The 31st Clean Coal Day International Symposium (2022)
Session II(i) CCS Situation to Carbon Neutrality

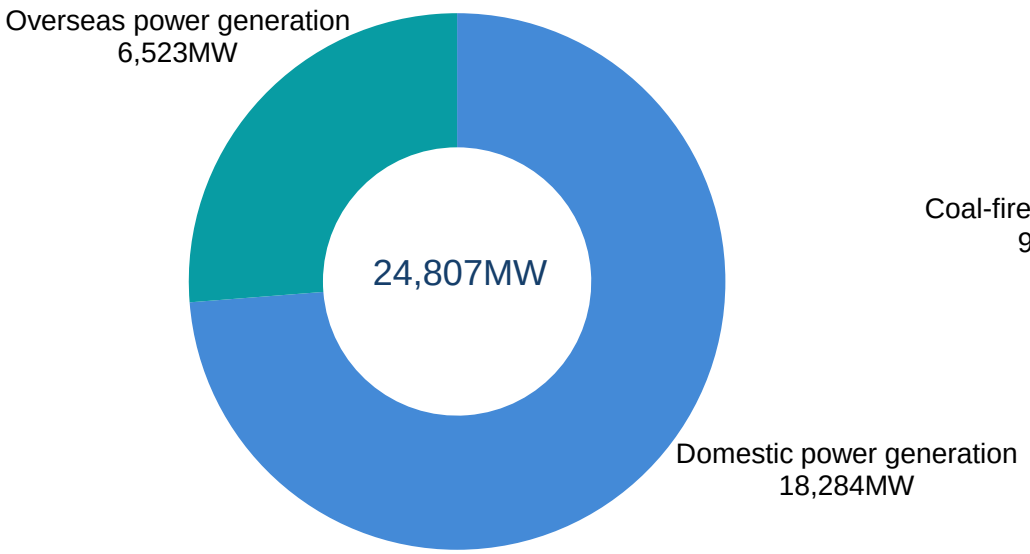
J-POWER Group's Strategy to Achieve a Carbon-Neutral and Hydrogen Energy Society

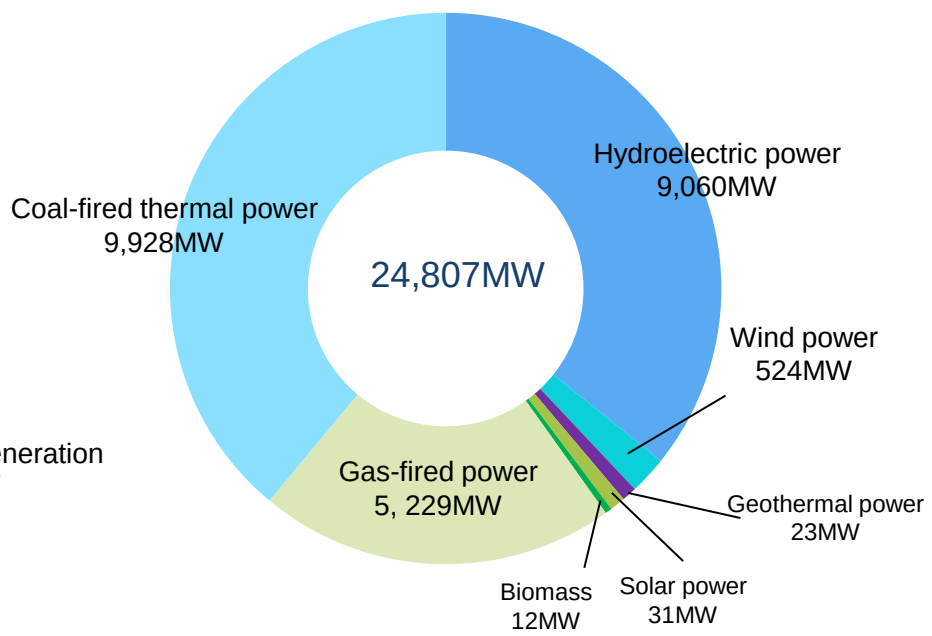
September 6, 2022
J-POWER

Balanced Portfolio

- With a balanced portfolio of hydroelectric, thermal, wind power, geothermal, and transmission and substation facilities, J-POWER has comprehensive technical capabilities ranging from fuel procurement to siting, construction, operation, and maintenance of facilities.
- Based on extensive experience in Japan, J-POWER has been engaged in consulting and power generation business overseas for more than half a century.

Consolidated power generation facilities*1 (As of March 31, 2022)

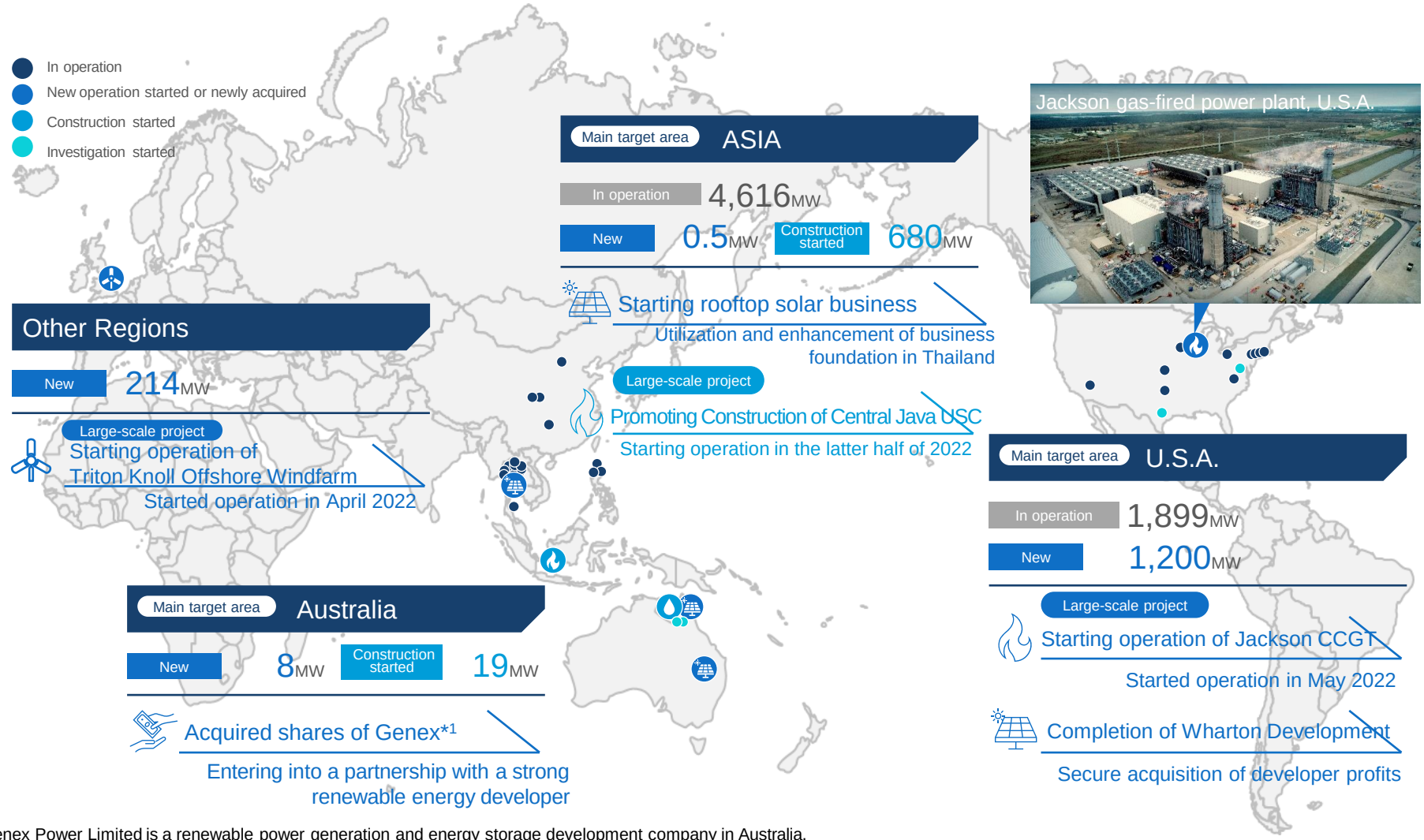




*1 Capacity is based on owned maximum power output

Steady Expansion of Overseas Business Foundation

While steadily executing large-scale projects, J-POWER has strengthened its business foundation and diversified its business in the three priority areas.

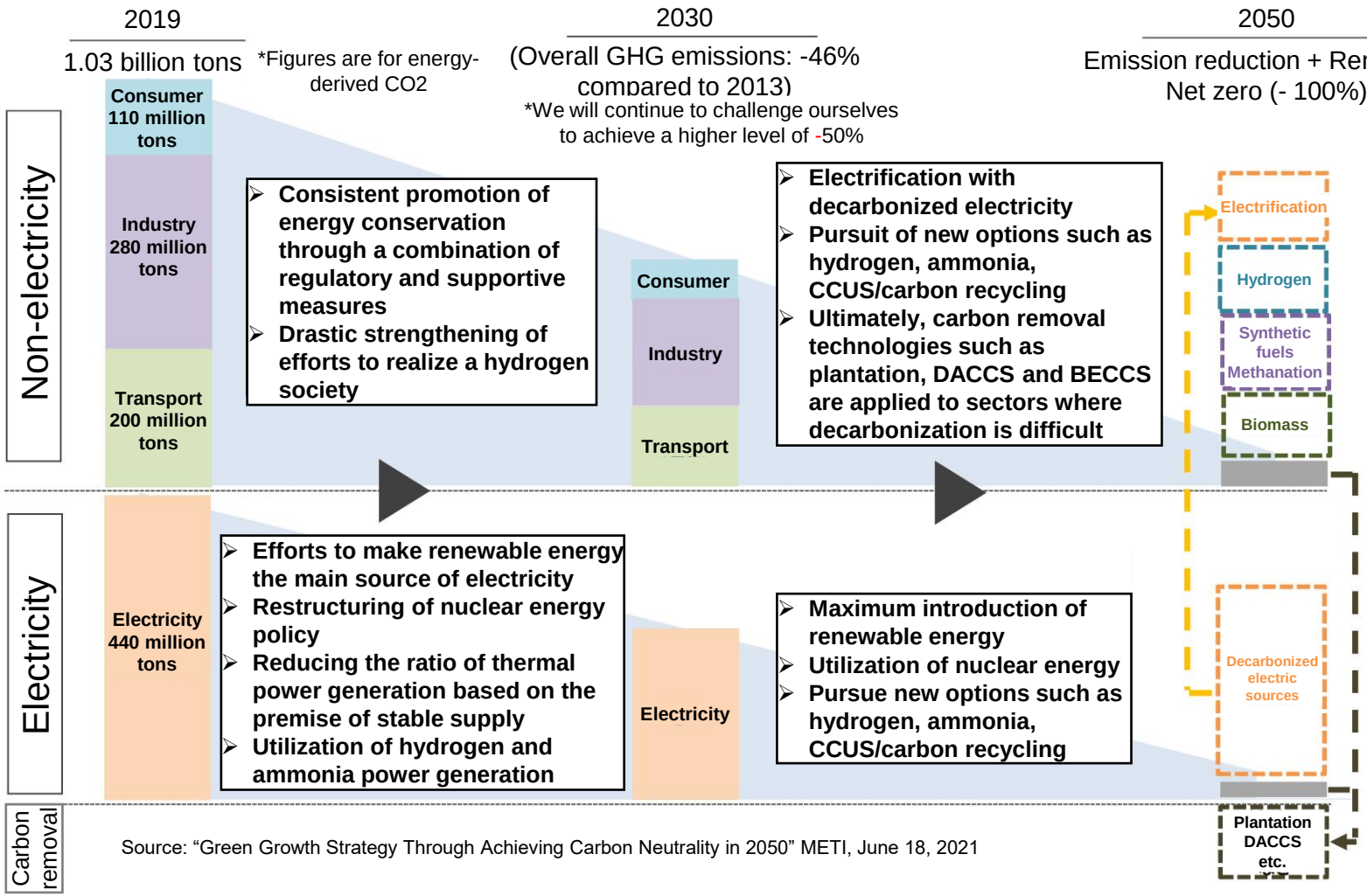


*1: Genex Power Limited is a renewable power generation and energy storage development company in Australia.

Image of Achieving Carbon Neutrality in 2050

(Ministry of Economy, Trade and Industry (METI))

- Promote electricity from non-fossil sources, use of CCUS and electrification of non-electricity sector.
- Since most non-electricity sector cannot be electrified, carbon-neutral fuels and carbon recycling will be used.
- There is a strong need for large-scale introduction of CO_2-free hydrogen and biomass.



Source: “Green Growth Strategy Through Achieving Carbon Neutrality in 2050” METI, June 18, 2021

J-POWER "BLUE MISSION 2050"

Towards a carbon-neutral and hydrogen energy society

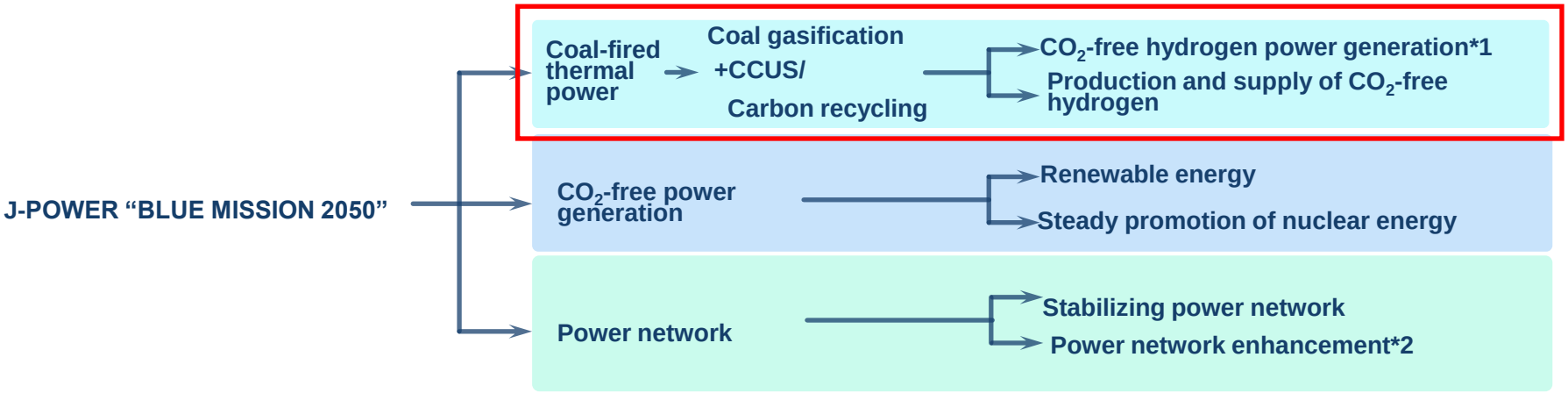
We have developed the J-POWER "BLUE MISSION 2050" to achieve carbon neutrality by 2050.

- By combining our experience and integrated technologies, we aim to achieve zero CO_2 emissions from our power generation operations by 2050.
- As a milestone, we aim to reduce our CO_2 emissions by 40%* by 2030. We will take up this challenge in stages.
  (*Compared with the three-year average from 2017 to 2019)
- As one of these challenges, we will contribute to the realization of a hydrogen energy society by producing "CO_2-free hydrogen" from coal.

ACTION PLAN

CONCEPT

The J-POWER "BLUE MISSION 2050" is making an action plan based on the priorities of "acceleration" and "upcycling."



*1 Including the use of hydrogen extraction from ammonia for power generation *2 The power network enhancement is an initiative for J-POWER transmission.

Priorities for implementation (priority items)

Acceleration

Upcycling

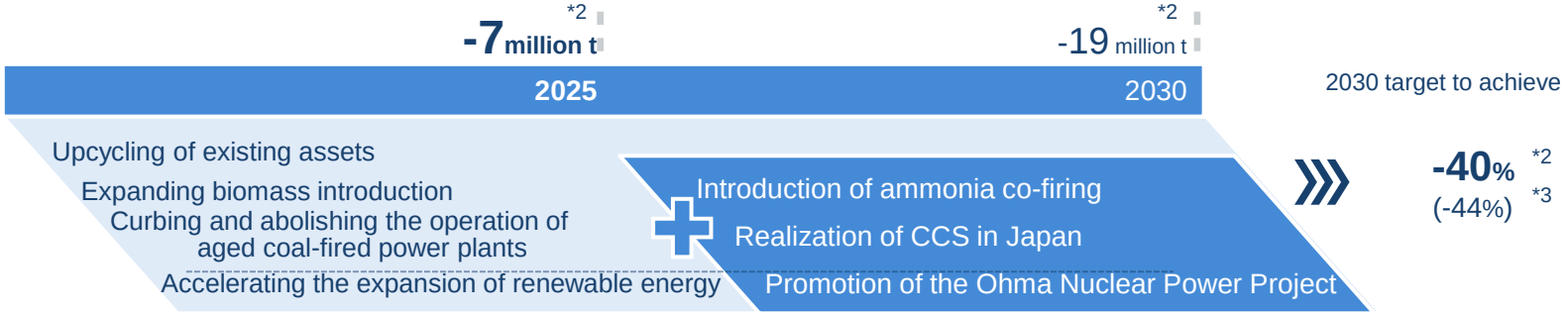
Toward the Realization of J-POWER BLUE MISSION 2050

To achieve the target for 2030, J-POWER has newly set the CO_2 emissions reduction target by FY2025, a halfway mark.

To realize carbon neutrality in 2050, J-POWER will work on CO_2-free hydrogen power generation.

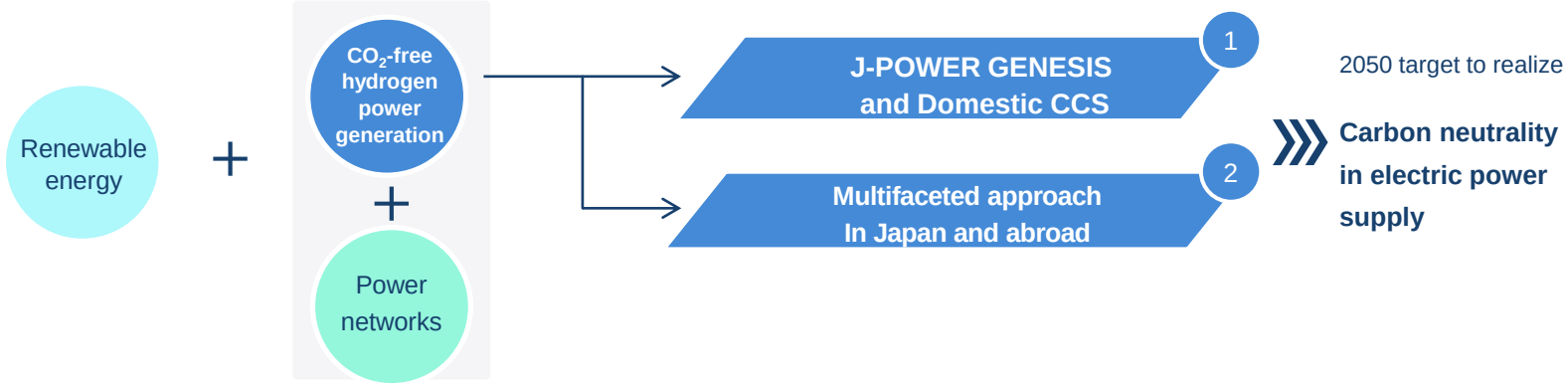
Toward 2030

- In addition to expanding renewable energy and rearranging its assets through upcycling, J-POWER will reduce the carbon consumption of thermal power plants by co-firing biomass.
- Furthermore, J-POWER will implement a plan to curb and abolish the operation of aged coal-fired thermal power plants, aiming to reduce CO_2 emissions by 7 million tons in FY2025.*1



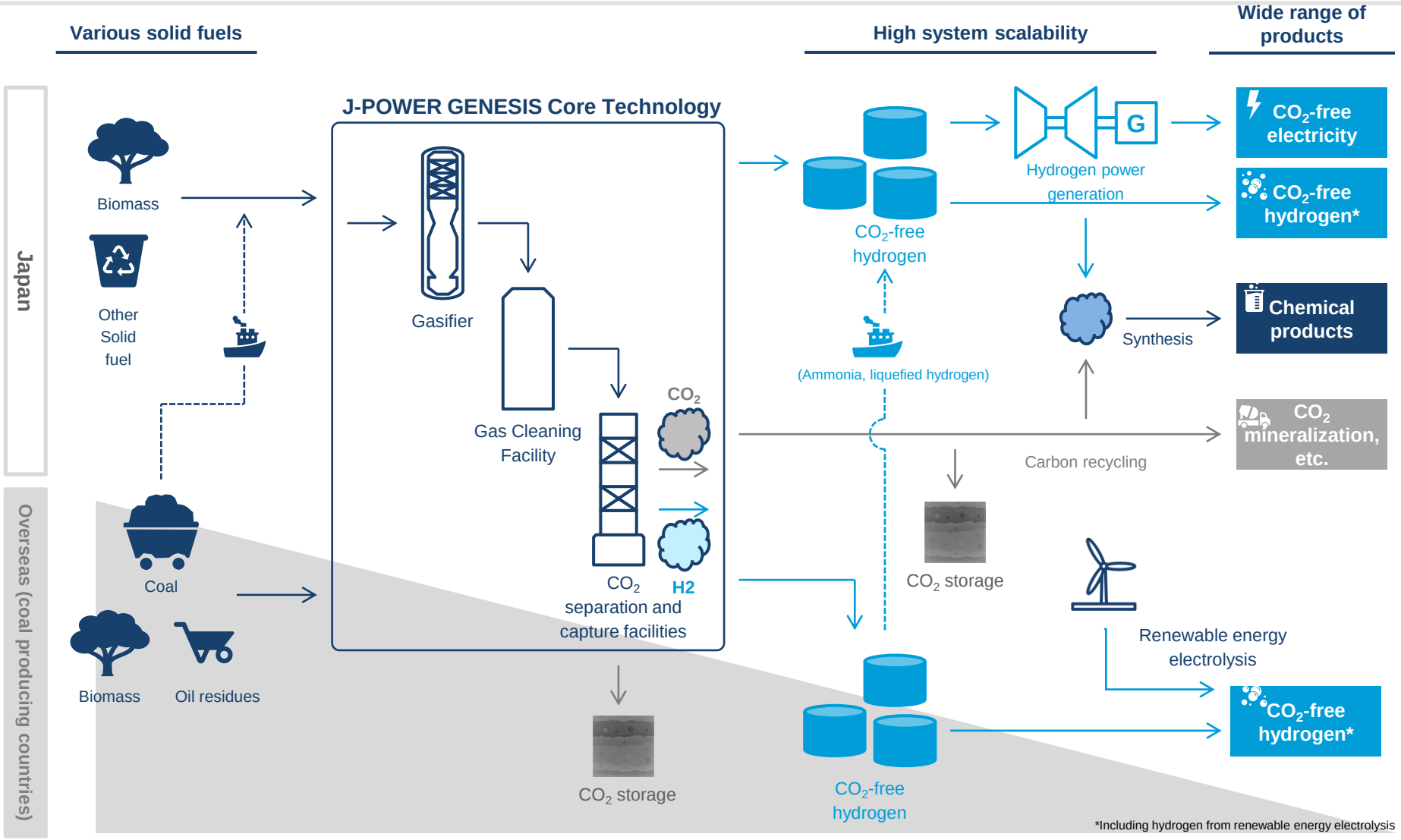
Toward 2050

- J-POWER will accelerate the expansion of renewable energy by introducing CO_2-free hydrogen power generation with excellent output adjustment and enhancement of electric power networks.
- Toward CO_2-free hydrogen power generation, in addition to the combination of J-POWER GENESIS and domestic CCS, J-POWER will take a multifaceted approach in Japan and abroad.



*1: The targets will be updated as appropriate, if the preconditions such as the government policies and economic conditions significantly change.;
*2: Compared to the 3-year average of actual emissions in FY2017-FY2019;
*3: Compared to actual emissions in FY2013

J-POWER GENESIS Vision Overall Concept

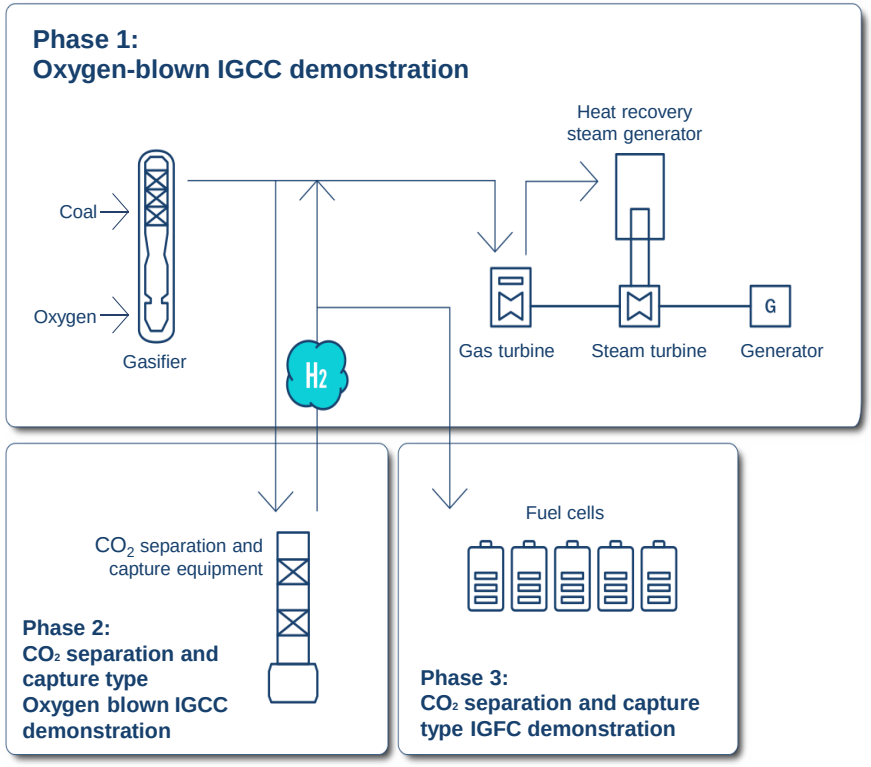


J-POWER GENESIS | Gasification ENErgy & Sustainable Integrated System

* Trademark registered

Outline of the Osaki CoolGen Project

- J-POWER is promoting Osaki CoolGen*2 by utilizing the technical knowledge of oxygen-blown IGCC + CO_2 separation and recovery, which has been promoted since 2002 as an EAGLE*1 project, and has been technically established.
- Characteristics of **"high pressure," "small gas volume," and "high CO_2 concentration" of the product gas enable efficient CO_2 separation and recovery, and advance power generation technology toward zero-emissions coal use**.

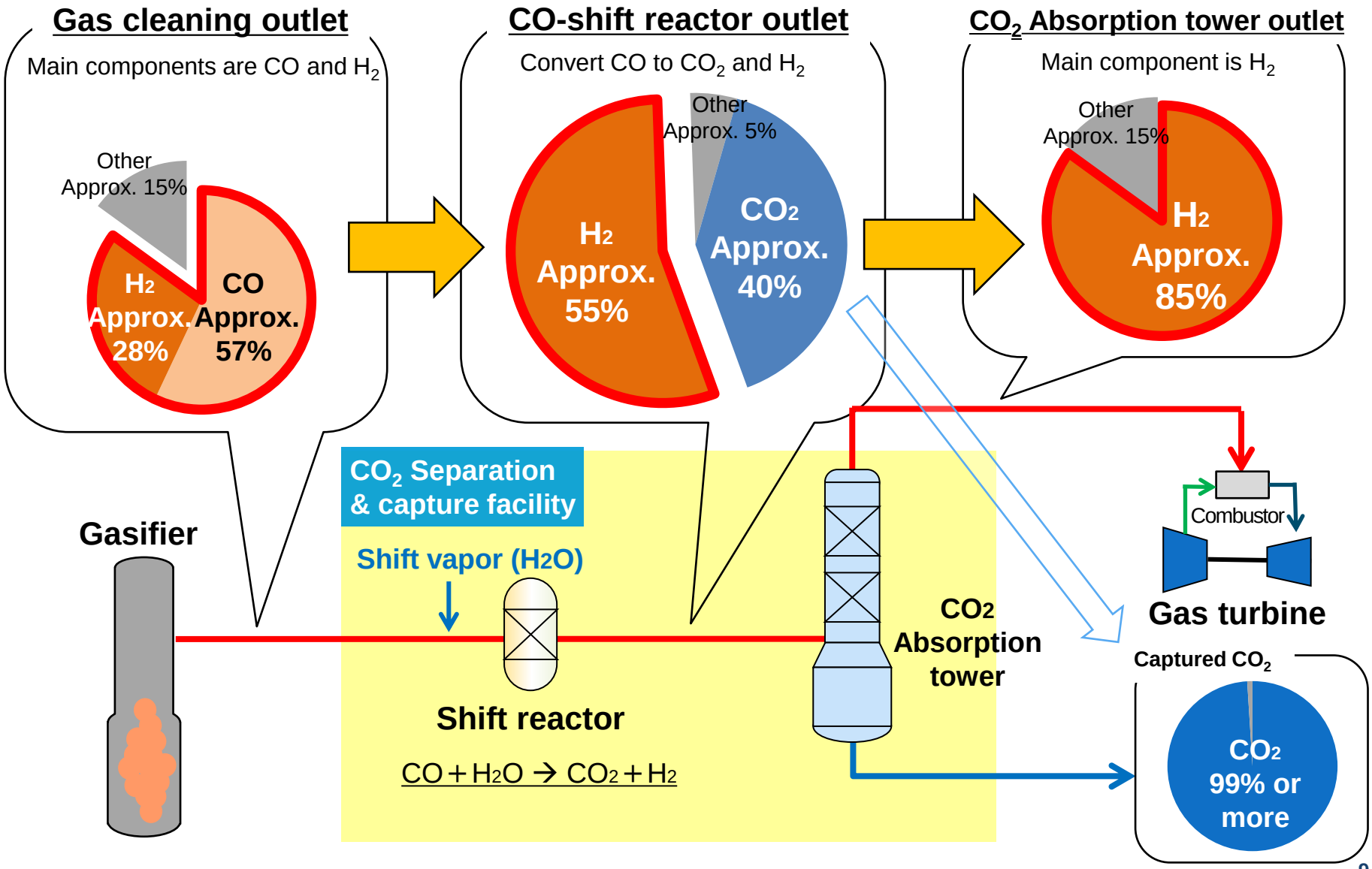


Phase 1	2016-2018 Oxygen-blown IGCC demonstration	**Power generation with approximately 25% hydrogen**
Phase 2	2019-2022 CO_2 separation and capture + oxygen blown IGCC demonstration	**Power generation with approximately 85% hydrogen** (High purity hydrogen can be produced by refining)
Phase 3	2021-2022 CO_2 separation and capture + IGFC demonstration	**Power generation with approximately 85% hydrogen** (ditto)

○IGCC (Integrated coal gasification combined cycle)
Combined cycle power generation system using two forms of power generation: a gas turbine that generates power by burning gas containing hydrogen generated from coal, and a steam turbine that generates power by using exhaust heat from the gas turbine, etc.

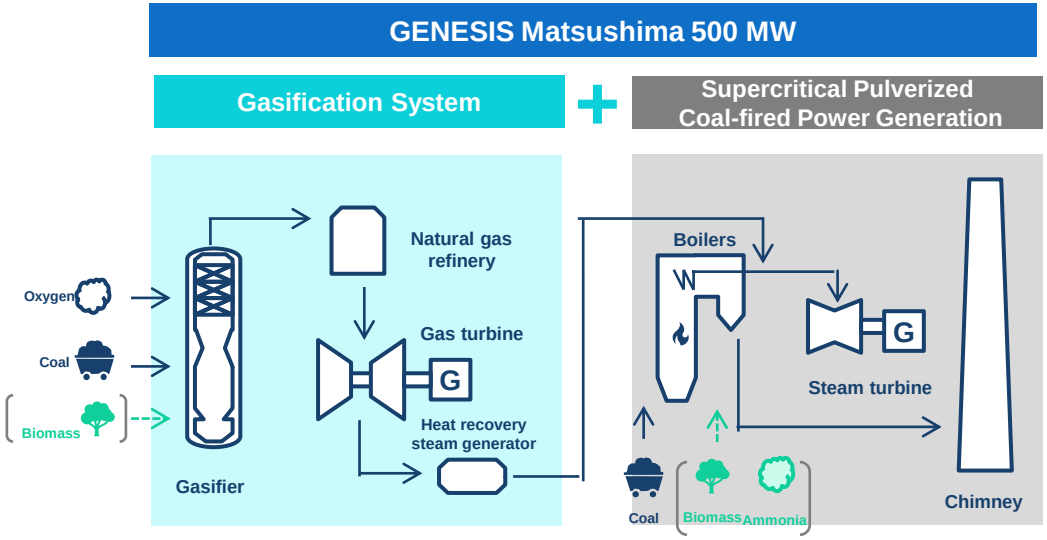
(Investment ratio: J-POWER 50%, Chugoku Electric Power Co. 50%, Osakigamijima-cho, Toyota-gun, Hiroshima, 166MW)
*1 EAGLE: Oxygen blown coal gasification project at Wakamatsu Research Institute of J-Power. Short for Coal Energy Application for Gas, Liquid & Electricity
*2 A project subsidized by New Energy and Industrial Technology Development Organization (NEDO), a national research and development corporation, in collaboration with Chugoku Electric Power Co.

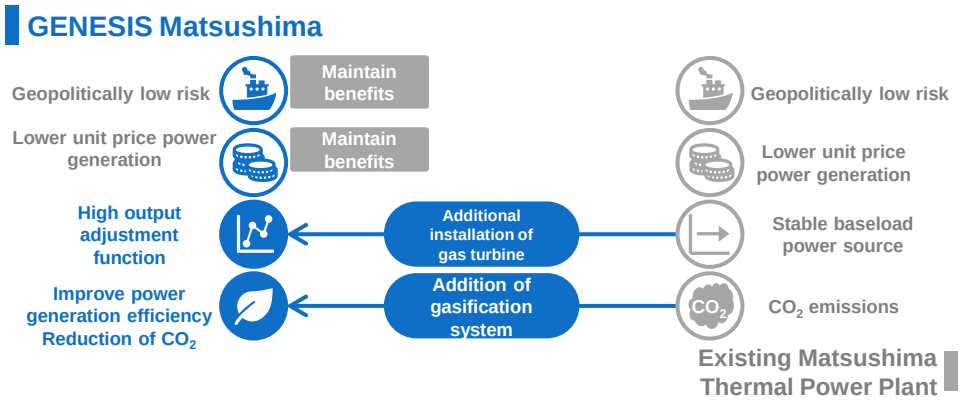
Change in Gas Composition due to CO_2 Separation and Capture

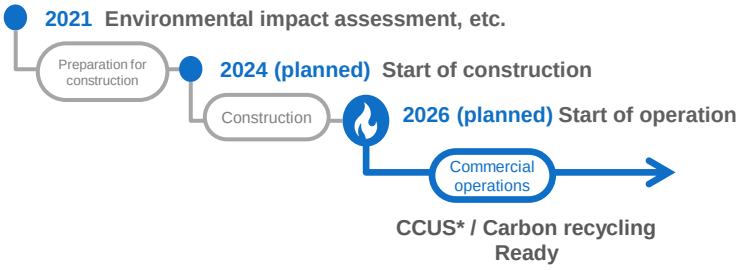


J-POWER GENESIS Vision (GENESIS Matsushima)

- J-POWER will take the first step in CO_2-free hydrogen power generation at our Matsushima site, which pioneered the use of imported coal after the oil crisis.
- By applying new technology to our existing assets, J-POWER will reduce its environmental impact as soon as economically reasonable, while maintaining a stable power supply.





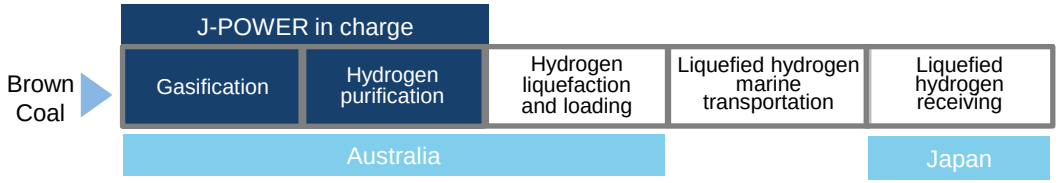


* CCUS: CO_2 Capture, Utilization and Storage

Overview of Japan-Australia Hydrogen Energy Supply Chain Project

- J-POWER has joined a demonstration project to build a supply chain for production and transportation of liquefied hydrogen produced from gasification of brown coal in Australia.
- J-POWER is in charge of brown coal gasification and hydrogen purification facilities*1, leveraging its expertise in coal gasification. Hydrogen production has started in January 2021 and achieved 99.999% hydrogen purity in February. Demonstration tests using multiple brown coals and biomass mixed brown coals.
- In April 2022, the supply chain including transportation and loading/unloading of hydrogen to Japan was completed. A progress was made to realize a society that takes hydrogen for granted as an energy source.
- J-POWER will now proceed with studies for the realization of commercial facilities. The CO_2 captured during hydrogen production will be stored in CCS facility to enhance CO_2-free hydrogen.

Global hydrogen supply chain overview



Advantages of brown coal
- Abundant
- Low cost for coal

An event was held in Kobe in April to celebrate the completion of the supply chain for hydrogen produced from Australian brown coal.

Provided by: HySTRA

Fiscal year	2019	2020	2021	2022	2023	2024
Demonstration schedule	Design, fabrication, installation, and commissioning		Demonstration test			

January 2021 Hydrogen production started

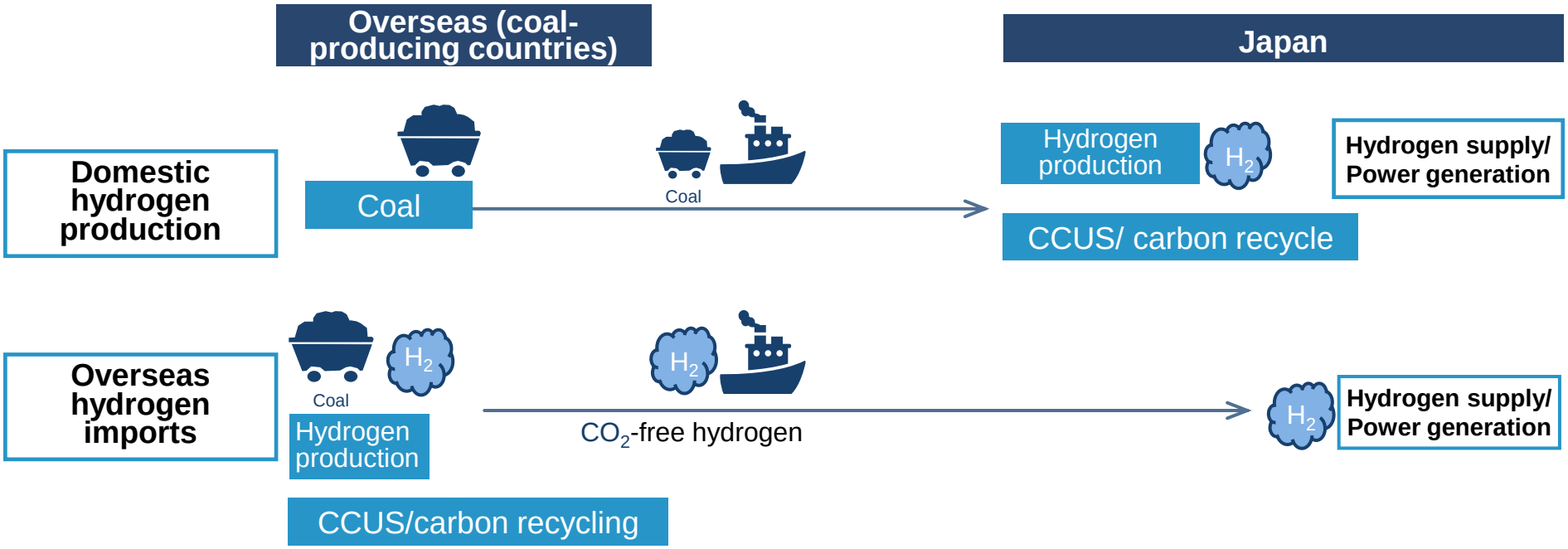
April 2022 Supply chain completion

*1 The brown coal gasification test was subsidized by the New Energy and Industrial Technology Development Organization (NEDO), while the hydrogen purification test was subsidized by the Australian Federal Government and the State Government of Victoria.

Two types of CO_2-free Hydrogen Production Methods from Coal

- Domestic hydrogen production: Import coal from overseas to produce hydrogen domestically and make it CO_2-free.
- Overseas hydrogen imports: CO_2-free hydrogen is produced in coal-producing countries and transported to Japan

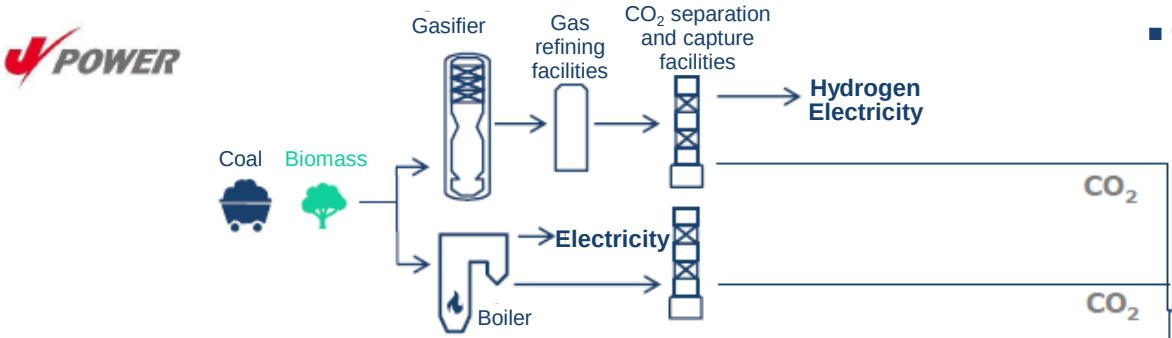
➡ Although each type of hydrogen production has its own advantages and challenges, such as the selection of suitable sites for CCS and economical transportation methods, J-POWER will conduct CO_2-free hydrogen production in the future through demonstration tests of two types of hydrogen production.



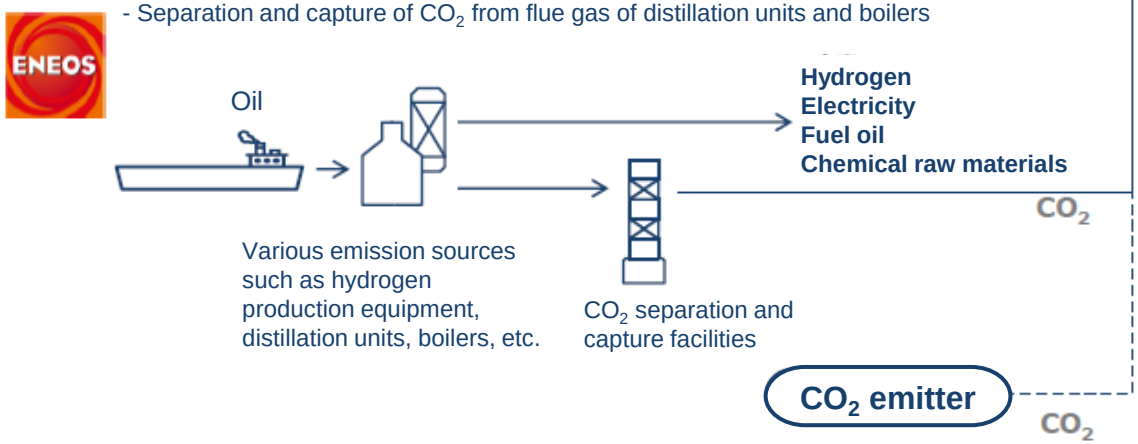
Joint Approach toward Carbon Neutrality in Energy Supply

As a major CO_2 emitter, we will take the lead in CCS and contribute to the realization of a stable energy supply and carbon neutrality. We will take on a challenge to start large-scale CCS in 2030 by joining forces of CO_2 emitter and cooperating and collaborating with construction, equipment, and transportation businesses.

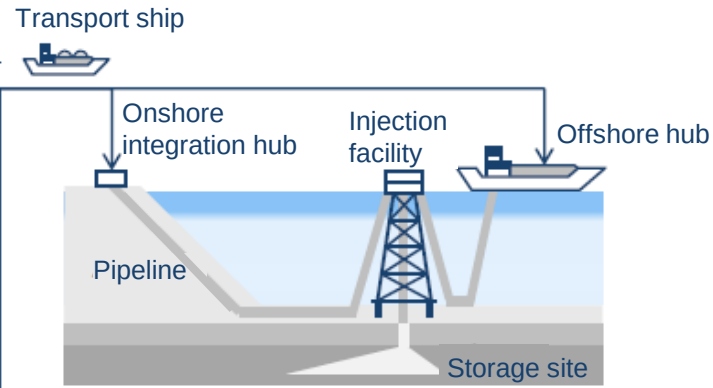
■ Separation and capture of CO_2 emitted from coal-fired power generation
- CO_2-free hydrogen power generation by combining gasification technology with CO_2 separation and capture technology
- Separation and capture of flue gas from existing coal-fired power plants is also assumed



■ Contribution to refinery decarbonization by separating and capturing CO_2 emitted during the oil refining process
- Separation and capture of highly concentrated CO_2 from hydrogen production equipment
- Separation and capture of CO_2 from flue gas of distillation units and boilers



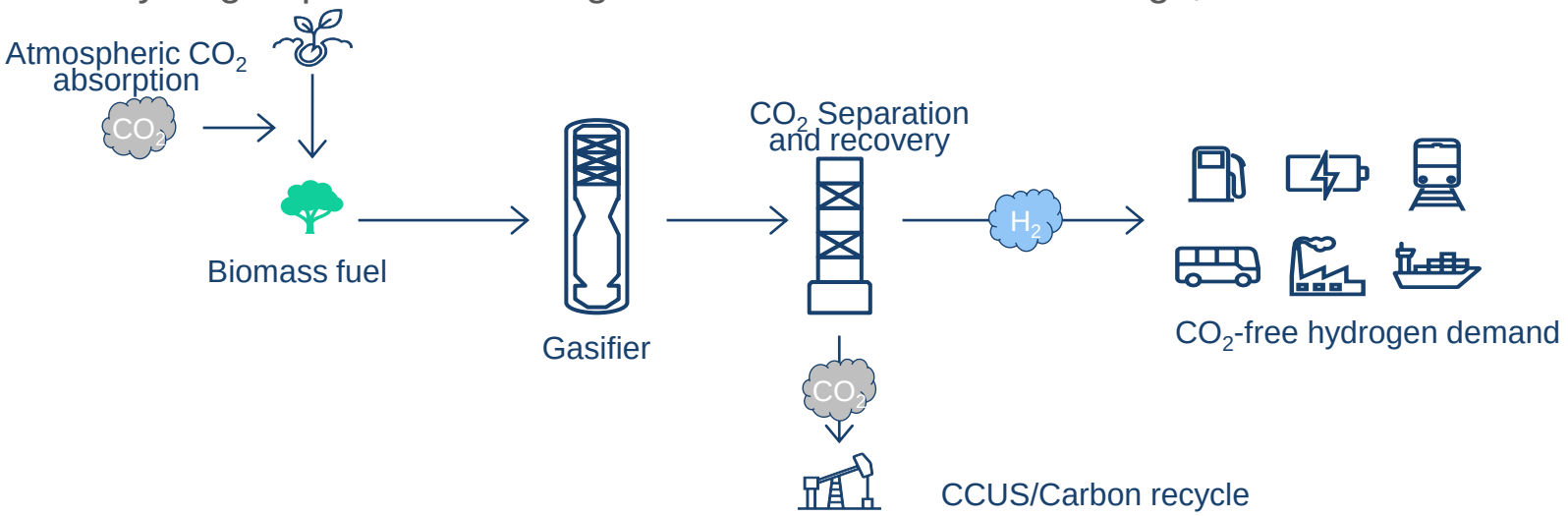
■ CO_2 transported to a storage site for injection and storage
- Examination of candidate areas with potential for a CO_2 storage site
- Investigate methods of transporting CO2 from emission source to a storage site
- Consideration of an injection facility for a storage site



Joint Approach toward Carbon Neutrality in Energy Supply

Joint study of negative emission hydrogen production

In Japan, J-POWER has started a joint study on biomass gasification and negative emissions hydrogen production using CCUS *1 with ENEOS Holdings, Inc.

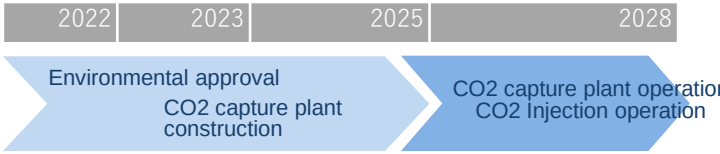


*1: Carbon dioxide Capture, Utilization and Storage

Participation in CO2 Capture, Transportation, and Storage Project in Queensland, Australia

- Participated in Glencore's CTSCo*1 Carbon Capture and Storage (CCS) Project in Queensland, Australia, focusing on capturing CO2 from coal-fired power station, transporting and storing.
- Australia's first CCS project for coal-fired power emissions, a demonstration project aimed at technical verification from CO2 capture to storage. Aim to start storing up to 110,000 tCO2 per year from 2025.
- 500 million tons of CO2 storage potential is available in the area. This project will contribute to economic development and job creation by creating new industries for blue hydrogen production in Australia.

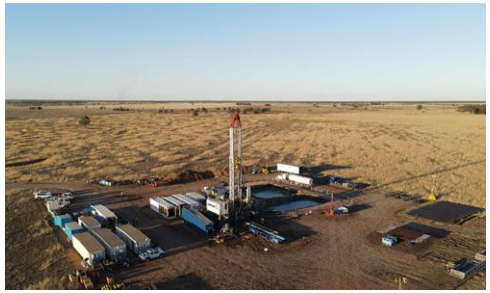
Project Status



Project partners

Australian Government
LETA
anlecr&d
J-POWER GLENCORE Marubeni

Rendered image of the proposed CO2 capture plant and Millmerran Power Station in Queensland, Australia



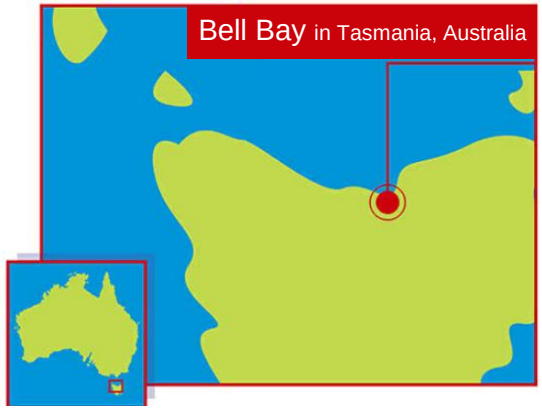
CO2 injection site near Moonie in Queensland, Australia

*1 Carbon Transport and Storage Company（CTSCo）is a Glencore wholly owned company. J-POWER and Marubeni each funded A$10 million in this project.

Pursuing the potential of green hydrogen

Joint study of green ammonia production

J-POWER has signed a memorandum of understanding (MOU) with Origin Energy Limited*1 of Australia and started a joint research on the production of green ammonia using hydro power and wind power in Tasmania and export to Japan.



*1: Origin Energy Limited is an integrated energy company in Australia.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