

Sumitomo Heavy Industries Group's Initiatives for Carbon Neutrality

Save the Earth



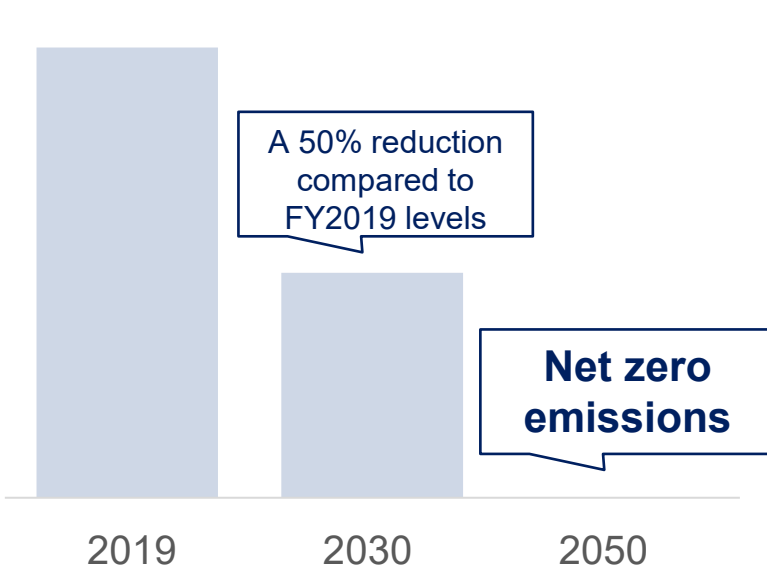
Sumitomo Heavy Industries, Ltd.

January 2024
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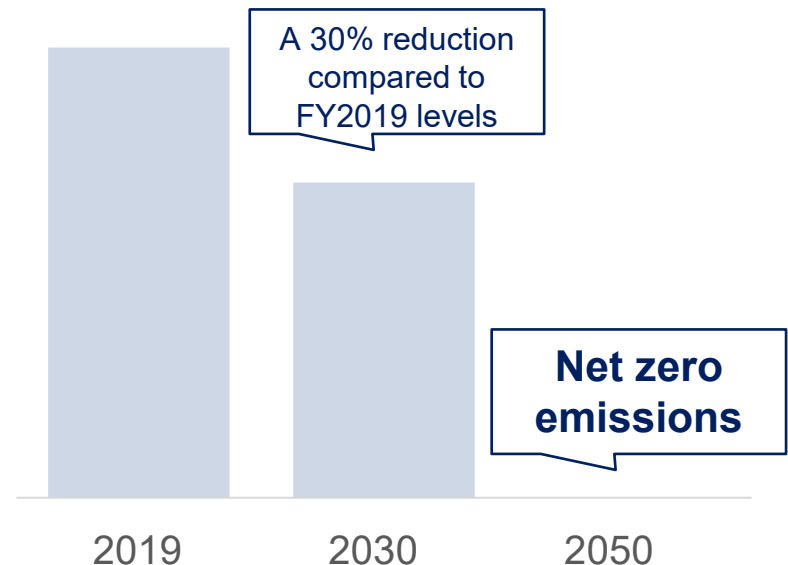
Response to Climate Change Risks

- The Sumitomo Heavy Industries Group (SHI Group) is working on reducing environmental impacts from the perspectives of "reducing the impact its business activities have on the environment" and "improving the environmental performance of its products. "Notably, the SHI Group positions "climate change" as a social issue it should contribute to solving.
- The SHI Group aims to become carbon neutral by 2050 and set CO₂ emission reduction targets up to 2030 to achieve the ultimate goal.

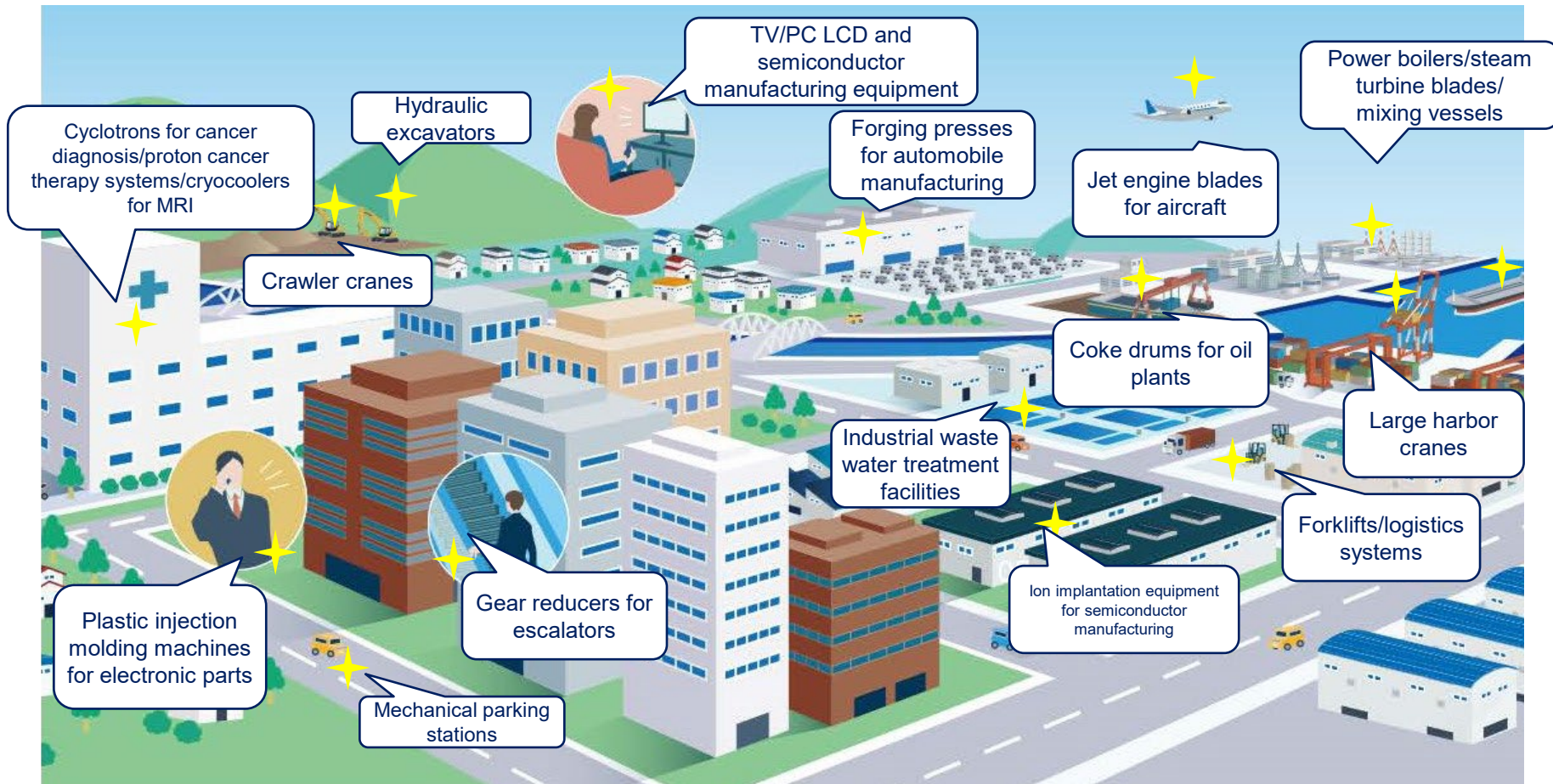
Targets for reducing CO₂ emissions from product manufacturing (Scope 1, 2 emissions)



Targets for reducing CO₂ emissions from product use (Scope 3 Category 11 emissions)



Sumitomo Heavy Industries Group's Products that Support Society



Various products made by the SHI Group are working around you.
This presentation will explain the initiatives SHI is implementing for carbon neutrality.

Decarbonizing our Products for Carbon-Neutral

- SHI's products are classified mainly into the following four categories. For each product category, SHI is committed to pursuing energy saving, mechanical efficiency improvement, fuel conversion, and effective energy use.

Move and Carry Things



- Hydraulic excavators
- Crawler cranes
- Harbor cranes
- Forklifts



→ **Energy saving promotion/conversion to carbon-neutral (CN) fuels/electrification**

Create and Store Energy



- Biomass power generation
- Biogas systems
- Energy storage systems
- Gasification systems



→ **Conversion to carbon-neutral (CN) fuels/energy storage**

Manufacture Things (Equipment)

This product category includes injection molding machines, semiconductor manufacturing equipment, precision positioning equipment, press machines, machine tools, chemical equipment, and food machinery.

→ **Mechanical efficiency improvement/energy saving promotion/electrification**

Manufacture Things (Components)

This product category includes gear reducers, motors, inverters, cryocoolers, precision parts, turbines, and pumps.

→ **Mechanical efficiency improvement/energy saving promotion**

Products to "Move and Carry Things"

R&D

FS/demonstration

Product/service

Examples of our response to carbon neutrality

Electrification

Electric Excavators
p.6



Electric Forklifts
p.7



Biofuel-powered

Crawler Cranes
p.8



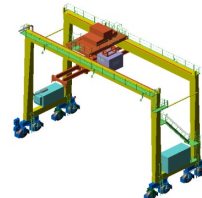
Energy saving

Hybrid Rubber-Tired Gantry Cranes (RTGs) p.9



Hydrogen-powered

Fuel-cell Hybrid
p.10



Small electric excavators

R&D

FS/demonstration

Product/service

Sumitomo Construction Machinery Co., Ltd.

- The company unveiled a **7.5t electric excavator** at the "Construction & Survey Productivity Improvement Expo (CSPI-EXPO)" held at Makuhari Messe on May 24 through 26, 2023.
- This excavator, equipped with a bucket with an inner volume of 0.28m³ and utilizing the excellent torque responsiveness of the electric motor, **exhibits power that outperforms diesel-engine-powered machines.**
- The electric excavator generates lower levels of vibrations and noise than engine-powered machines, helping to improve the work environment.
- In the future, the company will develop battery-powered excavators and increase the number of electric-powered models.

The company internally set up the "Electrification Business Promotion Department," independent of the Technical Department, to accelerate the development of such electric excavators.



CN points

- ✓ **Contributing to zero emissions (zero exhaust gas) at construction sites**
- ✓ **Aiming for an operating time of around eight hours**

Sumitomo Nacco Forklift Co., Ltd.

- The company has developed a new battery-powered forklift that is more environmentally friendly than ICE ^{*1} forklifts. This battery-powered forklift is **equipped with a high-efficiency IPM motor** and can **reduce energy consumption and extend its operating hours**.
- Furthermore, **optional lithium-ion batteries enables rapid charging**, allowing a **longer continuous operation with a shorter charging time**.
- Lithium-ion batteries have a high charging efficiency, **saving about 20% of the electricity cost** compared to lead-acid storage batteries.
- By tactically utilizing the high-efficiency and rapid charging characteristics, this battery-powered forklift could achieve an operating hours close to that of ICE forklifts, expanding the possibility of this electric forklift **replacing conventional ICE forklifts**.

*1) ICE = Internal Combustion Engine



CN points

- ✓ **Contributing to zero emissions (zero exhaust gas)**
- ✓ Switching an ICE forklift to a battery-powered forklift could **reduce CO₂ emissions by about 60%** during product use.

Sumitomo Heavy Industries Construction Cranes Co., Ltd.

- The company's **crawler cranes** are contributing to realizing a decarbonized society **by using renewable diesel (hereinafter, "RD")**, a next-generation biofuel that can significantly reduce CO₂ emissions*¹.
- RD, made from raw materials such as used cooking oil and animal and vegetable oils, is an HVO*² with improved vulnerability to oxidation of conventional biodiesel fuels. Using RD as a fuel would **reduce** greenhouse gas emissions by **about 90% based on fuel life cycle assessment (hereinafter, "LCA")**.
- RD is a "drop-in" fuel that does not require engine refurbishment or additional capital investment, making it possible **to minimize the introduction cost needed for decarbonization**.

*1 : RD can power crawler cranes and foundation work equipment mounted with an engine that complies with the EU Stage IIIA / Tier3 regulations and later standards.

*2 : Hydrotreated Vegetable Oil



**SCX
3500-3**

CN points

- ✓ **Contributing to reducing greenhouse gas emissions at construction sites (by about 90% based on fuel LCA)**
- ✓ **Minimizing the introduction cost needed for decarbonization is possible**

Sumitomo Heavy Industries Material Handling Systems Co., Ltd.

- Rubber Tired Gantry cranes (RTG) are widely used in container terminals to stack containers. RTGs are equipped with diesel engine generators to freely travel within the container terminal.
- The company's hybrid power pack is designed to combine storage batteries with a diesel engine generator to supply power for the RTG motion. By applying this design, **the hybrid RTG requires a reduced engine size while maintaining the necessary power with the help of the company's proprietary regenerative power control technology, reducing CO₂ emissions and improving fuel efficiency (a 60% reduction).**
- This hybrid power pack can enable future replacement of the diesel engine generator **with a fuel cell (FC), achieving zero CO₂ emissions.** This will contribute to carbon neutrality at ports moving forward to hydrogenation.



CN points

- ✓ **Reducing CO₂ emissions by about 60% while maintaining the necessary power**
- ✓ **Achieving zero CO₂ emissions is possible by converting the diesel engine to a fuel cell (FC)**

Fuel-Cell Hybrid RTGs

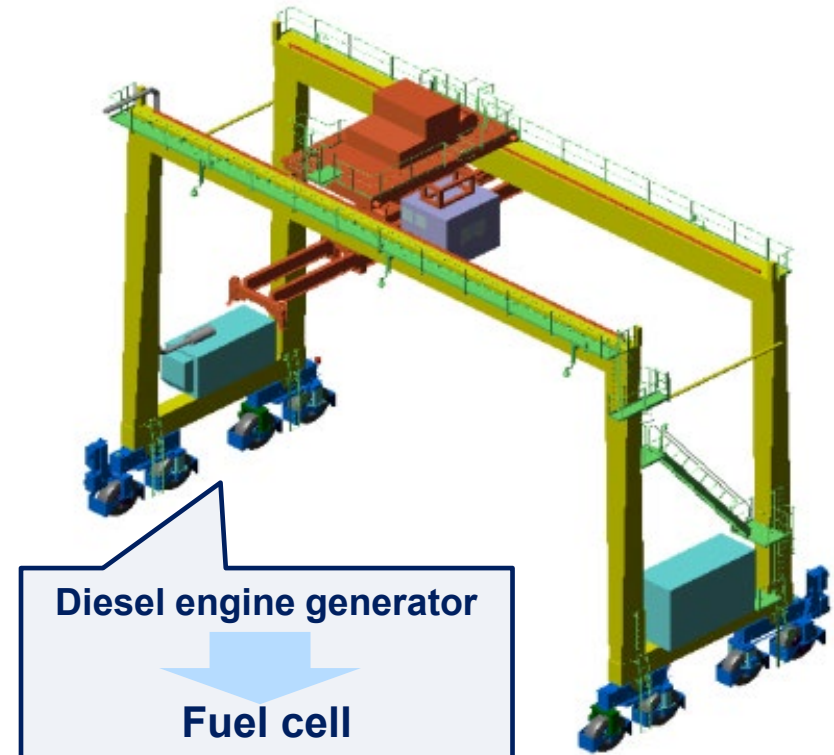
R&D

FS/demonstration

Product/service

Sumitomo Heavy Industries Material Handling Systems Co., Ltd.

- Fuel-cell hybrid RTGs will use **a fuel cell (FC)** as the main power supply device, **thus eliminated the conventional diesel engine generator.**
- Using a fuel cell would enable **zero CO₂ emissions.**
- By adapting a battery bank hybrid type, the company's proprietary optimum power control technology will minimize the fuel cell size, realizing a higher level of energy saving.
- Fuel-cell hybrid RTGs will contribute to carbon neutrality at ports moving forward to hydrogenation.



CN points

- ✓ **Zero CO₂ emissions due to eliminated a diesel engine generator**
- ✓ **The hybrid RTG can be operated with a minimum-capacity fuel cell**

Biomass utilization

Biomass Power Generation
p.12





Biogas Power Generation
p.13



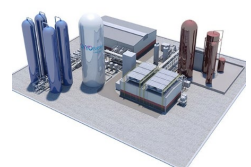
Gasification Furnaces
p.14




Electricity
·
Heat


Energy storage

LAES
p.15



Thermochemical heat storage
p.16



FT
Synthesis
p.18



CN fuels



Energy & Environment Group

- Biomass power generation uses carbon-neutral fuels such as wood-derived fuel and agricultural residue is an environmentally friendly technology that **will not generate additional CO₂ during combustion**. Carbon negative is possible by capturing CO₂ generated at biomass power plants and combining it with subsequent storage and utilization processes.
- SHI's circulating fluidized bed (CFB) boilers and bubbling fluidized bed (BFB) boilers can stably burn a wide range of fuels, from biomass to recycled fuels. These boilers are widely used for feed-in tariff (FIT) and private power generation.
- CO₂ can be easily captured by utilizing oxyfuel combustion technology (such as Flexi-Burn™ technology), which supplies oxygen into a conventional CFB boiler and burns biomass fuel.



CN points

- ✓ Supplying adjustable power for stable grid operation
- ✓ **Contributing to post-fossil fuel and the reduction of CO₂ emissions while utilizing locally available biomass and recycled fuels**

Biogas Gas Generation from Organic Wastewater and the Utilization

R&D

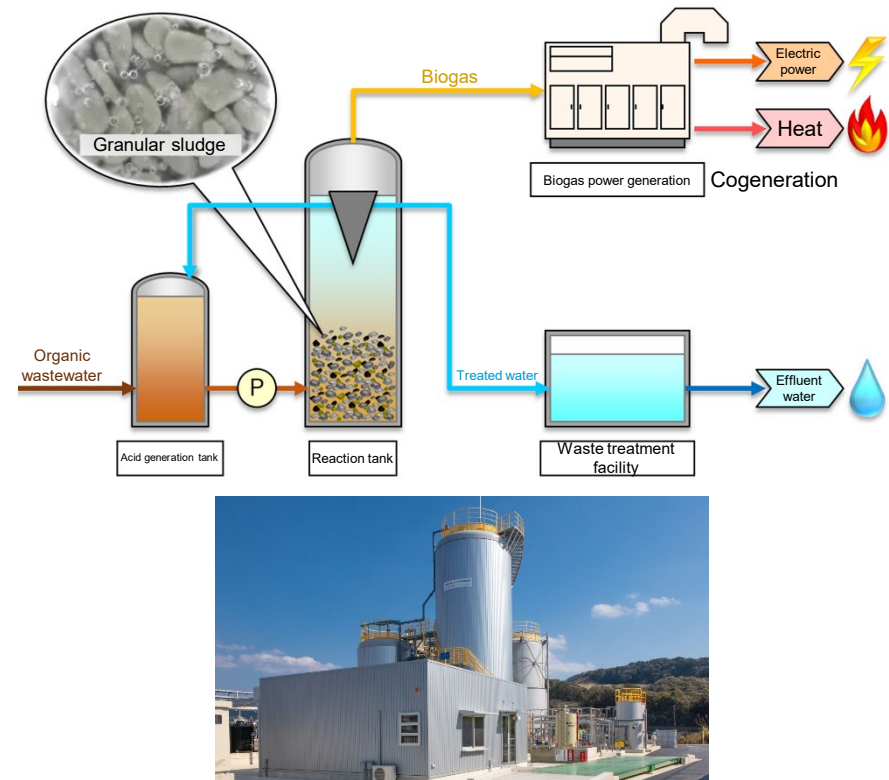
FS/demonstration

Product/service

Sumitomo Heavy Industries Environment Co., Ltd.

"Anaerobic Wastewater Treatment and Biogas Power Generation System"

- This system captures biogas from organic wastewater generated in the production process of food-processing factories and the like. The biogas captured will be used as a fuel for power generation, and the electric energy will be recovered for utilization. **This system offers opportunities for energy creation, reduced environmental impacts, and reduced waste disposal costs.**
- The anaerobic wastewater treatment (methane fermentation) system that does not require oxygen treats organic substances in wastewater. Unlike aerobic treatment, this treatment does not require power for aeration, **contributing to energy saving and CO₂ emission reduction.**
- **This system significantly reduces the amount of sludge generated and decreases the volume of waste materials to be treated.**
- **This system will contribute to a sustainable society by preserving the water environment through water purification and using biogas as a fuel.**



CN points

- ✓ Generating biogas from organic wastewater. **The consumption of fossil fuel at a factory can be reduced by using biogas as a fuel.**

Gasification Furnaces to Generate Synthesis Gas

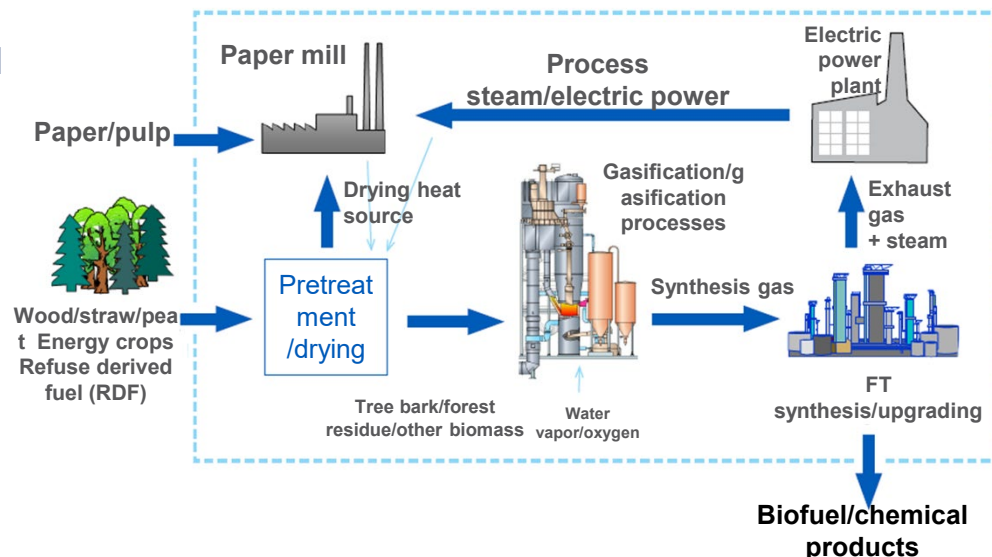
R&D

FS/demonstration

Product/service

Energy & Environment Group

- **Gasification is the process of transforming solid fuel into synthesis gas (hydrogen and carbon monoxide).** The synthesis gas generated can also be used **as a raw material for chemicals such as methanol and for aviation fuel**, making it an alternative to fossil resources for use in multiple applications.
 - SHI's fluidized bed gasification furnaces can utilize a wide variety of resources, such as waste plastics, construction waste, forest residue, and agricultural residue. These gasification furnaces will contribute to decarbonization by using synthetic gases derived from biomass and recycled materials, for chemicals and aviation fuel as carbon resources to replace fossil resources.
- * SHI has delivered this technology as biomass gasification equipment since the 1980s.



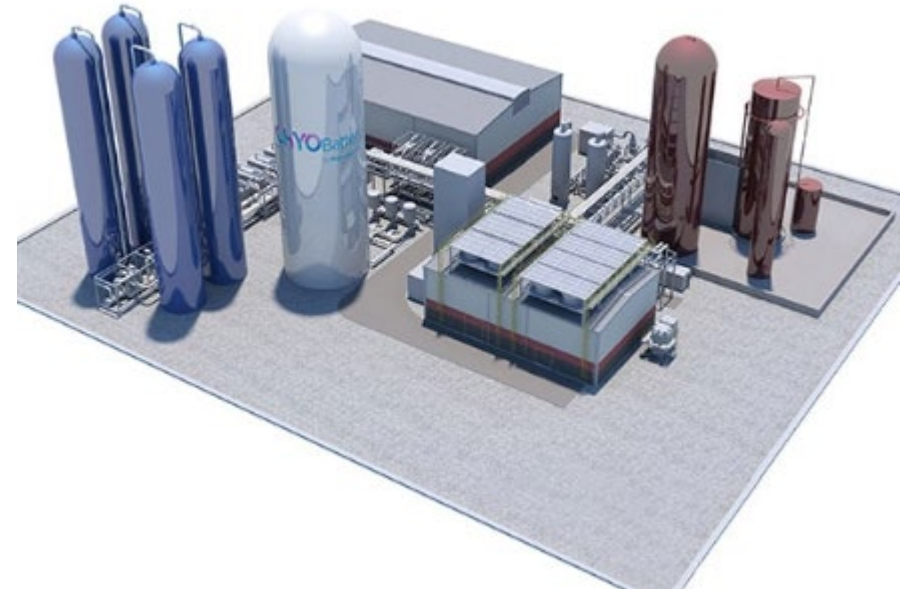
CN points

- ✓ Production of green fuels without additional CO2 emissions
- ✓ Reducing the use of fossil resources



Energy & Environment Group

- The liquid air energy storage (LAES) system is composed of the charging process, in which air is compressed, cooled, and liquified using excess renewable energy-derived and other electric power to store liquified air in a tank, and the discharging process, in which liquified air is evaporated, heated, and expanded to drive a turbine generator for power generation.
- This system can **absorb solar and wind power output fluctuations** by storing and supplying electric power at the right time, **contributing to the widespread use of renewable energy. The system can also provide the inertial force to stabilize the power system's frequencies.**
- SHI is constructing a commercial demonstration plant in partnership with HIROSHIMA GAS Co., Ltd.

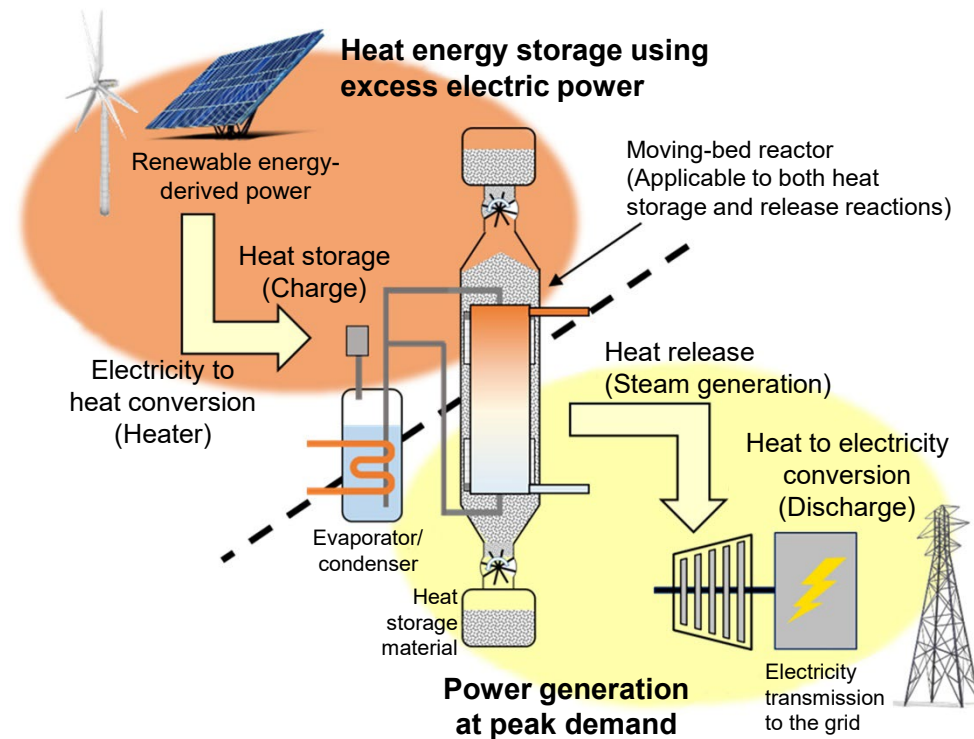


CN points

- ✓ **Contributing to stabilizing the power system**
- ✓ **Contributing to making renewables a main power source**
- ✓ Utilization of external waste heat and waste cold heat is possible

Technology Research Center

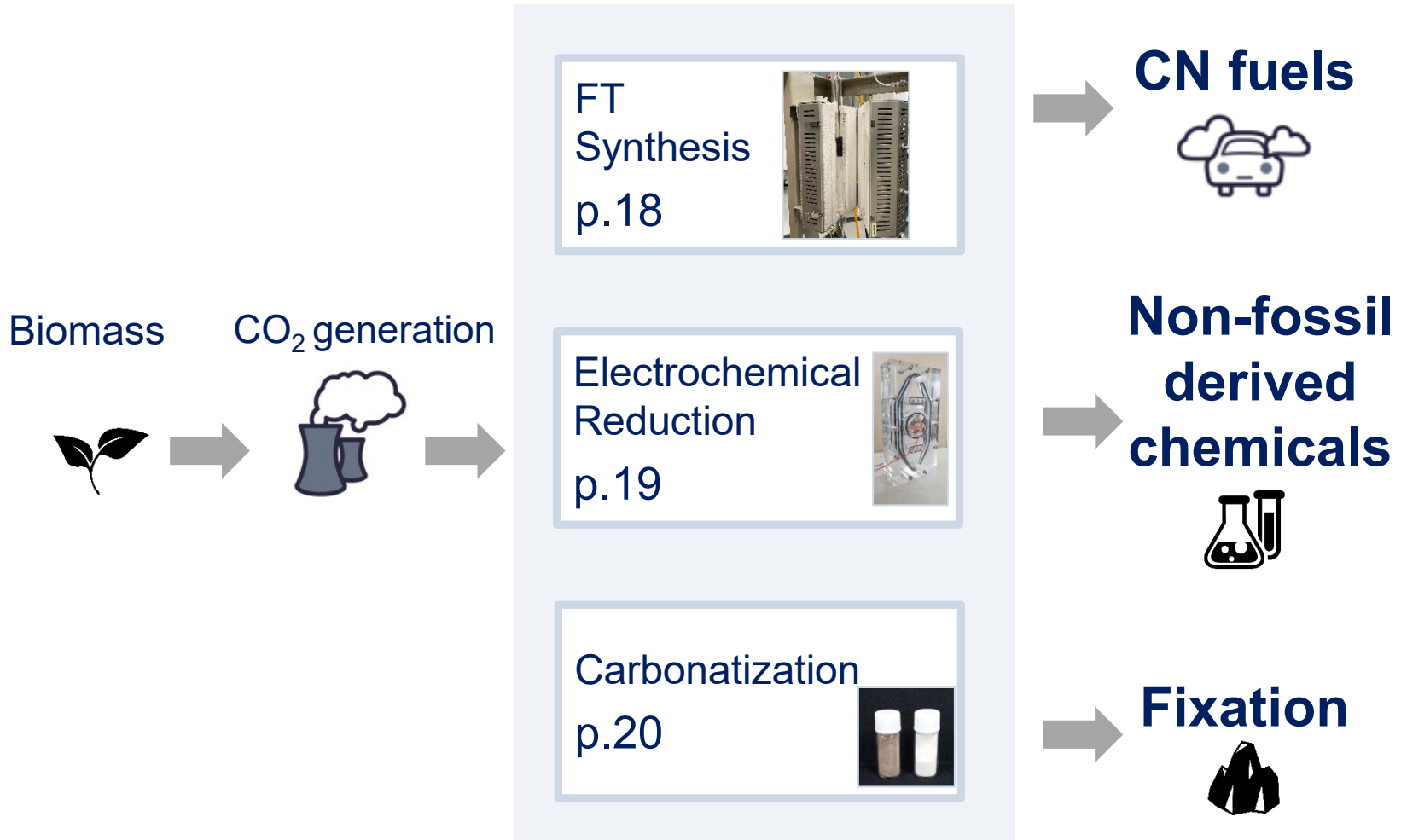
- SHI is developing **the thermochemical heat storage system, which has a high energy density and offers advantages in terms of size reduction and cost.** This system can play a critical role in promoting waste heat utilization and enabling the storage and leveling of renewable energy.
- Cost-effective and widely available $\text{CaO}/\text{Ca}(\text{OH})_2$ is used as the heat storage material, allowing for efficient heat storage at around 500°C . During the heat releasing process, it can produce heat energy at even higher temperature around 600°C by controlling the steam pressure for reaction, providing additional benefits through the effective use as a heat pump.
- Waste heat from factories or plants can be stored in this system and then released when needed or transported to other locations for alternative heat use. This technology can also provide **low-cost renewable energy storage, potentially replacing conventional battery solutions.**



CN points

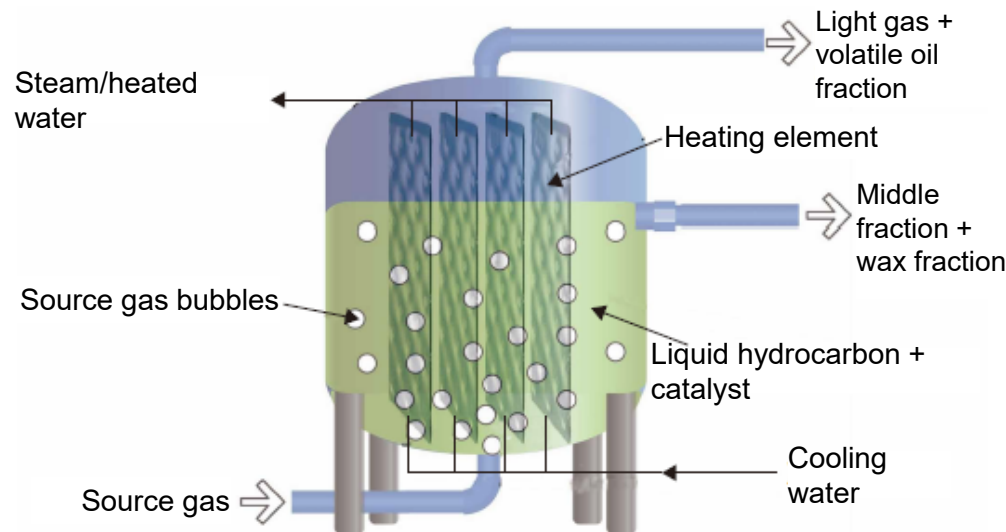
- ✓ **This technology contributes to a reduction in overall energy consumption** by using heat that would otherwise be wasted.
- ✓ **This system can offer a cost-effective solution for renewable energy storage.**

- Multiple technologies are currently under consideration to effectively utilize CO₂ generated at biomass power plants



Technology Research Center

- SHI is conducting R&D on **Fischer-Tropsch (FT) synthesis**, designed to synthesize liquid high-cetane fuels with zero sulfur content from **synthesis gas (CO and H₂) containing CO₂** using own catalyst. The crude oil synthesized will be distilled and separated into **light oil and jet fuel**.
- While conventional FT synthesis requires decarboxylation, SHI has a technology to produce **liquid fuel without separating CO₂**. SHI is also considering **the conversion of the synthesis gas from its gasification system into fuel**.
- Synthetic fuels have the advantage of **utilizing the existing internal combustion engines and fuel infrastructure**, which means the users can **minimize the cost needed to respond to decarbonization**.
- SHI is conducting joint research on this synthesis with Gunma Prefectural Industrial Technology Center.

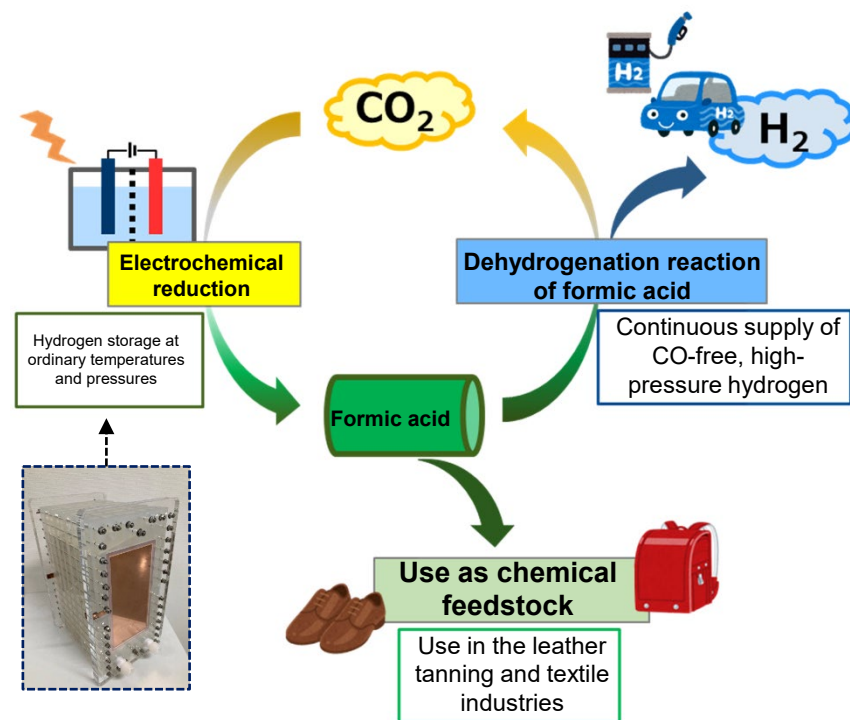


CN points

- ✓ This synthesis approach can **manufacture carbon-neutral fuel** from biomass-derived synthesis gases.
- ✓ This synthesis approach can **minimize the cost needed to respond to decarbonization**.

Technology Research Center

- SHI is developing a technology to convert CO₂ emitted from power plants and machinery into valuable resources through **electrochemical reduction**.
- With the generation of formic acid and synthesis gas targeted**, the technology is characterized by using boron-doped diamond electrodes (hereinafter, "BDD electrodes") for the electrochemical reduction of CO₂. BDD electrodes have a characteristically wide potential window, making it possible to initiate electrolytic reactions that conventional electrodes could hardly accomplish. Furthermore, these electrodes are physicochemically stable, promising stability and durability during system operation.
- Formic acid is expected to be used as feedstock for chemical products and as a hydrogen carrier. On the other hand, synthesis gas is expected to be used as feedstock for chemical products and fuel.

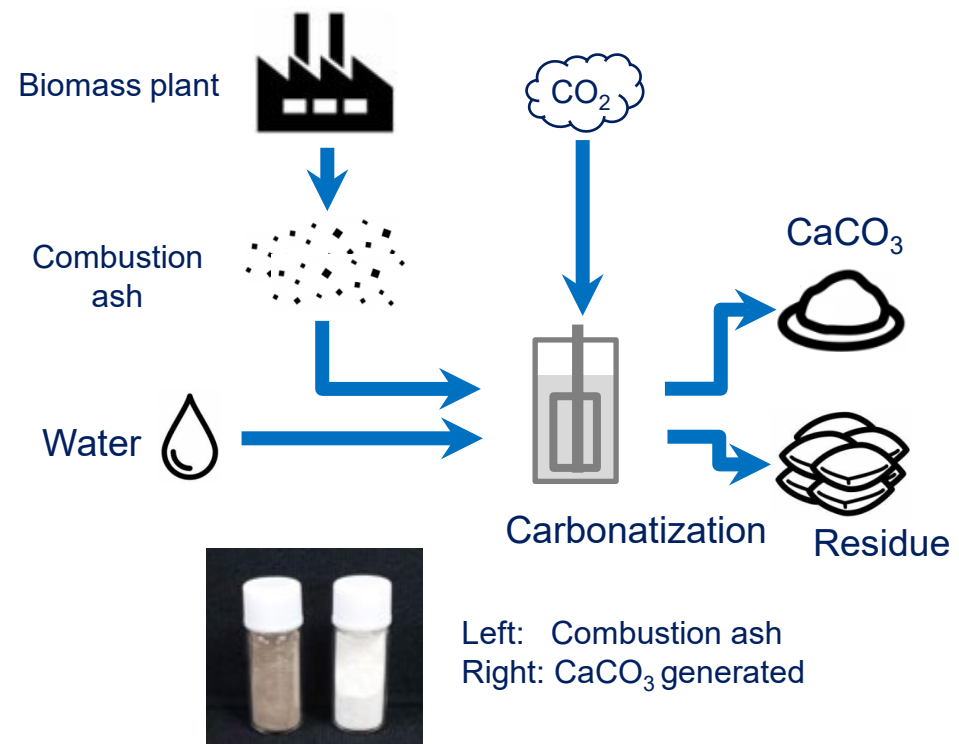


CN points

- ✓ **CO₂ recycling**
- ✓ It is possible to synthesize feedstock for chemical products that require a shift to post-fossil fuels and materials that support a hydrogen society.

Technology Research Center

- This technology fixes CO_2 in exhaust gas and others in the form of CaCO_3 (calcium carbonate) with the help of calcium (Ca) contained in boiler combustion ash.
- Combustion ash obtained from boilers fueled by biomass is richer in Ca content, promising a higher potential for CO_2 fixation than other ash types.
- CaCO_3 , obtained by the reaction of Ca and CO_2 , has a lower Gibbs free energy than CO_2 and **does not require energy for the reaction**, making it possible to fix CO_2 economically with only the energy required for stirring.
- Because the calcium carbonate obtained has high purity and fine particle size, SHI aims to apply it to high-value-added products.



CN points

- ✓ No need for energy other than mechanical power makes **low-cost CO_2 fixation** possible.
- ✓ **Carbon neutral or negative** can be targeted if the CO_2 is derived from biomass.

Roadmap

- SHI will pursue the commercialization of existing initiatives and add new initiatives one after another, contributing to a shift to carbon neutrality in various fields.

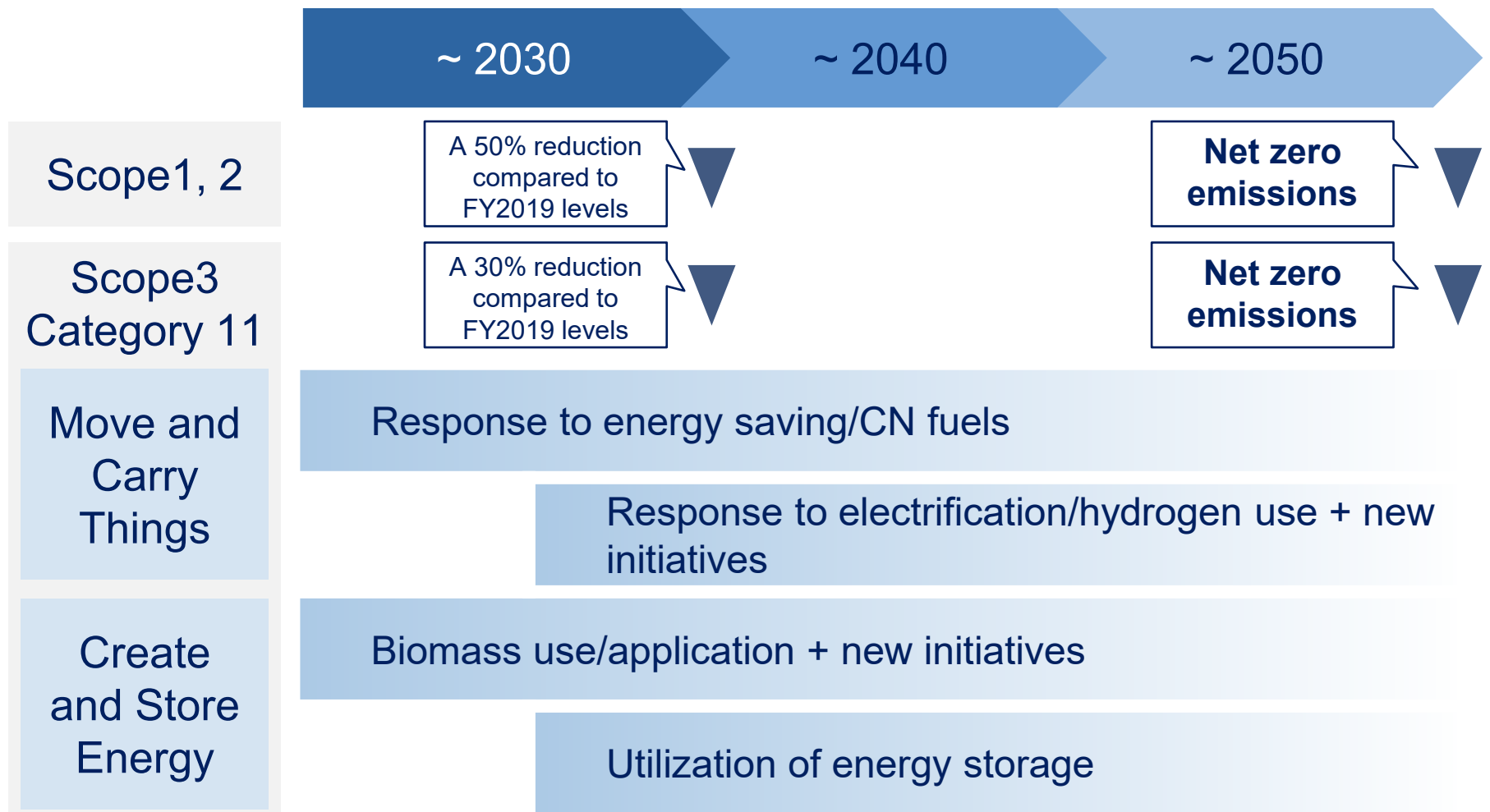
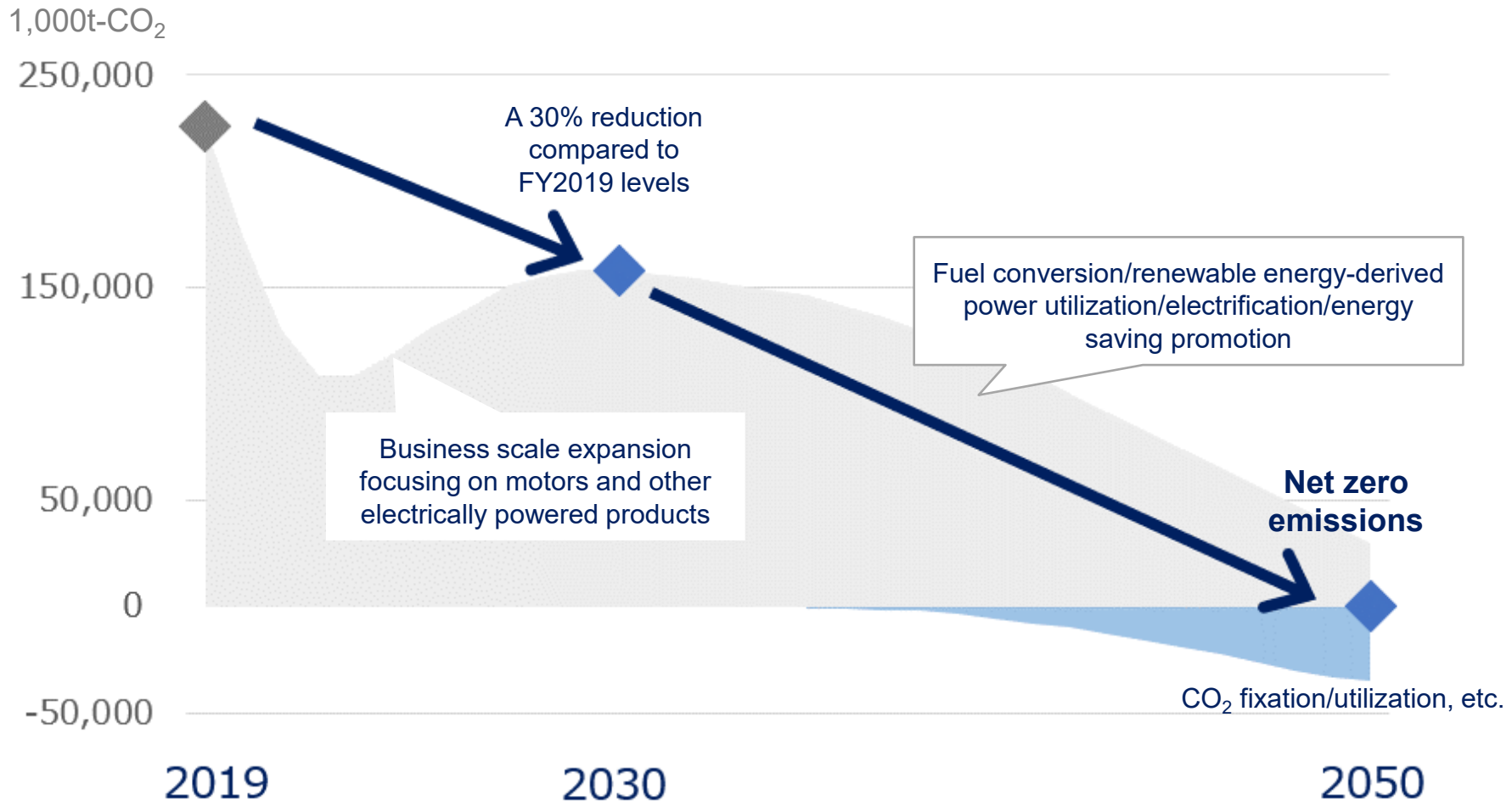


Image of Reducing CO₂ Emissions from Product Use Up to 2050

- SHI aims to achieve the goal of zero CO₂ emissions in 2050 by developing various decarbonization technologies.



Sumitomo Heavy Industries Group
will continue accelerating its initiatives
to achieve a carbon-neutral society.

