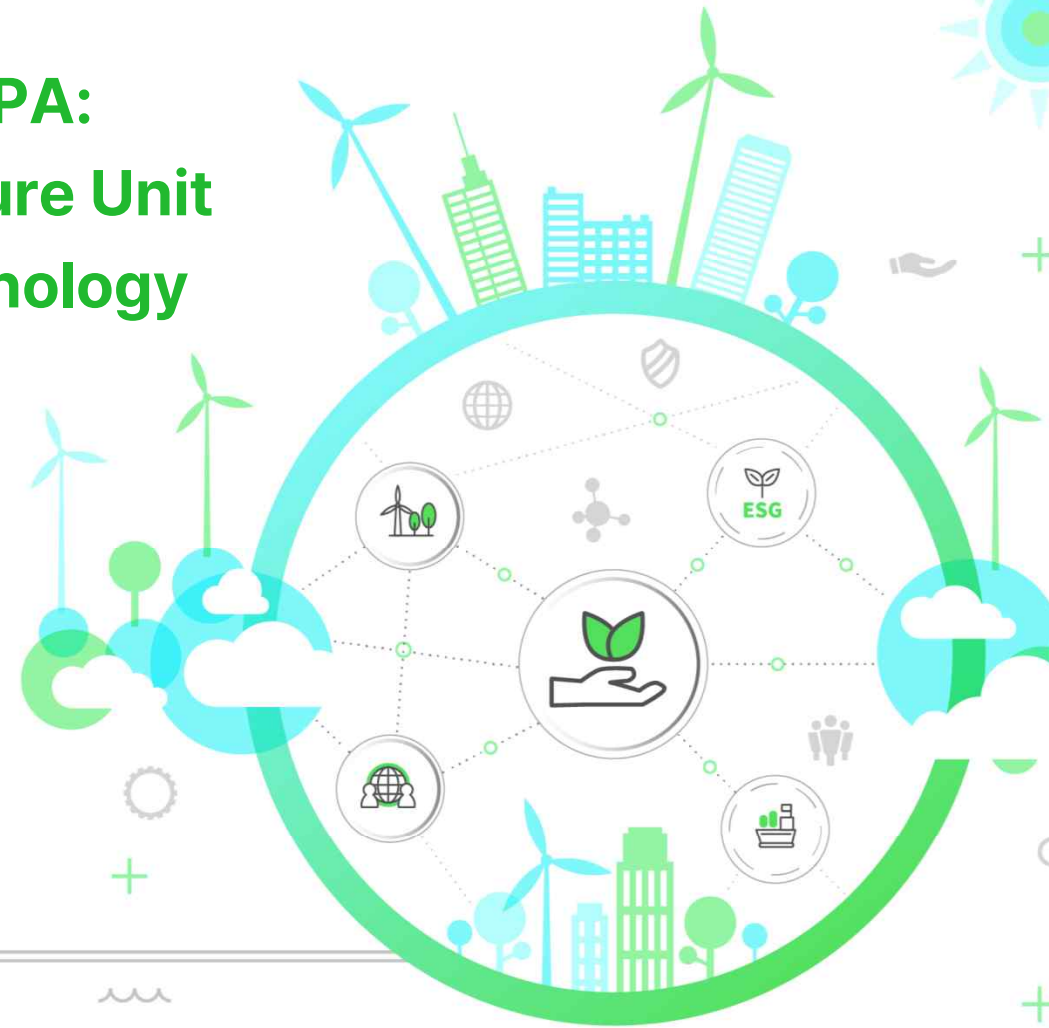


Environmental care field

Pioneering Domestic and International PA: Introducing a Port-Based Carbon Capture Unit Utilizing DAC(Direct Air Capture) Technology

introduction of Carbon Capture Utilization
and Storage(CCUS) Technology

| 2024.05



Introduction to Ulsan Port

Eco-friendly shipping port and local community • Establishing Ulsan Port to lead carbon neutrality

Operation of the Vessel Speed Reduction(VSR) Program

- ▶ Operation of the Vessel Low Speed Program (VSR) system
 - A reduction of up to 40% in port entry and departure fees for slow steaming vessels (shipping companies) to mitigate greenhouse gas and pollutant emissions.
 - Expanding the replacement of fossil fuel usage through the activation of AMP (Alternative Maritime Power supply facilities).

Implementation of a carbon neutral port

- ▶ Implementing a 2035 carbon neutrality strategy and creating eco-friendly energy specialized ports.
 - Establishing a mid-to-long-term strategy for achieving early carbon neutrality (by 2035).
- | division | 2027 | 2030 | 2035 |
|-------------------|---|---|---|
| reduction project | LNG, methanol bunkering ships low speed operation | hydrogen fuel cell Introduction and unloading equipment electrical conversion | Ammonia Bunkering Blue Carbon Expansion |
| reduction rate | 34.0% | 44.5% | 148.1% |
- A greenhouse gas reduction strategy through the transition to zero-carbon ship fuels such as hydrogen and ammonia.

Creating an eco-friendly port ecosystem

- ▶ Expanding internal and external participation to promote the sharing of eco-friendly values.
 - Establishing and implementing a resource circulation cooperation system in collaboration with local organizations for waste PET and waste electrical products, etc.
 - Exploring CCUS technologies for carbon neutrality and raising public awareness.
 - Revitalizing port environment cleaning activities with port business organizations, local communities, etc.



Introduction to Ulsan Port

Creating an eco-friendly port ecosystem through port waste resource circulation

First time in the country! Upcycling of waste tires!

▶ For the first time in the country, creating a playground for children in underprivileged areas through the recycling of waste tires.

- Reducing approximately 49.25 tons of CO2 emissions through the recycling of 51 tons of waste tires.
- Creating a unique and creative playground by incorporating the ideas and designs of local children, making it one-of-a-kind in the world.
- Awarded the "Minister of Health and Welfare" commendation in 2021 for creating shared value with the local community.



Introduction to Ulsan Port

Creating an eco-friendly port ecosystem through port waste resource circulation

Use of waste plastic, donation of safety vests

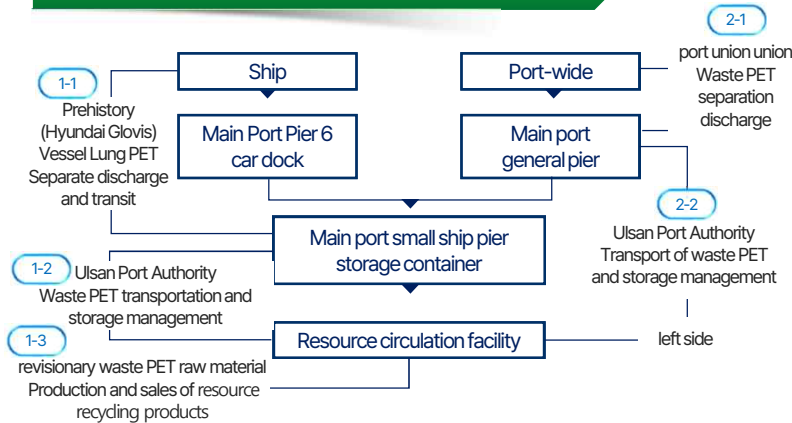
▶ Manufacturing safety vests utilizing waste plastic bottles generated from port-related activities such as quays, and donating them to relevant organizations.

- 21,000 waste plastic bottles recycled into resources Produced and donated 1,450 safety vests

→ CO2 emissions reduced by approximately **1.423 Ton**

- Resource circulation activities, community expansion and environment simultaneous realization of safety value
- Practicing ESG management in ports and local communities

Roles and locations by institution



[Reference] Calculation of greenhouse gas reduction effect

[Calculation basis : (Attachment 7 (Social value of plastic packaging reduction (2022.07 / Social Value Research Institute)

[Calculation formula : $1) 17,400 \text{ pieces}_{PET} \times 2) 0.0162\text{kg}_{PET} / \text{piece}_{PET} \times 3) 1.8\text{kgCO}_{2eq} / \text{kg}_{PET} \approx 507.4\text{kg}$

- Number of plastic bottles required to make a safety vest
- Recommended weight standards for 500ml PET bottles (Ministry of Environment)
- Greenhouse gas reduction when recycling 1kg of PET bottles (effect of replacing new production)

[Greenhouse gas reduction effect compared to land waste disposal method

- Reduction of greenhouse gases by 1,178.3 kg (compared to waste incineration)
→ 670.9kg (generated amount from waste incineration) + 507.4kg (effect of replacing new production)
- Reduction of greenhouse gases by 539.8 kg (compared to waste landfill)
→ 32.4kg (amount generated when selling waste) + 507.4kg (effect of replacing new production)



Introduction to Ulsan Port

Creating an eco-friendly port ecosystem through port waste resource circulation

PA's first resource recycling of waste electrical and electronic products

▶ For the first time among domestic port authorities, establishing a recycling and resource circulation system for waste electrical and electronic products.

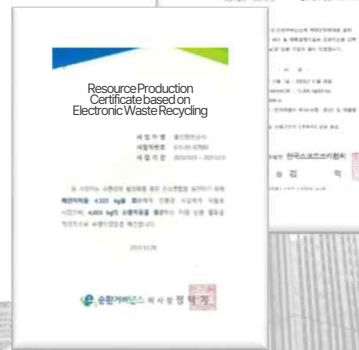
- Recovering 4.322 tons of waste electrical and electronic products, producing 4.033 tons of recycled resource
→ **Reducing approximately 10.095 tons of greenhouse gas emissions**
- Expanding the scope of resource circulation (waste electrical and electronic products)
- Recovering and recycling rare metals (such as platinum) and useful resources from waste electrical products



1. Confirmation of carbon reduction activities
 2. Confirmation of contribution to production of circular resources
 3. Confirmation of social contribution activities
- ESG Sharing**

Deliver ESG performance

- ▶ For the waste electrical and electronic products generated, **calculating and donating an amount** of money proportional to the quantity at the end of the year to **designated organizations**
- ▶ Issuing and providing ESG performance certificates
- ▶ Carbon reduction activity certificate calculated in accordance with international standards



Greenhouse Gas Emission Reduction Certificate

Strengthening government-wide systems to implement carbon neutrality, including implementation of the Carbon Neutral Framework Act (March 2022) and selection of government tasks.

Carbon Neutral Framework Act

To achieve the national goal of carbon neutrality by 2050, the following are defined:

- Establishing national strategies, mid-to-long-term greenhouse gas reduction targets, basic plans, and legal procedures for implementation monitoring and policy measures
- Emphasizing the social responsibility of the nation and public institutions

National task number 86

Transformation into a green economy by preparing a scientific carbon neutral implementation plan

(Task Goal) Actively promote carbon neutral policy to respond to global decarbonization transition

Background

1 current situation

There is a lack of large-scale planting space needed to achieve sufficient carbon reduction goals near the port.



2 problem

Due to the nature of the port and the surrounding industrial complex, plant growth is difficult due to smoke and dust when planting plants.



3 Necessity

There is a need to increase the added value of ports and improve the air environment by improving air quality through carbon dioxide capture and utilization.



Can be used in small spaces

Expanding carbon neutrality efforts through 'introduction and activation of carbon capture devices'

Promotion efforts

Discovering a Carbon Capture Utilization unit(CCU) using DAC(Direct Air Capture) innovative technology

What is a carbon capture device?

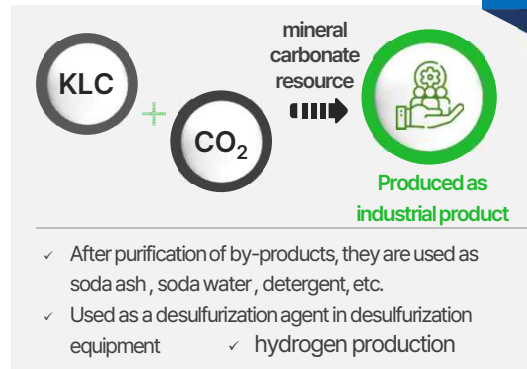
Equipment principle
Carbon capture effect
Equipment size
Installation fee

- ▶ Reacting carbon dioxide in the air with quicklime, slaked lime, etc., to produce calcium carbonate and sodium carbonate - (calcium carbonate) used as a raw material for paper, cement, etc., (sodium carbonate) used as a raw material for dyes, pharmaceuticals, etc.
- ▶ A concept that goes a step further than NET ZERO, involving not only removing emitted carbon but also removing all additional carbon present in the atmosphere.

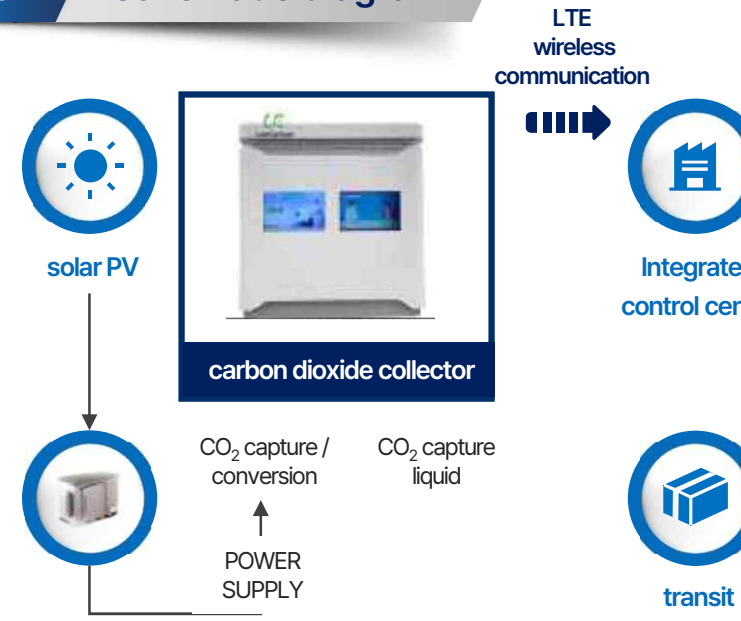
- ▶ Directly absorbing and removing carbon dioxide from the air, with a carbon removal effect exceeding 55kg monthly and 660kg annually.

- ▶ With an installation area of 3.4m x 1.5m x 2.5m, each unit occupies approximately 1.55 pyeong (around 5.1 square meters).

- ▶ Cost per 50KG unit: 200 million won



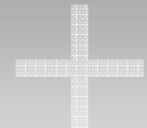
CCU schematic diagram



* CO₂ proportional to facility size Increased collection

Direct Air Capture (DAC) technology

- Directly capturing CO₂ from ambient air and generating a concentrated CO₂ stream.



Carbon Capture Utilization (CCU) technology

- A process utilizing the captured CO₂ as a resource.

Promotion efforts

First introduction of carbon capture device in the port through cooperation with TOC(Terminal operation company) (June 2023)

Promoting the introduction of carbon capture devices

- ▶ Purchased carbon dioxide capture units through collaboration with terminal operating companies to actively pursue carbon neutrality and greenhouse gas reduction activities at Ulsan Port
 - Awarded the Commissioner of the Korean Intellectual Property Office Prize at the 2023 Invention Patent Exhibition.



Operating a carbon capture device in front of the office building

- ▶ Utilizing the display installed on the front to show real-time carbon capture amounts
- ▶ For the power required to display the screen, self-generating, storing, and using electricity through solar power facilities - Achieving additional power reduction by self-securing 2-2kW per day



Promotion efforts

Increasing port stakeholder awareness of eco-friendliness and carbon neutrality

UPA TOC(Terminal operation company) signed a joint carbon reduction agreement

- ▶ Commitment to joint efforts to promote eco-friendly and carbon-neutral management
- ▶ Discussion on realizing an eco-friendly port through carbon reduction agreement and carbon capture device operation

UPA-Plantec (steel manufacturing company) signed a business agreement to create an eco-smart port

- ▶ Contributing to the environment and national development through carbon reduction practices by identifying projects and collaborating with the public and private sectors to establish carbon-neutral ports.



Performance

Carbon reduction effect

'As of April 24 (297 days after installation)
Ulsan Port carbon dioxide accumulation
Collection amount

Total 646.5kg

30-year-old pine 98 trees
Amount of CO collected per year

hour ≤ technology

10 year old pine tree 100 trees Carbon dioxide (CO₂) 1 unit

Yearly CO₂ absorption 660kg/year
National Institute of Forest Science
(2012.11.14)

Annual CO₂ absorption
Over 660kg/year
Installation area: 1.55
pyeong

Installation area: 1,100 pyeong (616=36m²)
pyeong

annual CO ₂ absorption amount per tree (kg/ tree / year)						
Tree species / age (years)	10	20	30	40	50	60
Gangwon region pine tree	0.6	1.8	4.6	6.8	7.2	7.2
Central region pine tree	1.1	5.1	8.6	6.3	3.8	2.5
Pine (average)	0.9	3.5	6.6	6.6	5.5	4.8
pine tree	1.6	8.5	12.2	13.8	13.8	13.0
larch	2.4	9.0	13.4	15.5	15.8	15.3
Rigida pine tree	0.8	4.8	7.4	7.7	6.2	5.3
cypress	2.1	4.3	5.0	5.0	4.7	4.0
oak tree	6.6	14.1	14.6	15.5	16.2	16.6
Quercus tree	1.0	5.8	7.0	9.2	11.2	12.8
Oak (average)	3.8	10.0	10.8	12.4	13.7	14.7

Korea Forest Science Institute Forest carbon absorption national standard development 2012.11.14

The carbon dioxide captured is Added to concrete, etc.
Used as sidewalk blocks and construction materials

Prevent secondary spread of air pollutants and Contribution to achieving eco-port



Performance

Carbon reduction effect

Cost savings of 73.7% with 0.1% of the natural forest area required for the same CO2 capture.

Creating a forest within an apartment complex



Installation area 1ha (3,025 pyeong)

Seedling quantity About 3,000 trees

CO₂ capture amount 660kg/year (based on tropical rainforest)

Area assembly cost About 760 million won

Area assembly period 10 years

* CO₂ in forests Comparison of environmental and functional aspects such as collection amount, assembly area and cost, excluding emotional landscaping value



Installation of 1 carbon capture device



Installation area 3.4mx 1.5mx 2.5m (approximately 1.55 pyeong)

CO₂ capture amount 660kg or more/year (55kg or more/month)

1 unit installation cost 200 million won

Performance

Carbon reduction effect

The captured carbon dioxide is added to concrete, etc.
Used as sidewalk blocks and construction materials

Air pollutants through permanent sequestration of carbon dioxide
Contributes to preventing secondary spread and achieving eco-port

Sequestration

Carbon dioxide is permanently isolated by adding the carbon dioxide collection solution to concrete, etc., and then used as building material and sidewalk blocks.

When carbon dioxide capture liquid is added to concrete at a certain rate, concrete strength is improved and used as sidewalk blocks and construction materials



The carbon dioxide capture solution obtained by capturing carbon dioxide **Carbon dioxide capture** by adding it to concrete Can be **permanently quarantined**

Comparison of compressive strength between concrete specimens mixed with carbon dioxide capture liquid and ordinary concrete specimens



	General concrete specimen Compressive strength (Mpa)	Carbon dioxide capture solution mixing Specimen compressive strength (Mpa)
1	17.0	18.1
2	16.7	16.6
3	15.9	17.1
평균	16.5	17.3

carbon dioxide Collection liquid added **The compressive strength** of concrete is Compared to regular concrete **About 5% higher**

| Pilot project status |

Carbon dioxide underlocking sidewalk block Construction completed in Gangjin Ecological Park



Strengthening eco-friendly efforts through expanded introduction of carbon capture devices in ports

Additional introduction of carbon capture devices at Ulsan Port

- ▶ Installing additional carbon capture units in areas and terminals with high carbon emissions within the port to achieve carbon neutrality at Ulsan Port by 2035
 - Targeting areas with high concentrations of vehicles, cargo handling equipment, etc.



- ▶ Target to reduce 2,000 kg per year by installing 2 additional units
 - (Currently) Capture 660kg per year
 - (Target) Capture 1,980kg per year



Promoting the construction of sidewalk blocks in nearby areas using carbon dioxide capture liquid

- ▶ Collaborating with Ulsan City, the captured carbon dioxide is recycled into concrete paving blocks near the port.



- ▶ Strengthening construction eco-friendly efforts and achieving an eco-port by permanently sequestering carbon dioxide and utilizing local sidewalk blocks and construction materials



Environmental protection field

The world's first port introduction of Carbon Capture Unit(CCU), utilizing Direct Air Capture(DAC) technology



Thank You