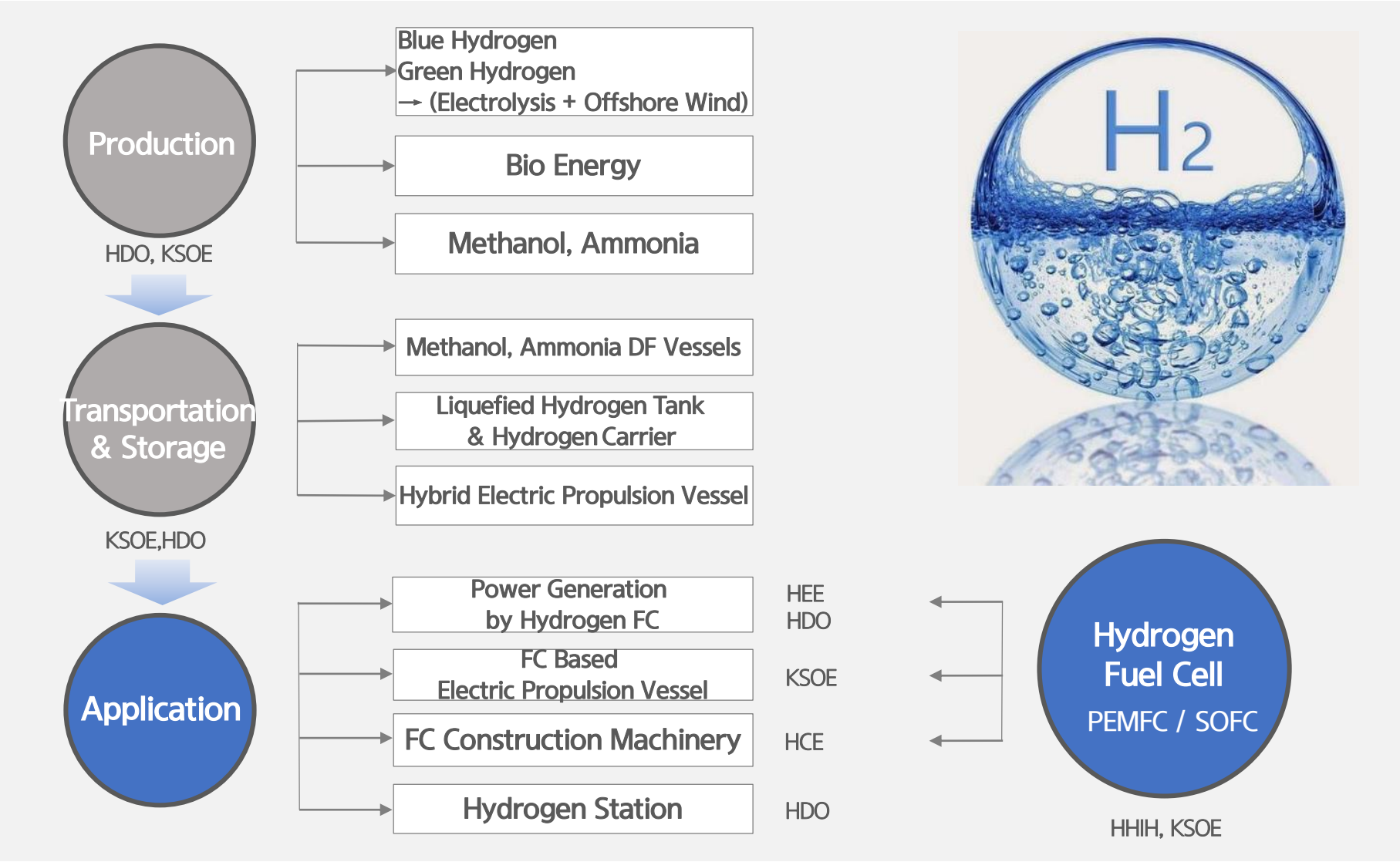


Hyundai Heavy Industries Group Future Growth Plan

KSOE

**Hyundai
Oilbank** 

Hydrogen Value Chain led by Hyundai Heavy Industries Group



Shipbuilding · Offshore

Eco-Friendly Shipbuilding and Offshore Business

FY2030

To become a No.1 shipbuilding and offshore corporation with market leading eco-friendly shipbuilding technologies

Green Hydrogen Infra



Building Offshore Platform for Electrolysis applying world-class offshore technologies

Digital Ships



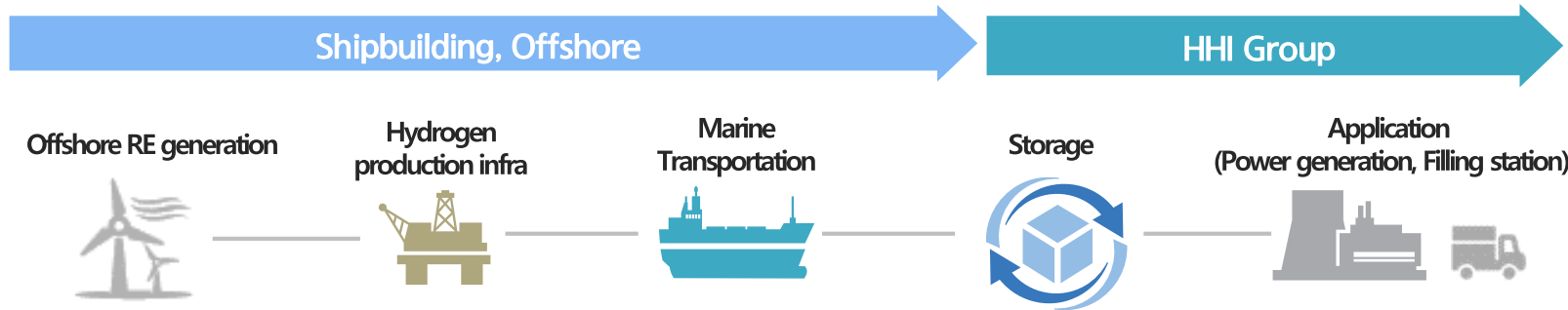
Providing Total Solution Service for Autonomous Navigation in collaboration with affiliates in the group

Eco-Friendly Vessels



Leading eco-friendly shipbuilding technologies in compliance with intensified environmental regulation

Aim to preoccupy the offshore green hydrogen infrastructure market on the back of world No.1 shipbuilding and offshore technologies



Offshore RE generation Infra



- RE generation through offshore wind power generation
- Produce green hydrogen through water Electrolysis by utilizing energy generated from offshore wind power

Offshore Hydrogen Production Infra



- Co-Development of core technologies for energy efficient water electrolysis system with domestic research Institution under way
- Develop Offshore Green Hydrogen Production Plant by combining offshore and water electrolysis technologies('25)

Hydrogen Transportation Infra

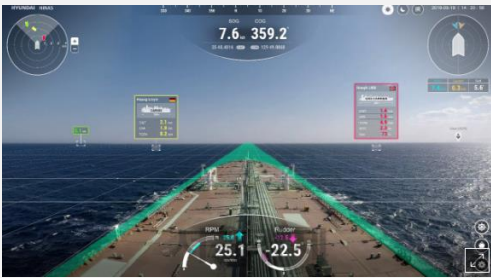


- Acquired AIP Certificate for basic design of liquefied hydrogen carriers in '20
- Develop International Standard for Hydrogen Carriers('21)
- Develop liquefied hydrogen fuel tank('23)
- Demonstration test for Hydrogen Carriers ('27)

Strive to ensure best safety management in vessels with highest efficiency by applying digital technologies

Autonomous Navigation Service

- Apply the world's first autonomous navigation supporting system
- Upgrade Autonomous Navigation supporting system progressively
 - To prevent safety accident through automatic recognition of surrounding ships
 - To provide efficient navigating environment



[Navigation Supporting System]

Safety Management in Vessels

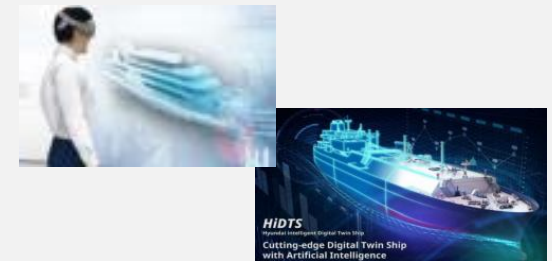
- Alarm the risk of potential abnormal accident in advance through video analysis system
 - Swift initial response through automatic recognition of accident occurrence in ships (eg. Fire)



[Video analysis system – Fire Detection]

Digital Twin

- Provide the world's first virtual sea-trials service via digital twin
- Expand to 'advance notice service' for maintenance through risk prediction
 - Response via preliminary detection of system and parts errors in ships and prediction for potential risk



[Digital Twin Platform]

To lead the era of the New Intelligent Ships via combining ICT skills and vessels, and position as a high-quality shipbuilding brand

The era of autonomous navigation has already begun through the application of autonomous navigation supporting technologies to the real ships

Autonomous Navigation Technologies

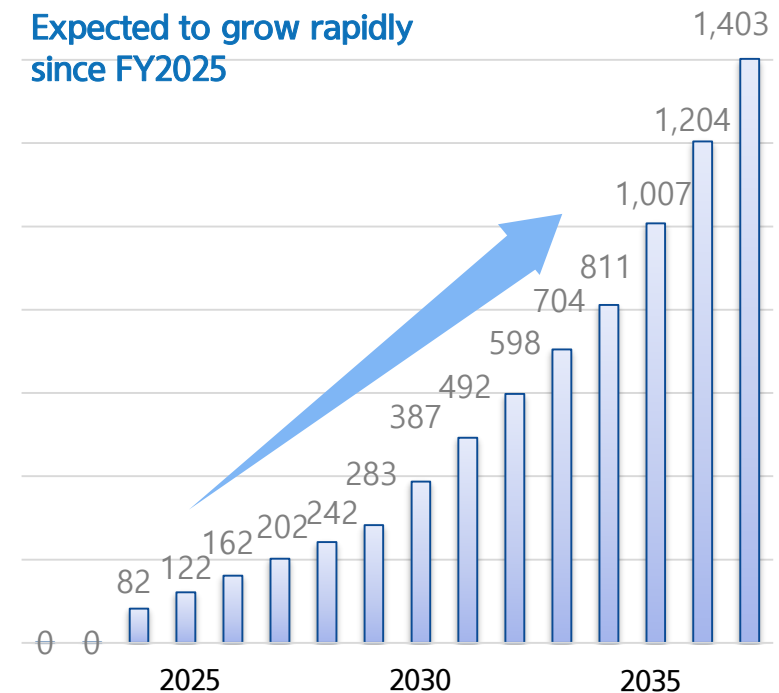
- 1 Autonomous Sailing/Control System**
(Object recognition, risk judgement/Aversion)
 - To minimize human errors via autonomous sailing/berthing skills
- 2 Monitoring/maintenance of parts/equipment of ships**
 - Preliminary risk prediction through upgrade of digital twin skills
- 3 Communication & Network Technology**
 - Cyber Security skills, Network technologies
- 4 Hyper-connected network integrating Onshore Control Center, port, etc.**
 - External support for smooth autonomous navigation by providing environmental information, schedules, etc.

Already secured basic technologies for autonomous navigation
→ Aim to lead the era of autonomous navigation through R&D and technological advancement

Autonomous Navigation Market Outlook

(Unit: '000 ships)

Expected to grow rapidly since FY2025



Source: Clarksons Research, UN - FAO, NSA(USA), MOF(Korea), KOSTAT, IHS

Aim to strengthen our competitiveness in the LNG era through continuous advancement of eco-friendly technologies

Future technology of LNG propulsion

Methane Slip Reduction Technology

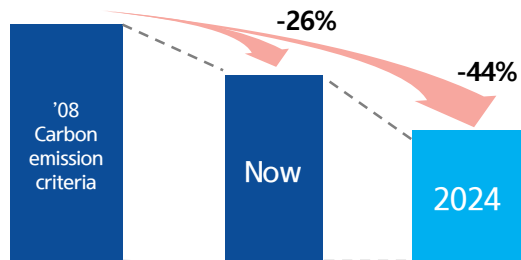
Make **zero emission** for Methane generated from LNG combustion by preventing Methane(Greenhouse gas) from leakage

Energy Efficiency Assisting Devices

Reduce Carbon emission by saving fuel
- Rotor sail (Fuel efficiency improvement about 6%)
- Air lubrication (Fuel efficiency improvement about 4%), etc

Carbon Capture of Exhaust Gas

Develop additional storage/processing devices for capturing Carbon from exhaust gas



*Based on our Eco-friendly technology development plan

Preemptive response to Methane Emission Blocking technology



Reduction of fuel usage by increasing operational efficiency



Integration of Eco-friendly technology combined with Carbon capture devices

Maintain our competitive advantage in the LNG era

Aim to secure leading position in ammonia(next generation fuel) propulsion technologies on the basis of similar LPG technologies that the group has already secured

Features for eco-friendly fuel, Ammonia

Carbon Zero

- Ammonia does not emit GHG
- NOx reduction technology has already been commercialized.

Wide Distribution

- Major global ports utilize ammonia.
- Port storage system and other infrastructure support fuel availability.

Safety

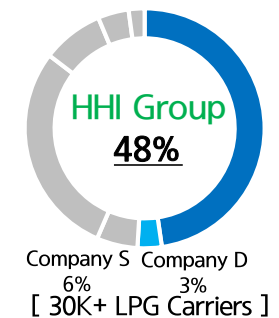
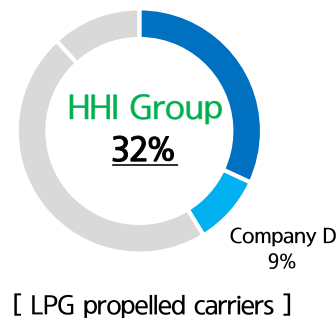
- Safety is considered as a merit thanks to low explosiveness, while toxicity needs to be resolved.

Traits	Ammonia	Propane (LPG)
Weights	0.6	1.5
Critical Temperature	132.4°C	96°C
Boiling point	-33.5°C	-42°C
Ignition point	351°C	423°C

* Ammonia requires similar technologies to LPG for storage and application since it has similar boiling point to LPG.

Technology Status for LPG & Ammonia propulsion

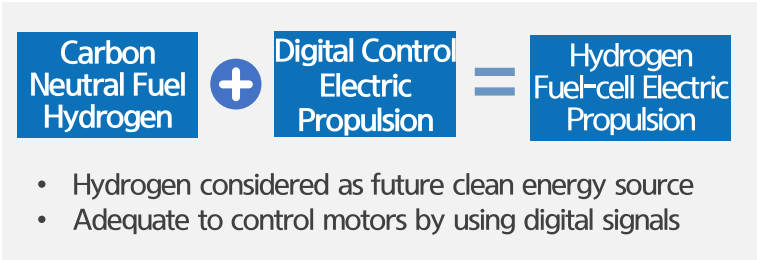
Technology	Ammonia	LPG	Current Status
Fuel Tank	O	O	Already secured
NOx emission control	O	O	
FGSS	X	O	Plan to develop on the basis of similar LPG technologies
Ammonia Engine	X	O	



Source : Clarksons / New orders in CGT since 2016

(3) Hydrogen


Strive to achieve world's first future technologies that will satisfy both carbon neutral and autonomous navigation



Commercialize world's first hydrogen fuel-cell electric propulsion vessel in order to penetrate market with Eco-friendly full autonomous vessel

Current Capabilities

Hydrogen Fuel Tank



Reliable experience of Making LNG fuel tank
LNG : -163°C,
Hydrogen : -253 °C

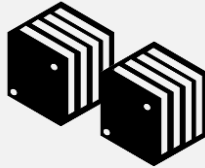
Electric Propulsion Control



Preemptive market positioning in digital control and electric propulsion system by receiving order of sea travel vessel

Areas of Development Plan

Hydrogen Fuel-Cell



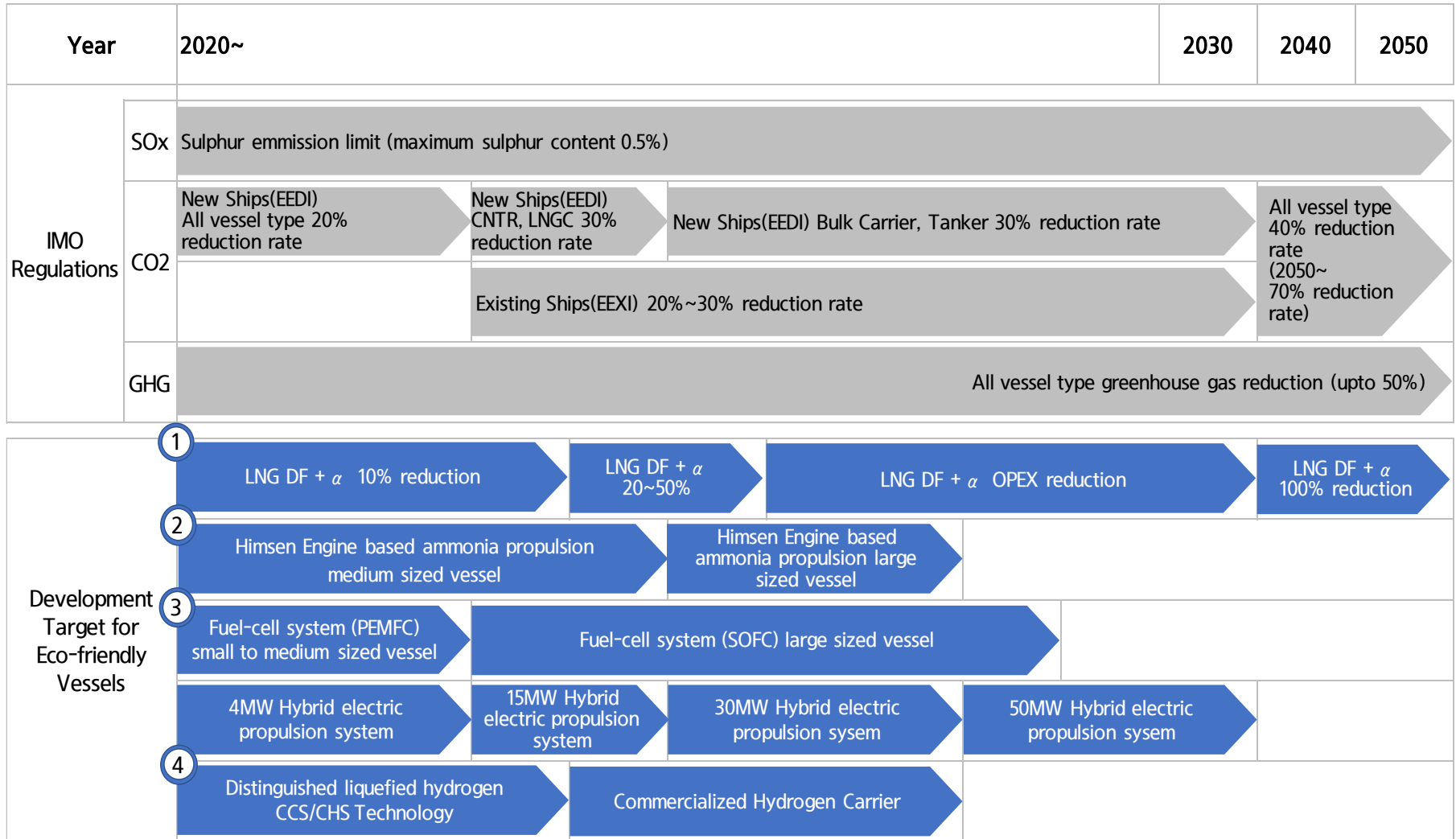
Cooperation with fuel-cell companies in order to develop efficient fuel-cell system for ships.

Hydrogen Supply Systems



Develop vapor-fed hydrogen fuel supply systems.

[Appendix] Roadmap of Developing Eco-friendly Vessels



Energy

Clean Energy Business

In preparation for global climate change and carbon neutrality initiative, our refining business will transform to a platform for clean energy, chemical and materials business.

Competitive advantages in oil refining business



Transformation to a clean energy business platform

Low-cost Feedstock

We will use low-cost by-products from ultra heavy crude refining as a clean energy feedstock

Carbon Capture & Utilization

We will use a carbon capture technology to enhance decarbonization of resources

Clean Utilities

We will provide clean utilities through fuel cell and low-carbon LNG generation to support our new business.

Clean Energy Business

2030

As our business expands to renewable energy and eco-friendly sector, the share of sales from oil refining will decrease around 40% by 2030.

Eco-friendly Future Businesses

1 Blue Hydrogen Business

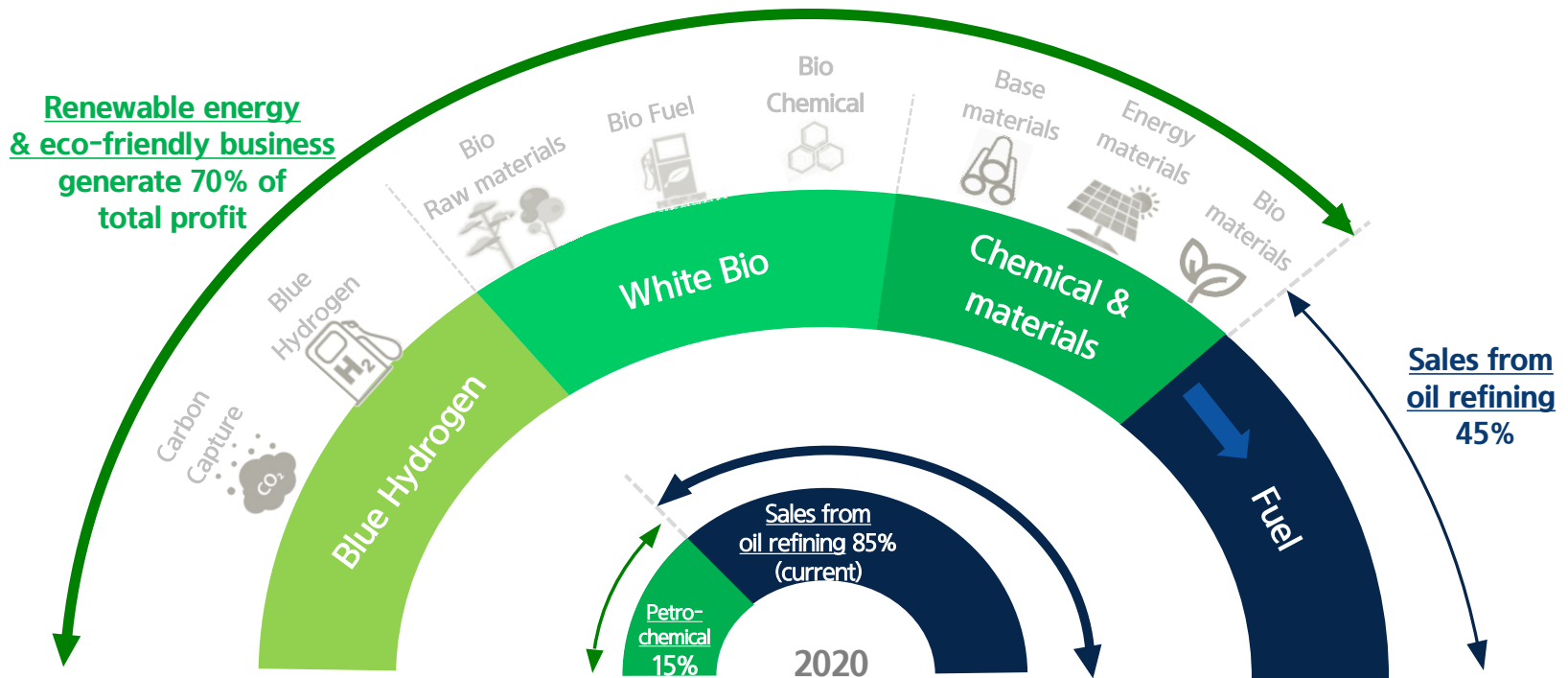
- ① Blue Hydrogen 100K ton in 2025
- ② H2 charging station & fuel cell generation

2 White Bio Business

- ① 2nd generation white bio in 2023
- ② 1M ton bio-ecosystem set up by 2030

3 Eco-friendly Chemical & Materials

- ① HPC starts commercial operation in 2021
- ② Chemical & materials business expansion



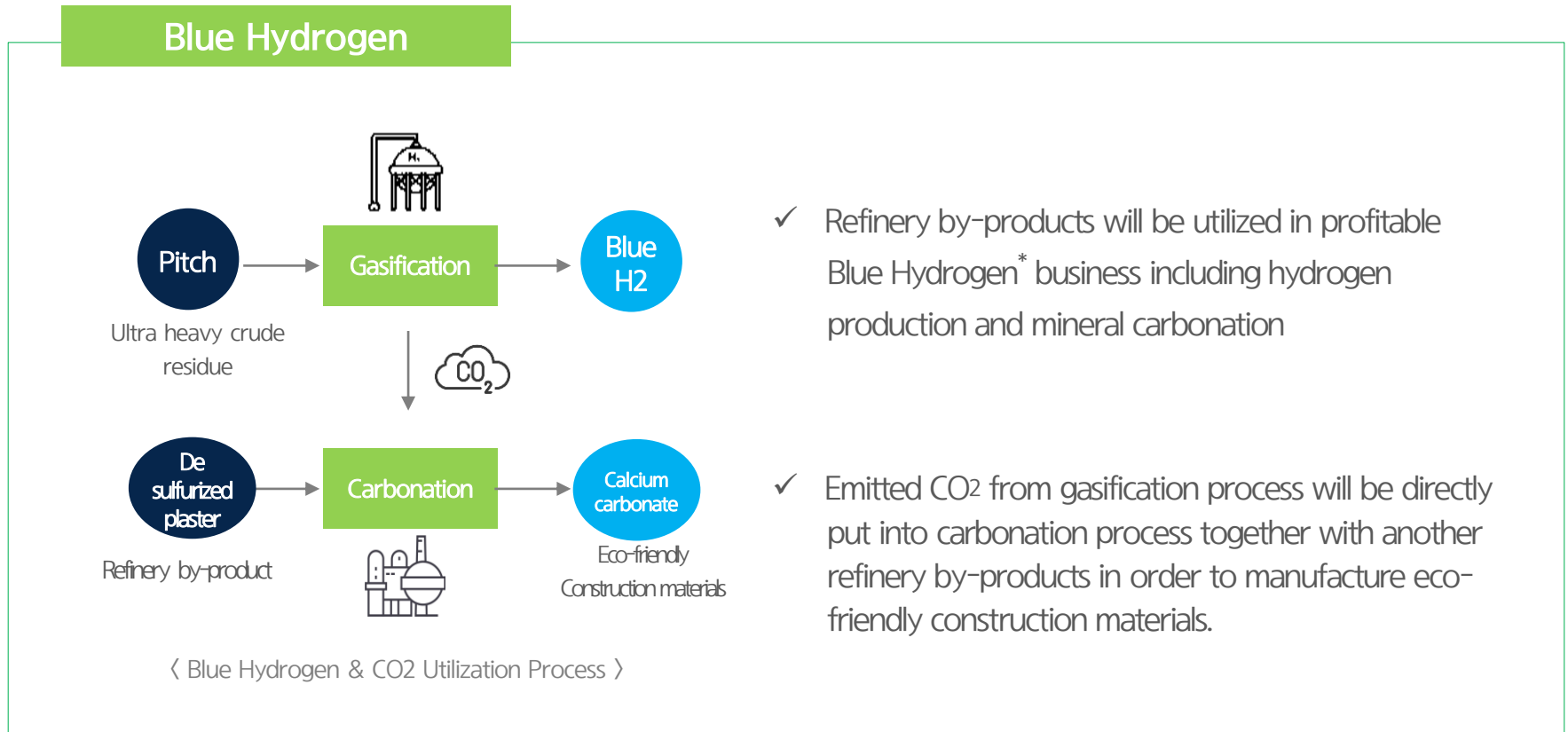
(1) Blue Hydrogen

Blue Hydrogen

White Bio

Eco-friendly
Chemical & materials

We will secure carbon capture and utilization technology, with our production target of 100,000 ton per annum by 2025 for profitable and eco-friendly blue hydrogen.



* Blue Hydrogen : Hydrogen that produced by collecting and storing CO₂ and could reduce greenhouse gas emissions.

(2) Hydrogen Charging

Blue Hydrogen

White Bio

Eco-friendly
Chemical & materials

We plan to develop hydrogen charging and hydrogen fuel cell generation business with Blue Hydrogen.

[High purity hydrogen production & hydrogen charging station]

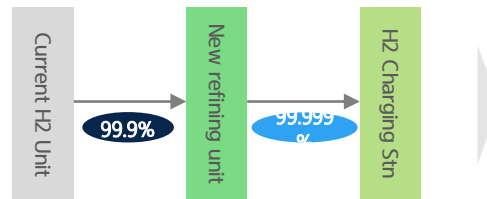
We plan to produce 99.999% purified hydrogen used for hydrogen vehicle.

We will expand charging station network around capital metropolitan area.



H2
Charging
Station

High Purity Hydrogen Production

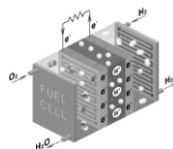


< H2 refining unit scheduled to begin construction in 2021 >

H2 Charging Station Plan

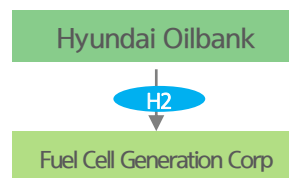
	'22	'25	'30
Policy Target*	100	310	660
HDO	10	60	180
M/S	10%	19%	27%

* Source : 2020 Hydrogen Economy Committee



Hydrogen
Fuel cell
Generation

[Hydrogen Fuel Cell Generation]



As HPS* will take effect from 2022, we plan to set up 50MW fuel cell generation with low-cost and eco-friendly Blue Hydrogen produced in HDO.

* HPS (Hydrogen Energy Portfolio Standard)

: Fuel cell generation obligation policy which requires 8GW plant completion by 2040

(1) White Bio Business

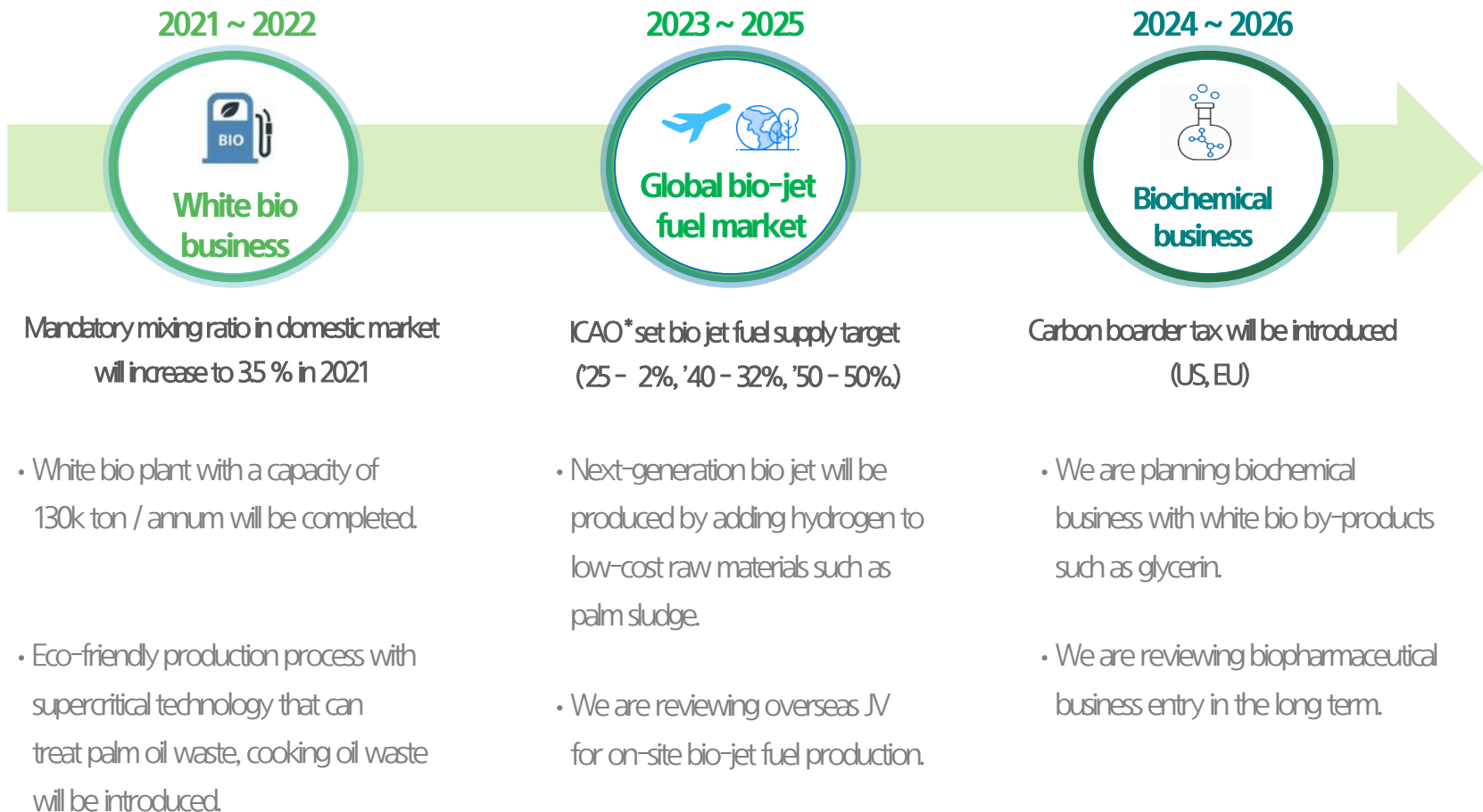
Blue Hydrogen

White Bio

Eco-friendly
Chemical & materials

Supercritical technology-applied plant is planned to start construction this year.
Second-generation white bio business is planned to start in 2023.

- White Bio Business : Carbon-neutral industry that refers to bio fuels, chemicals, plastics produced from biological raw materials.



*ICAO (International Civil Aviation Organization)

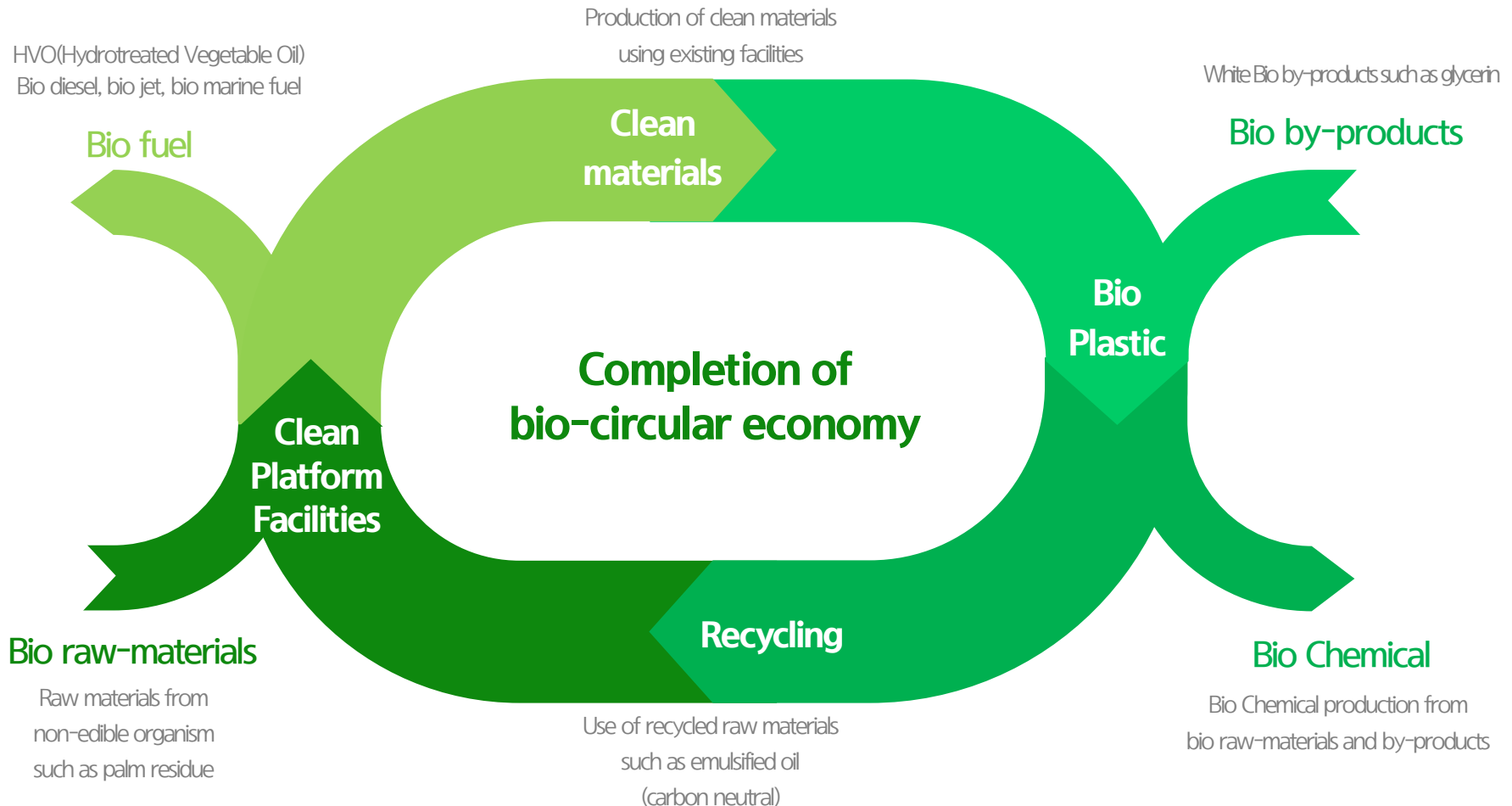
(2) White Bio Expansion

Blue Hydrogen

White Bio

Eco-friendly
Chemical & materials

We set our target to build an 1 million ton of White Bio ecosystem by 2030.



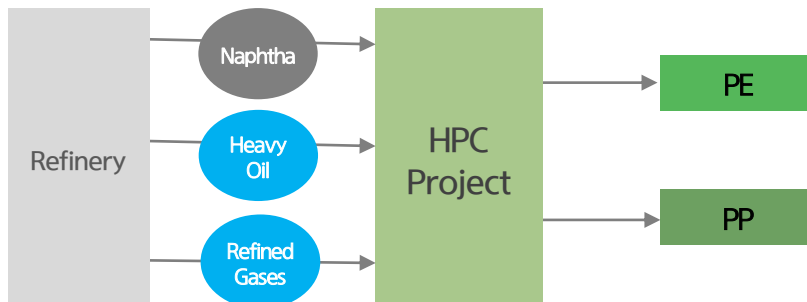
HPC project is on schedule with a target of commercial operation in Nov 2021.

HPC Project (Heavy Feed Petrochemical Complex)

Unique petrochemical facility in Korea that produces plastic materials from heavy residues in oil refineries

- Overview : Production of petrochemical basic oils and plastic materials such as ethylene
- Product : Polyethylene 850KT/A, Polypropylene 500KT/A
- Schedule : Completion & Test Run (Aug 2021)

Commercial Operation (Nov 2021)



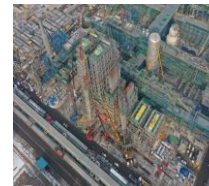
• Feedstock Comparison (compared to NCC)

Up to 60% of refined gas and T-DAO can be used depending on market conditions

Feedstock	NCC	HPC
LPG / Refined gases	0 ~ 10%	26%
T-DAO	-	34%
Light Naph	90 ~ 100%	40%

* T-DAO : Treated De-Asphaltene Oil

• Completion rate : 84% (as of Feb 2021)



⟨HPC plants⟩



⟨Product tanks⟩

We will expand our downstream business focused on eco-friendly chemical and materials.

Basic materials

Carbon Black

Carbon black is a EV tire materials with robust durability and a low noise

We plan to expand capacity with increasing EV demand

[2024 150KT/A → 200KT/A]



Carbon Black
Supports high loads of EV and absorbs noise

“EV tire materials”

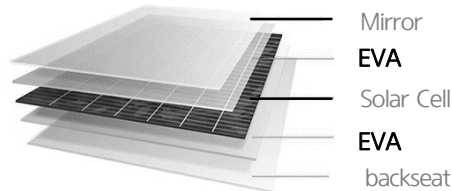
Energy materials

EVA

EVA has outstanding permeability and adhesiveness.

It is used as a solar cell protective film

[Solar Module]



“Renewable energy solar module materials”

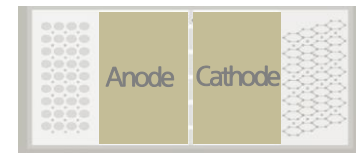
* EVA : Ethylene Vinyl Acetate

Secondary Cell materials

Liquid Paraffin & UHMWPE

It is a secondary cell requiring high-intensity / resin used for separation membrane.

R&D is in progress using refinery by-products and HPC products as raw materials



Separation membrane
Thin film that keeps anode and cathode away

“Secondary cell separation membrane materials”

* UHMWPE : Ultra High Molecular Weight Polyethylene

[Conclusion] Two Growth Pillars of HHI Group: Eco-Friendly vessels and Energy

Eco-friendly Shipbuilding and Offshore

KSOE

- 1 Eco-friendly carriers
- 2 Eco-friendly fueled vessels
- 3 Autonomous navigation, Intelligent Ships
- 4 Offshore wind power + Electrolysis

Clean Energy

HDO & Hyundai Chemical

- 1 RE Platform Transformation
- 2 Blue Hydrogen
- 3 White Bio
- 4 Eco-friendly Chemical / materials

Complete hydrogen value chain with two growth pillars: Eco-friendly vessels and Energy