	트롤리 횡행 속도	육지측 도달거리	m/min	트랜스퍼 크레인	트롤리 이동거리	m	주행 방향 크레인 폭	m
(육지측 제일중심 기준)	m		(육지측 제일중심 기준)	m	제일식 트랜스퍼 크레인	컨트롤 제일 간격	m	(범퍼 끝에서 범퍼 끝까지)	
상방 인양고도	m	컨트롤 주행 속도	상방 인양고도	m/min	트롤리 이동거리	m	차중	톤	
(컨트롤 제일 상면 기준)	m		(컨트롤 제일 상면 기준)	m	제그 간격 내측 간격	m	구조물 사용 등급	사이클	
하방 인양고도	m	불 관상, 관하 소요시간	하방 인양고도	분	공급전 원(전기식)	Ph V Hz	작업시 속도	m/sec	
(컨트롤 제일 상면 기준)	m		(컨트롤 제일 상면 기준)	m	연식	형식(제조사/모델명)	작업시 하중	m/sec	
컨트롤 제일 간격	m	평균 작업주기 시간	컨트롤 제일 간격	초	연식	모리원 출력	kW(hp)@ rpm	기타	
컨트롤 제일 규격	m	종속	컨트롤 제일 규격	m/sec	연식	형식(제조사/모델명)	작업시 하중	톤/m	
제그간 내측 간격	m	표지시	제그간 내측 간격	m/sec	연식	모리원 출력	V Ph Hz	톤	
물밀방 통과높이	m	작업시 육지측	물밀방 통과높이	톤/m	연식	모리원 출력	중 IP	톤	
주행방향 크레인 폭	m	바다측	주행방향 크레인 폭	톤/m	연식	모리원 출력	중 IP	톤	
(범퍼 끝에서 범퍼 끝까지)	m	표지시 육지측	(범퍼 끝에서 범퍼 끝까지)	톤/m	연식	모리원 출력	중 IP	톤	
차중	톤	바다측	차중	톤/m	연식	모리원 출력	중 IP	톤	
구조물 사용 등급	사이클	기타	구조물 사용 등급	기타	연식	모리원 출력	중 IP	톤	

Source: Prepared by the author based on KOTEC advisory consultation

- Legal grounds for strengthening management of aging diesel-powered equipment must be established through amendments to the *Special Act on the Improvement of Air Quality in Port Areas* and the *Harbor Act*.
- To enable systematic management of diesel-powered equipment with high emission contributions, this study proposes institutional reforms including: (1) establishing regular emission inspection standards for equipment, (2) providing legal grounds for recommending early scrapping of aged cargo handling equipment, and (3) creating legal grounds for supporting early scrapping programs.

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- This approach builds on the existing air pollutant regulatory framework, considering that aged diesel cargo handling equipment tends to experience simultaneous increases in both GHG and air pollutants due to deteriorating fuel efficiency over time.
 - Leveraging the existing system is more advantageous in terms of feasibility and management effectiveness, given that an air pollutant management system is already established.
 - To achieve this, the study proposes including emission inspections in the periodic inspection of cargo handling equipment.

〈Table 1〉 Revision to the Special Act on the Improvement of Air Quality in Port Areas (draft)—Periodic Emission Inspections for Cargo Handling Equipment

Current Provision	Revision (draft)
Article 14 (Emission Standards for Cargo Handling Equipment, etc.) ①-② (Omitted) 〈New Provision〉	Article 14 (Emission Standards for Cargo Handling Equipment, etc.) ① -② (Same as current provision) ③ Pursuant to Article 33 of the Harbor Act, port-based business operators shall undergo periodic emission inspections of cargo handling equipment at regular intervals to verify compliance with emission standards. However, environmentally friendly cargo handling equipment designated by the Minister of Oceans and Fisheries may be exempt from periodic emission inspection requirement.

Source: Prepared by the author

〈Table 2〉 Revision to the Harbor Act (draft)—Periodic Inspections for Cargo Handling Equipment

Current Provision	Revision (draft)
Article 33 (Inspection of Port Facilities and Equipment, etc.) ① Port facility and equipment managers shall undergo inspections conducted by management authority for port facilities and equipment under their use and management according to the following classifications: 1–2. (Omitted) 3. Periodic inspection: An inspection conducted periodically at intervals prescribed by Ordinance of the Ministry of Oceans and Fisheries from the date of manufacturing inspection or installation inspection to verify the safety status of port facilities and equipment in use 4. (Omitted)	Article 33 (Inspection of Port Facilities and Equipment, etc.) ① (Same as current provision) 1–2. (Same as current provision) 3. Periodic inspection: An inspection conducted periodically at intervals prescribed by Ordinance of the Ministry of Oceans and Fisheries from the date of manufacturing inspection or installation inspection to verify the safety status of port facilities and equipment in use, and periodic emission inspections of cargo handling equipment pursuant to the <i>Special Act on the Improvement of Air Quality in Port Areas</i> 4. (Same as current provision)
②–③ (Omitted)	②–③ (Same as current provision)

Source: Prepared by the author

- In conjunction with these measures, the *Special Act on the Improvement of Air Quality in Port Areas* and its Enforcement Decree must be amended to establish a foundation for encouraging the transition of aged diesel-powered cargo handling equipment to environmentally friendly alternatives.

〈Table 3〉 Revision to the Special Act on the Improvement of Air Quality in Port Areas (draft)—Operation Management of Aged and High-Emission Cargo Handling Equipment

Current Provision	Revision (draft)
〈New Provision〉	<u>Article XX (Operation Management of Aged and High-Emission Cargo Handling Equipment, etc.) ① Where the Minister of Oceans and Fisheries deems it necessary to improve air quality in ports and reduce emissions of climate and ecosystem-disrupting substances, the Minister may recommend early scrapping to owners of cargo handling equipment that meets the requirements prescribed by the Minister of Oceans and Fisheries.</u> <u>② The State or local governments may provide necessary financial support to port business operators who implement early scrapping of cargo handling equipment pursuant to the recommendation under paragraph (1), in order to promote the adoption and transition of environmentally friendly cargo handling equipment.</u>

Source: Prepared by the author

〈Table 4〉 Revision to the Enforcement Decree of the Special Act on the Improvement of Air Quality in Port Areas (draft)—Cargo Handling Equipment Subject to Early Scrapping

Current Provision	Revision (draft)
〈New Provision〉	<u>Article XX (Cargo Handling Equipment Subject to Early Scrapping) “Cargo handling equipment that meets the requirements prescribed by the Minister of Oceans and Fisheries” under Article XX, paragraph (1) of the Act refers to cargo handling equipment that satisfies all of the following requirements:</u> <u>1. Cargo handling equipment that has been continuously registered for at least six months, calculated retroactively from the time the recommendation for early scrapping is made</u> <u>2. Cargo handling equipment that has passed the periodic inspection pursuant to Article 33 of the <i>Harbor Act</i></u> <u>3. Cargo handling equipment that complies with the emission standards under Article 14 of the <i>Special Act on the</i></u>

Current Provision	Revision (draft)
	<u><i>Improvement of Air Quality in Port Areas</i> and Article 9 of its Enforcement Decree</u>
	<u>4. Aged cargo handling equipment that meets the standards prescribed by the Minister of Oceans and Fisheries</u>

Source: Prepared by the author

- To establish a systematic framework for calculating GHG emissions, the *Guidelines for Calculating GHG Emissions from Cargo Handling Equipment* should be enacted, and national emission factors for cargo handling equipment should be developed.
- To establish a standardized calculation framework, this study proposes that the Ministry of Oceans and Fisheries lead the development of administrative *Guidelines for Calculating GHG Emissions from Cargo Handling Equipment*, verify their adequacy through pilot port applications, and subsequently adopt them as the national calculation framework.
- The guidelines should incorporate calculation formulas, clear definitions and scope of activity data for calculations, data quality standards, and emission factors. A detailed proposed structure is presented in Table 5.
- To this end, this study proposes undertaking a project to develop Korea-specific emission factors that reflect the characteristics of cargo handling equipment.

〈Table 5〉 Structure of the Guidelines for Calculating GHG Emissions from Cargo Handling Equipment (Draft)

Category	Content
Purpose	• Standardization of GHG emission calculation methods for cargo handling equipment and ensuring interoperability • Provision of practical guidance to enable calculation entities to easily understand and calculate emissions
Basic Principles	• Aim for precise activity data-based calculations (IPCC Guidelines Tier 3 level) where feasible, while maintaining flexibility based on the characteristics of target GHG and data availability
Intended Users	• Cargo handling equipment managers and port authorities • Foreign ports and other port stakeholders may also utilize as a reference standard
Main Content	• Scope of calculation and applicability • GHG subject to calculation • Calculation standards • Emission factor selection • Activity data selection • Quality assurance and data management standards

Source: Prepared by the author

- This study proposes establishing a legal basis for developing a GHG inventory for cargo handling equipment through the amendment of the *Harbor Act*.
- Specifically, the study proposes the amendment of Article 30 of the *Harbor Act* to provide the Minister of Oceans and Fisheries with authority to compile port GHG statistics disaggregated at the port level and the equipment level.

〈Table 6〉 Revision to the Harbor Act (draft) – Legal Basis for Developing a GHG Inventory for Cargo Handling Equipment

Current Provision	Revision (draft)
Article 30 (Reduction of GHG, etc.) ①–② (Omitted)	Article 30 (Reduction of GHG, etc.) ①–② (Same as current provision)
〈New Provision〉	<u>③ The Minister of Oceans and Fisheries may establish statistics related to GHG emissions from ports for the effective formulation and implementation of relevant policies.</u>
〈New Provision〉	<u>④ Matters concerning the scope and methods for compiling statistics under paragraph (3) shall be prescribed by Presidential Decree.</u>

Source: Prepared by the author

〈Table 7〉 Revision to the Enforcement Decree of the Harbor Act (draft)—Legal Basis for Developing a GHG Inventory for Cargo Handling Equipment

Current Provision	Revision (draft)
〈New Provision〉	<u>Article XX (Units for Compiling GHG Statistics, etc.)</u> <u>① The units for compiling statistics pursuant to Article 30, paragraph (4) of the Act shall be as follows:</u> <u>1. Ports</u> <u>2. Cargo handling equipment</u>
〈New Provision〉	<u>② Where necessary for compiling statistics under Article 30, paragraph (3) of the Act, the Minister of Oceans and Fisheries may request data submission or cooperation from the heads of relevant central administrative agencies or port business operators.</u>

Source: Prepared by the author

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- Technology development and dissemination programs for GHG reduction and energy efficiency improvement in cargo handling equipment must be expanded.
 - Technology investment for GHG reduction and energy efficiency improvement is a core element of GHG mitigation policy. Therefore, government-led research and development, demonstration, and dissemination programs should be actively promoted to secure GHG reduction technologies.
 - An integrated approach linking core technology development, demonstration, and dissemination is essential. Dissemination programs should be implemented through public-private matching funds to ensure practical applicability of technologies and establish shared responsibility between the public and private sectors.
 - A transitional response framework for energy transition must be established.
 - LNG equipment belongs to the same category as diesel equipment in terms of being ultimately subject to conversion. However, it is rational to prioritize diesel conversion and assign LNG equipment a lower priority with a slower conversion timeline.
 - Therefore, policies promoting early scrapping of diesel equipment should be implemented first, with LNG equipment recognized as low-carbon equipment for a certain period. Only after substantial progress in phasing out diesel equipment should LNG equipment be incorporated as a primary conversion target.

- Furthermore, when electrification expansion reduces LNG equipment to below a certain proportion of total cargo handling equipment, temporary fuel cost subsidies may be considered as an exceptional measure to support stable operation of refueling infrastructure. However, such subsidies should be structured to avoid incentivizing the further adoption of LNG equipment.

3) Expected Outcomes

- **Policy effects**
 - Cargo handling equipment reduction policies can shift from a project-based approach to ongoing management.
 - The management and implementation framework for reducing GHG emissions in the port sector will be strengthened, enhancing the effectiveness of achieving national reduction targets.
 - The predictability and precision of cargo handling equipment reduction policies are expected to improve.
 - A foundation for designing GHG policies and developing plans for the port sector will be established.
- **Social and economic effects**
 - Data-driven policy formulation and performance evaluation will become feasible, mitigating policy risks and social costs.
 - Korean ports can strengthen their environmental competitiveness and enhance their international credibility.

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- A structure enabling reduction investments to be converted into operational performance will be established, enhancing the sustainability of reduction efforts.