

Distributed power generation with hydrogen fuel will contribute to the European energy security and carbon neutrality

Dec. 12, 2022

Motohiko NISHIMURA

Kawasaki Heavy Industries, Ltd.



Introducing Kawasaki Heavy Industries

130 year-old heavy construction company

Ship & Offshore Structure



Rolling Stock



Aerospace Systems



<https://www.khi.co.jp/mobility/aero/aircraft/b787.html>



Energy System & Plant Engineering



Motorcycle & Engine



Precision Machinery & Robot

Hydrogen Council

- Since 2017, KHI has been a founding member of the Hydrogen Council
- Mr. Yoshinori Kanehana, Chairman of Kawasaki Heavy Industries currently serves as co-chair of the Council.

Hydrogen Council

- Market capitalization of USD 8.2 trillion* at the initiative of nearly 150 global CEOs
- Providing reports and making policy recommendations
- Council report sees hydrogen market worth \$3 trillion and 30 million jobs in 2050



Mr. Yoshinori Kanehana

Founding 13 members

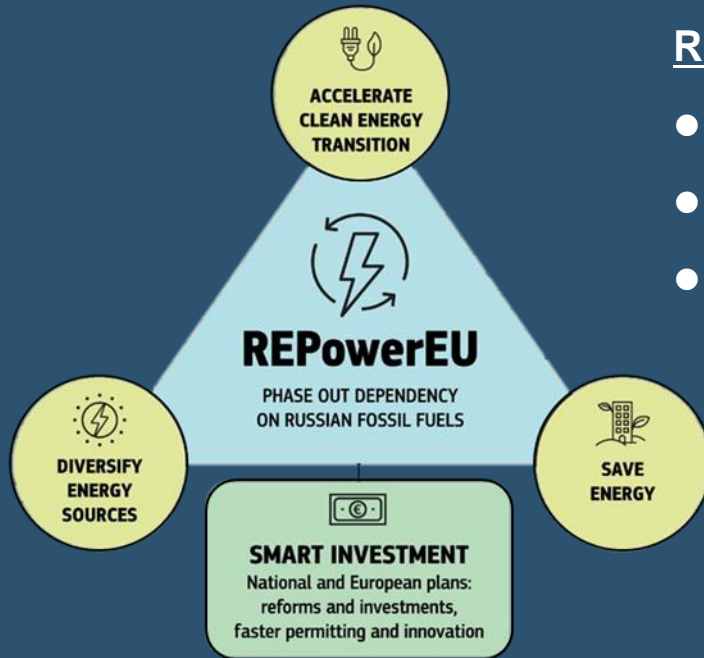
Air Liquide, Alstom, Anglo American, BMW Group, Daimler, Engie, Honda, Hyundai, Kawasaki, Shell, Linde, Total and Toyota.

*Hydrogen council Hydrogen Insights Sep 2022



Hydrogen power generation

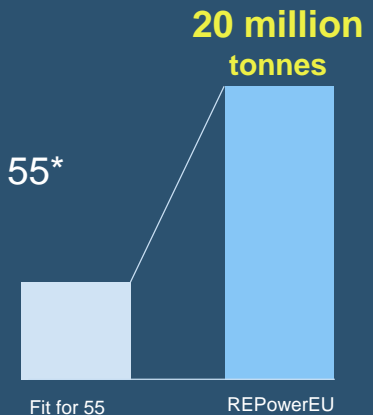
Growing demand for hydrogen in Europe



REPowerEU

- Reduce dependence on Russian fossil fuels by the end of 2022
- Aim to achieve elimination of dependence earlier than in 2030
- Approved by the European Council on 2022/3/11

Hydrogen demand in 2030
Approx. **3 times** for the Fit for 55*



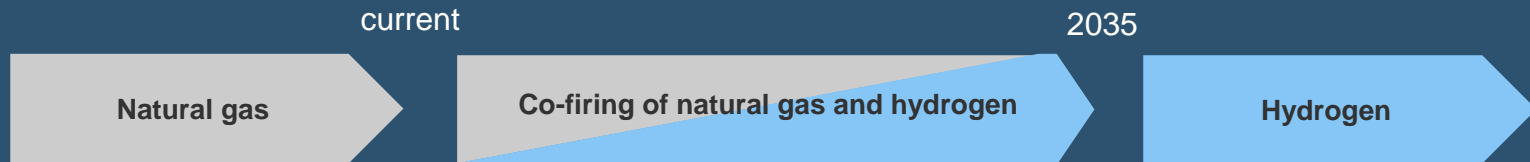
Source:EUR-Lex - 52022DC0230 - EN - EUR-Lex (europa.eu)

Growing demand for hydrogen power generation

Compliance for gas-fired power generation to EU taxonomy

- Strict GHG emission limits
- Carbon neutral after 2035

Fuel conversion for thermal power generation

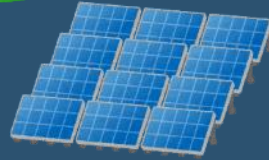
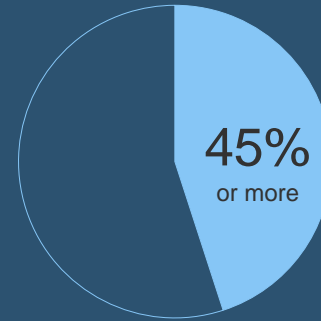


Hydrogen-ready power generation facilities (capable of co-firing or single-firing) needed

Growing demand for renewable energy

REPowerEU target for renewable energy (as of 2030)

- 45%* (increased by 5 pts from Fit for 55)
- Emphasis on solar power



Challenges of renewable energy power generation

- Output is unstable due to constraints such as weather conditions
- Back up the output by other power sources is necessary

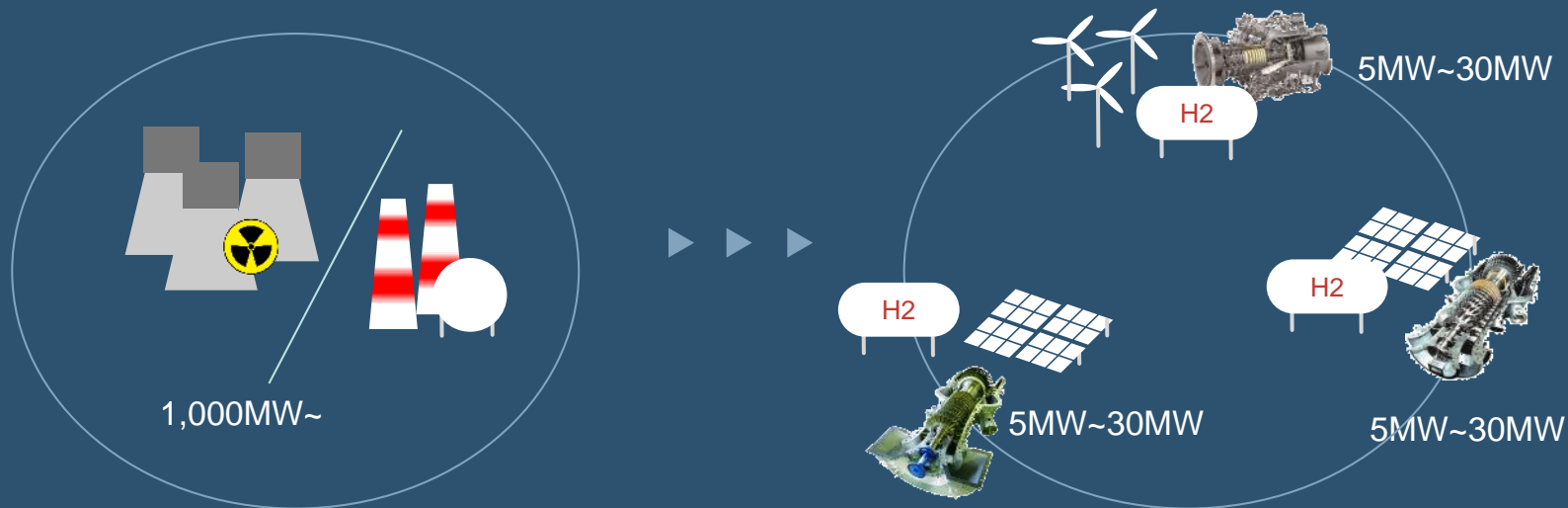
By installing **Hydrogen-ready** power generation facilities in the same area of a renewable power plant, clean backup power supply can be maintained

*Source: European Commission
18.5.22 COMMISSION STAFF WORKING DOCUMENT IMPLEMENTING THE REPOWER EU ACTION PLAN:
INVESTMENT NEEDS, HYDROGEN ACCELERATOR AND ACHIEVING THE BIO-METHANE TARGETS

Renewable energy and distributed hydrogen power generation

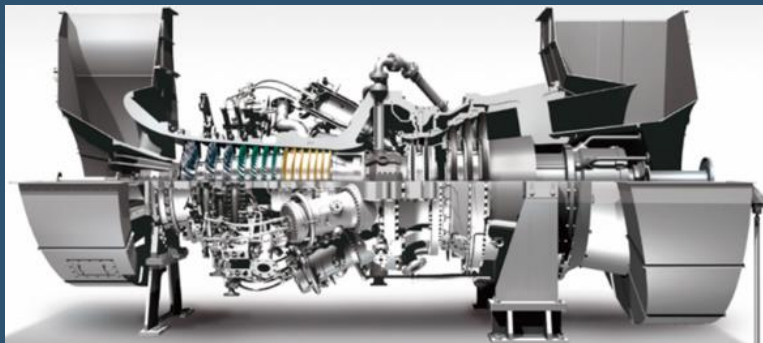
Distributed power generation

- Distributing relatively small power generation units near the point of consumption to provide electricity
- Complementary to renewable energy
- Suitable for Europe where electricity demand density per area is low



Kawasaki hydrogen gas turbine

From the natural gas to hydrogen transition to the future hydrogen transition, energy-saving and renewable energy targets in Europe can be achieved

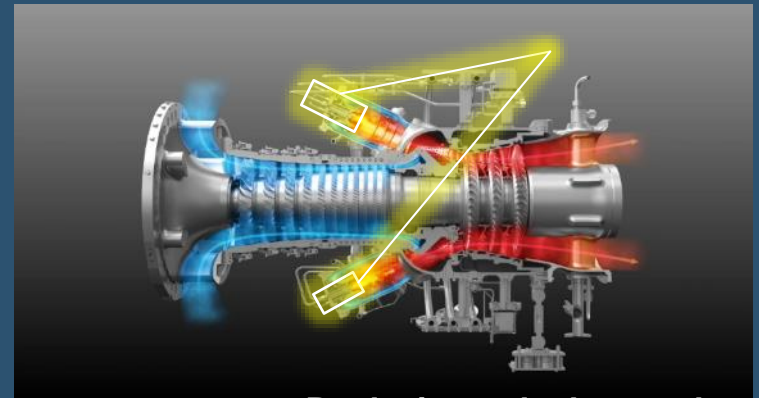


- Lineup of small and medium ranges suitable for distributed generation (5 MW to 30 MW)
- High start-up and load response to renewable energy and excellent complementary relationship with renewable energy
- Contribute to high efficiency and energy conservation
- Compatible with co-firing of natural gas to single-firing (0 ~ 100%)
- In addition, the switching time between co-firing and single-firing is as short as 5 minutes

Kawasaki Hydrogen GT

- Hydrogen transition achieved while reducing CAPEX
- The refurbishment cost is approx.10% of the total cost of gas turbine power plant

- Existing Kawasaki Gas Turbine can be hydrogen-compatible only by replacing the nozzle
- A smooth decarbonization solution for existing gas turbine users in operation as well as new users



Replacing only the nozzle

Hydrogen Gas Turbine CHP* at Kobe Port Island

*CHP: Combined heat and power

Started power generation by hydrogen combustion in 2018



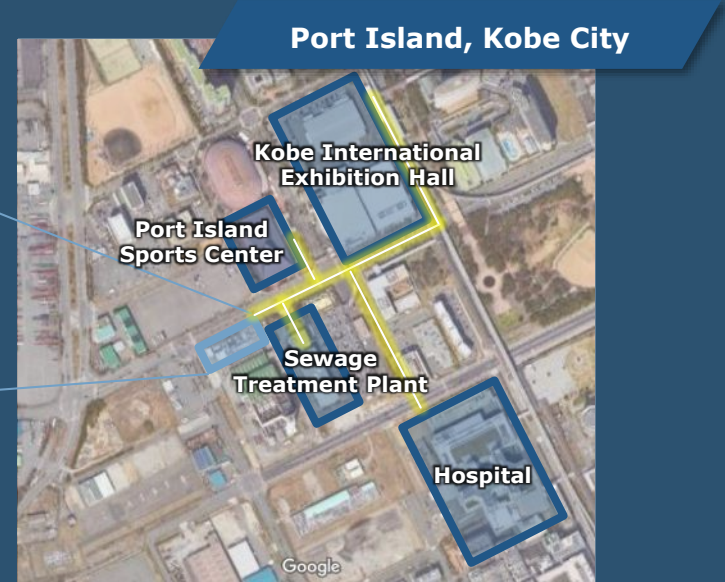
Supported by NEDO
NEDO: New Energy and Industrial Technology Development Organization

Hydrogen Power Generation

The world's first heat and electricity supply in an city area using 100% hydrogen

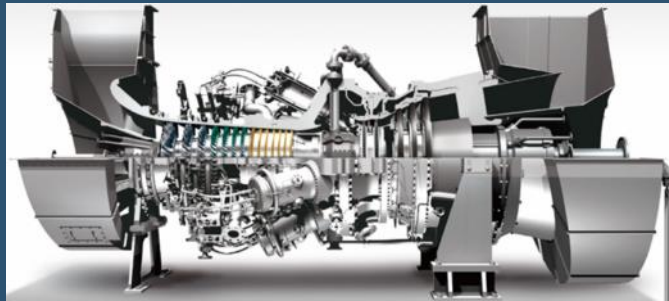


Heat and power generated by the Hydrogen CHP is supplied to four nearby public facilities



The world's first industrial scale 100% Hydrogen-To-Power Demonstration with RWE

- Agreed to develop a joint hydrogen power generation demonstration project with **RWE**, a major power company in the US & Europe
- The project is scheduled to start operation in 2025



30MW-class gas turbine




Planned location:
Lingen, Lower Saxony, Germany

High attention to Kawasaki hydrogen gas turbine

- Dozens of hydrogen power inquiries coming to our company from around the world
- Received an order from Chevron (Belgium) to remodel an existing natural gas turbine for hydrogen co-firing.





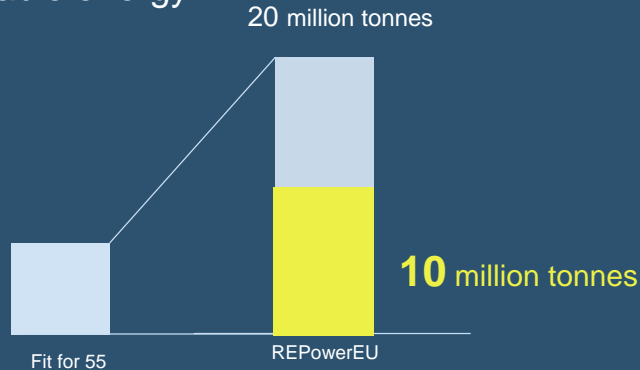
Hydrogen supply chain

Imported hydrogen

International transport of liquefied hydrogen needed for Europe

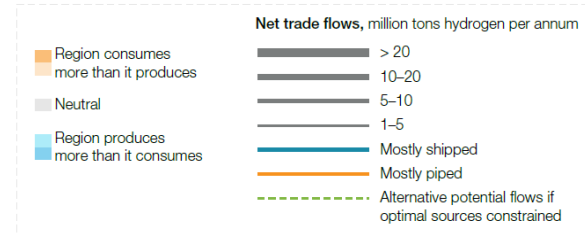
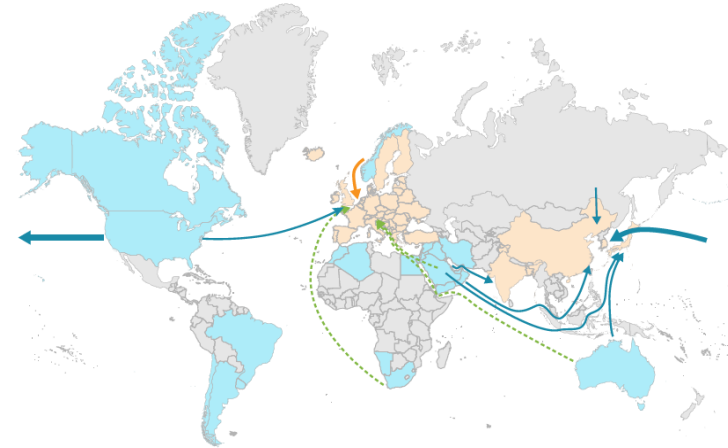
RePOWEREU

- 10 million tonnes^{*1} of renewable hydrogen imports by 2030
- Strengthen international efforts on hydrogen to expand renewable energy



*1 Source: European Commission
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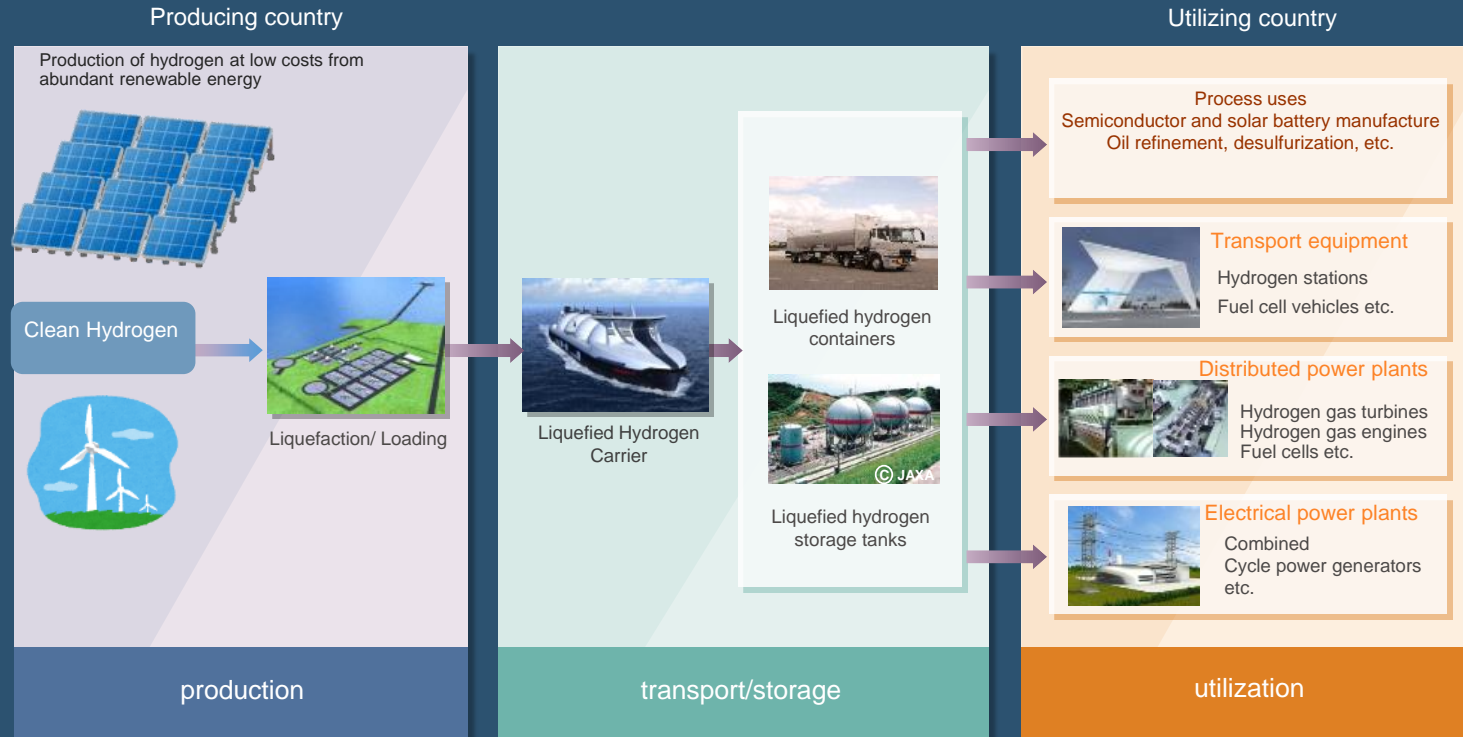
Major flows of hydrogen and derivatives, million tons hydrogen equivalent in 2030



Source: Hydrogen council Global Hydrogen Flows Oct 2022

Vision for Hydrogen Supply Chains

Stable energy supply while reducing CO2 emissions



International hydrogen supply chain: completed pilot demonstration

February 2022

World's First International Liquefied Hydrogen Transportation

Liquefied hydrogen carrier 'SUISO FRONTIER' attracts high level of interest from both home and abroad



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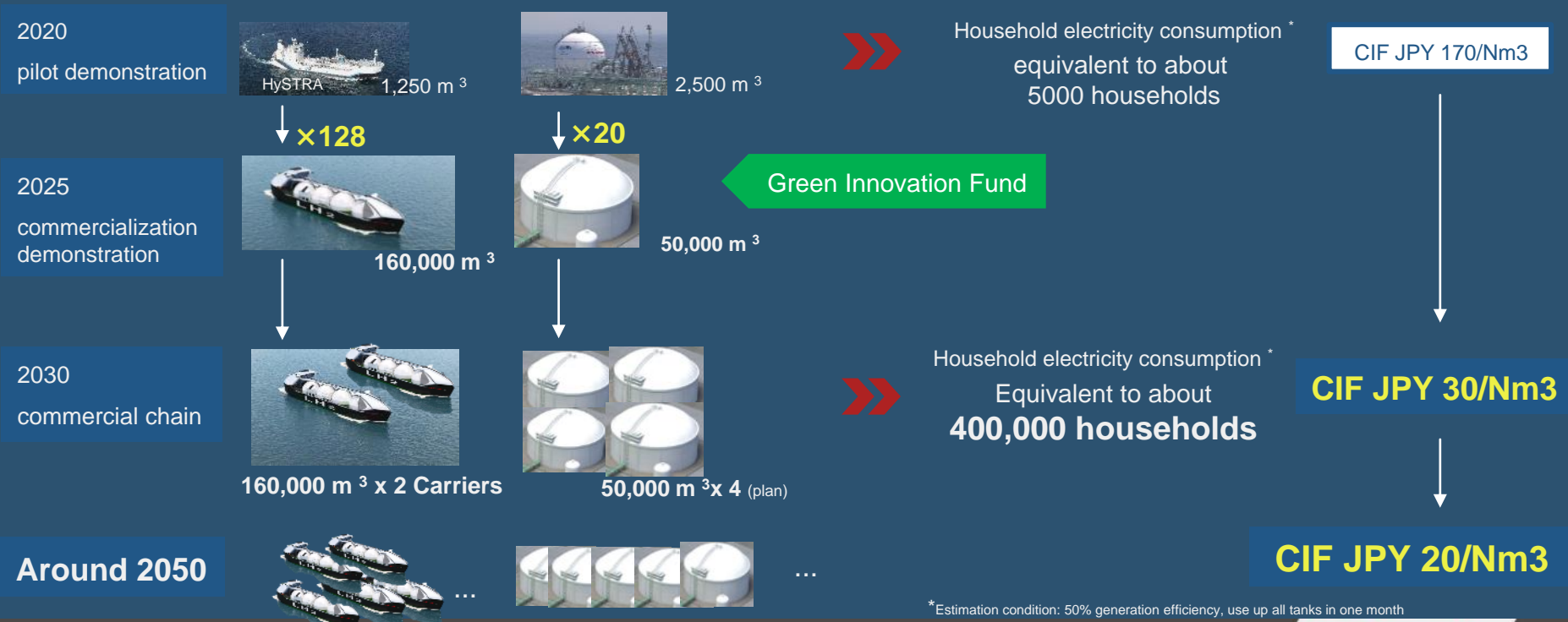
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*This project is supported by the "FY 2015 to FY 2022 NEDO Target-Set Industrial Technology Development Grants" Demonstration Project for Construction of Unused Lignite-derived Hydrogen Large-Scale Maritime Transport Supply Chain.

©Prime Minister's Office

Progress and scale of commercial demonstration of hydrogen supply chain

Reduce hydrogen costs by increasing the size of equipment





Kawasaki as a front runner for hydrogen

Expanding hydrogen fuel to Marine and Aviation

- Know-how to burn hydrogen safely and cleanly developed through hydrogen power generation
- Pursuing Kawasaki's combustion technology further, leading the world in mobility internal combustion engine



Development of Hydrogen-Fueled Vessel Propulsion System * 1

Complete lineup for various applications by around 2026



Hydrogen Aircraft Core Technology Development Project* 2

Promote development in anticipation of full-scale launch after 2035



Joint Research on Hydrogen Engines

Domestic two- and four-wheel manufacturers collaborate to develop hydrogen engine

*1 NEDO Green Innovation Fund Project "Development of a Hydrogen Fuel Ship Propulsion System" (about 21.9 billion yen in subsidies) (Yanmar Power Technologies to be Adopted in Consortium with Japan Engine Corporation)

*2 NEDO Green Innovation Fund Project "Core Technology Development for Hydrogen Aircraft" (grant: about 18 billion yen)

Collaboration with various companies

Accelerating cooperation to realize a hydrogen society



RWE to discuss demonstration of 100% hydrogen power generation



Hydrogen supply to hydrogen Corolla



Joint research on hydrogen engines



Wyoming KCC * Proof Test



Photo courtesy of Kansai Electric Power Co.

Kansai Electric Power Co., Inc., Maizuru Power Plant, KCC * Pilot Demonstration

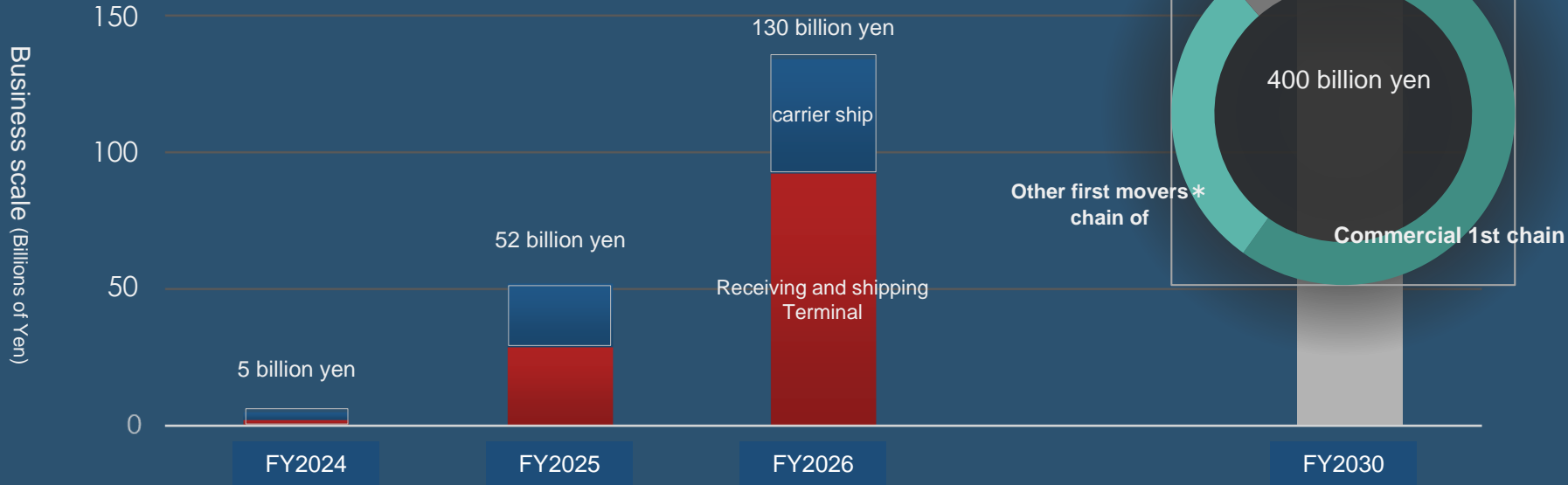


Airbus Partnership to study use of hydrogen in Japan

*Kawasaki Carbon Capture

Prospects for hydrogen business

- Demonstration for commercialization has been progressing steadily, and will become the first commercial chain in fiscal 2030.
- In parallel, other first-mover* chains have been in progress



*First mover: Operators planning to start supplying hydrogen by around 2030



Powering your potential