Carbon Neutrality Briefing

March 18, 2022
Eisaku Ito
Executive Vice President & CTO
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MISSION NET ZERO
MISSION NET ZERO

Through our group products, technologies, and services that help reduce CO₂ emissions, as well as new solutions and innovations to be developed with partners around the world, Mitsubishi Heavy Industries Group will contribute to realizing “Net Zero” emissions for the world as a whole.

To this end, each and every one of our employees is embracing and internalizing “Mission Net Zero” and will act to implement a “Net Zero” future.

<table>
<thead>
<tr>
<th>Target Year</th>
<th>Reduce CO₂ emissions across MHI Group Scope 1&amp;2</th>
<th>Reduce CO₂ emissions across MHI’s value chain Scope 3 + reductions from CCUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>-50% (compared to 2014)</td>
<td>-50% (compared to 2019)</td>
</tr>
<tr>
<td>2040</td>
<td>Net Zero</td>
<td>Net Zero</td>
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</table>

Scope 1&2: The calculation standard is based on the GHG Protocol.
Scope 3: The calculation standard is based on the GHG Protocol. However, we also account for reductions achieved by CCUS as an MHI original index.

GHG: Greenhouse Gas  CCUS: Carbon dioxide Capture, Utilization and Storage

*As CO₂ comprises 99% of MHI Group’s GHG emissions, we have focused our targets solely on the reduction of CO₂ in order to simplify our message.
Roadmap to MISSION NET ZERO

Reduce CO₂ emissions across MHI Group
Scope 1&2

Implement proprietary
technologies at MHI factories

Implement proprietary
technologies
Heat pump chillers
H₂, CCUS, etc.

Implement decarbonized
energy sources

Energy Conservation
Energy management

Fuel Conversion
Energy Transition

CO₂ Emissions

Kton CO₂

1,000
500
0

2014 2021 2030 2040

Reduce CO₂ emissions across MHI’s value chain
Scope 3 + reductions from CCUS

Rapidly establish decarbonization
technologies and drive commercialization

Japan’s GHG Emissions (2019)

Energy conservation/
electrification
New Mobility & Logistics
Electrify and improve
efficiency of existing businesses

Expansion of
CCUS business

Mton CO₂

1,500
1,000
500
0

2019 2021 2030 2040

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Roadmap to MISSION NET ZERO Achievement

Achieve Carbon Neutrality within MHI Group by 2040 and deploy decarbonization solutions around the world

<table>
<thead>
<tr>
<th>2021 Medium-Term Business Plan</th>
<th>2023</th>
<th>2040</th>
<th>2050</th>
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</thead>
<tbody>
<tr>
<td>Energy Transition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decarbonize energy supply side</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decarbonize existing infrastructure</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₂ Solutions Ecosystem</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂ Solutions Ecosystem</td>
<td>✔</td>
<td></td>
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<tr>
<td>New Mobility &amp; Logistics</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Decarbonize, conserve energy, and automate energy demand (use) side</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing Businesses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decarbonize, electrify, and optimize with intelligent systems</td>
<td>✔</td>
<td></td>
<td></td>
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</tbody>
</table>

Contribute to the realization of Carbon Neutrality in each country and region
Our Vision of a Carbon Neutral World
Towards Realizing a Carbon Neutral World

Sustainable increase in environmental value is predicated on balancing stable energy supply with both sound economics and safety.
MHI Group’s Carbon Neutrality Solutions Ecosystem

- Not just a value chain
- Create environmental and economic value by connecting diverse industries

→ Quickly commercialize with MHI’s wide range of products and services

6 keywords for achieving this:

- Utilize
- Exchange
- Separate
- Circulate
- Consolidate
- Synthesize
Our Approach to Scope 1&2 Net Zero Achievement

Decarbonize MHI factories and commercialize those solutions

**Step 0**
Calculate required energy

**Fuel Use**
 Scope 1
Electricity Use

**Scope 2**
Manufacturing Cost

**Step 1**
Reduce waste

- **Utilize**
- Casting

**Step 2**
Reuse heat

- **Circulate**
- Heat pump chillers

**Step 3**
Use non-fossil energy

- **Consolidate**
- Use solar heat

**Net Zero**

- Energy conservation & EMS*
- Solar power + battery energy storage

*EMS: Energy Management System
Prepare infrastructure for global H$_2$ procurement
Existing infrastructure for gas-fired thermal power facilities present both domestically and abroad.
Energy: Local Production & Consumption of H₂

Global H₂ Procurement

LNG Storage
Water Electrolysis
Reforming
CO₂ Storage
Transport

H₂ Storage (Receiving Terminal)
Gasification
H₂ Pipeline
H₂ Gas Turbine
Carbon Neutral Power

Local H₂ Production & Consumption Using Existing Facilities

Natural Gas
Liquefaction
Transport

LNG Storage
Gasification
LNG Pipeline
H₂ Gas Turbine (Retrofit)
Carbon Neutral Power

Utilize existing infrastructure for H₂ with minimal modification

Keyword (1)
Utilize

Reforming
CO₂ Storage
Water Electrolysis
Liquefaction
Pyrolysis
Solid Carbon

Local H₂ Production & Consumption Using Existing Facilities

New Facilities/ Processes

Global H₂ Procurement

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Energy: Local Production & Consumption of H₂

Global H₂ Procurement

Local H₂ Production & Consumption Using Existing Facilities

Natural Gas

Liquefaction

Transport

LNG Storage

Gasification

LNG Pipeline

Pyrolysis

Solid Carbon

H₂ Storage (Receiving Terminal)

Gasification

H₂ Pipeline

H₂ Gas Turbine

Carbon Neutral Power

Water Electrolysis

Reforming

CO₂ Storage

Demonstration Facility

Takasago Hydrogen Park
Slated to begin operation in FY2023 within MHI Takasago Machinery Works

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Produce H₂ and solid carbon for use as raw materials

Water Electrolysis

Pyrolysis

Solid Carbon

H₂ Gas Turbine (Retrofit)

Power Grid

H₂

Carbon Neutral Power

Material Manufacturers
(incl. chemical/steel manufacturers)

Natural Gas

Raw Materials

Manufacture

Sell
Energy: Local Production & Consumption of H₂

Exchange for new value or materials

- Natural Gas
- Water Electrolysis
- H₂ Gas Turbine (Retrofit)
- Pyrolysis
- Solid Carbon
- H₂

Material Manufacturers (incl. chemical/steel manufacturers)

Power Grid

Carbon Neutral Power

Carbon Neutral Materials

Raw Materials → Manufacture → Sell
CO₂ Recycling in Steelmaking

Steelmaking (Direct Reduction)

Blast Furnace Gas (incl. CO₂)

Power Generation/Heat Use

Steel Products

Iron Ore
Coal
Natural Gas

Iron Ore
Coal
Natural Gas
Materials: CO₂ Recycling in Steelmaking

Reuse carbon within the steelmaking process

Keywords:
- Iron Ore
- Coal
- Natural Gas
- Steelmaking (Direct Reduction)
- Blast Furnace Gas (incl. CO₂)
- CCU
- Carbon Recycling (incl. CO)
- Steel Products
Materials: CO₂ Recycling in Steelmaking

Reuse carbon within the steelmaking process

Keyword (4) Circulate

Iron Ore

Water Electrolysis

Pyrolysis

Natural Gas (CH₄)

Solid Carbon

Carbon Recycling

Blast Furnace Gas (incl. CO₂)

CCU

Carbon Neutral Steel Products

Water

H₂
Waste Treatment: The CO₂ Recycling Chain

Municipal Waste → Waste-to-Energy Boiler → CO₂
Waste Treatment: The CO₂ Recycling Chain

Municipal Waste → Waste-to-Energy Boiler → CO₂ Capture → CO Conversion → Oil/Chemical Synthesis → H₂

Keyword (5) Synthesize

Existing Facilities
Waste Treatment: The CO₂ Recycling Chain

Effectively utilize CO₂

Keyword (5)
Synthesize

Municipal Waste → Waste-to-Energy Boiler → CO₂ Capture → CO Conversion → Oil/Chemical Synthesis

Existing Facilities

Biomass → Gasification
Cycle I
Ferment food waste to produce methane

Heat Treatment
Food Waste
Methane Fermentation
Biogas
CO₂ Capture

Waste-to-Energy Boiler
Heat

CO₂ Capture

CO Conversion

Oil/Chemical Synthesis

Mix with Municipal Gas
Carbon Neutral Methane

Biomass
Gasification

H₂

Keyword (4)
Circulate

Waste Treatment: The CO₂ Recycling Chain
Waste Treatment: The CO₂ Recycling Chain

- **Heat Treatment**
  - Food Waste
  - Methane Fermentation

- **Plastic Waste**
  - Biogas
  - CO₂ Capture

- **Waste-to-Energy Boiler**
  - Heat
  - CO₂ Capture

- **CO₂ Capture**
  - CO Conversion

- **CO₂ Capture**
  - Gasification

- **Biomass**
  - Gasification

- **Recycled Plastic**
  - Heat

- **Recycled Plastic**
  - Carbon Neutral Methane

- **Oil/Chemical Synthesis**
  - H₂

**Keyword (4)**
Circulate

**Cycle II**
Recycle plastic waste

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Waste Treatment: The CO₂ Recycling Chain

1. **Food Waste**
   - Mix with Municipal Gas
   - Heat Treatment
   - Methane Fermentation
   - Biogas
   - CO₂ Capture

2. **CO₂ Capture**
   - Heat Treatment Boiler
   - CO₂ Capture

3. **CO Conversion**
   - CO₂ Capture

4. **Oil/Chemical Synthesis**
   - H₂
   - SAF Sustainable Aviation Fuel
   - Renewable Diesel

5. **Carbon Neutral Methane**

Key Term: *DAC: Direct Air Capture*
Waste Treatment: The CO₂ Recycling Chain

Cycle I
- Ferment food waste to produce methane

Cycle II
- Recycle plastic waste
- Mix with Municipal Gas
- Carbon Neutral Methane

Cycle III
- CO₂ Recycling in Mobility
- DAC

Existing Facilities

Keyword (4)
Circulate

Three Cycles

Food Waste
- Heat Treatment
- Methane Fermentation
- Biogas
- CO₂ Capture
- CO₂ Capture

Waste-to-Energy Boiler
- Heat

CO₂ Capture

CO Conversion

Oil/Chemical Synthesis
- SAF Sustainable Aviation Fuel
- Renewable Diesel
- H₂

Biomass
- Gasification

CO₂ Capture

DAC

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Consolidated CO\textsubscript{2} Processing

Provide CO\textsubscript{2} absorbent collection and supply services

Consolidate

Utilize

Large-Scale CO\textsubscript{2} Collection

Small-Scale CO\textsubscript{2} Collection/DAC

Oil/Chemical Synthesis

SAF
Sustainable Aviation Fuel

Renewable Diesel

Recycled Plastic

Factory/Power Plant/Waste-to-Energy Boiler/etc.

Heat Pump

Heat

Heat

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Status of Solutions Development
Carbon Neutrality Investments*

Execute large shift in funds to R&D and investments, reaching 2 trillion yen by 2030

¥300 bn/year (18 MTBP)
Carbon Neutrality
40%
CapEx R&D Investment

¥300 bn/year (21 MTBP and beyond)
Carbon Neutrality
80%
CapEx R&D Investment

Energy Management System

Begin use in FY2022
Validation to begin in FY2022 as a core part of the MHI Group Integrated Development Plan

- **Leverage position as equipment manufacturer**
  Utilize knowledge base regarding core energy supply products such as power plants and HVAC to develop algorithms which account for lifecycle costs and operability

- **Compatible with carbon neutral equipment**
  Install solar panels and battery energy storage equipment. Develop carbon neutrality management technologies.

- **Verify effectiveness with simulations**
  Simulate operational changes and/or installation of new equipment. Quantify cost and decarbonization effectiveness, and increase accuracy of return on investment calculations

- **Use latest evaluation indices**
  Energy cost and battery charge/discharge cost models using the latest techniques, including levelized lifecycle costing, are included in control algorithms

YHH CN Type EMS Core System Development

<table>
<thead>
<tr>
<th>Development</th>
<th>Validation</th>
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<tbody>
<tr>
<td>Install CN models in factories</td>
<td>Commercialization</td>
</tr>
<tr>
<td>EMS base system for customer use</td>
<td>Development</td>
</tr>
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</table>

2021 → 2022 → 2023

2021 Medium-Term Business Plan
Heat Pump Chillers

Begin validation in FY2022
Complete prototype design and fabrication in FY2022 and validate at in-house manufacturing facilities in FY2023

- **Reduce CO₂ emissions from heating processes**
  Electrify heating processes in factories and other facilities. Develop energy conserving heat pump chillers. Achieve large decrease in CO₂ emissions.

- **Leverage existing product development and manufacturing technologies**
  Quickly commercialize while ensuring high reliability

- **Provide decarbonization solutions for heating processes**
  Combine heat and energy equipment design and development capabilities with engineering knowledge base cultivated in existing businesses

### Factory Decarbonization Solutions

**Heat pump chillers**

**Reuse heat**

**Casting Process**
Effectively use high temperature waste heat

Decrease CO₂ emissions by replacing fossil fuel boilers

Utilize reused heat (waste heat) or atmospheric heat as heat sources
Achieve a fully Carbon Neutral factory by the end of FY2023

Demonstrate the achievability of MISSION NET ZERO by offsetting 10,000 tons-CO$_2$/year

- **Install solar panels**
  Install an amount of solar panels equivalent to the electricity consumption of Mihara Machinery Works. Achieve Scope 2 decarbonization with this dedicated renewable energy source.

- **Utilize as R&D proving ground**
  Execute challenging adoption of energy conservation, electrification, fuel conversion, and renewable energy sources while using as a proving ground for various technologies and carbon neutral solutions.

$\text{CO}_2 = 10,000 \text{ tons} \div \text{x 700,000 trees}$
Takasago Hydrogen Park

Begin operation in FY2023

A one-stop-shop for validating hydrogen-related technologies from hydrogen production to power generation

- **Add hydrogen production and storage equipment to existing demonstration plant**
  
  Test and validate water electrolysis, turquoise hydrogen*, SOEC** and other technologies in-house and improve product reliability
  
  *Turquoise hydrogen: H₂ obtained through pyrolysis of methane into H₂ and solid carbon
  **SOEC (Solid Oxide Electrolyzer Cell): High temperature steam electrolysis

- **Validate hydrogen gas turbine technology**
  
  Validate technology in lead up to commercialization of 30% mixed firing in heavy duty gas turbines and 100% hydrogen firing in small to mid-size gas turbines by 2025

- **Combine and evolve energy infrastructure and hydrogen technologies**
  
  Make progress toward establishing a hydrogen solutions ecosystem, which will help achieve a sustainable society by linking various industries with hydrogen technologies

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*Pictured: SOFC*
Hydrogen Gas Turbine (EU Taxonomy Compliant)

EU Taxonomy Compliant
Leveraging Takasago Hydrogen Park, develop hydrogen gas turbine technology that complies with the EU Taxonomy’s strict CO₂ emissions standards. Development schedule meets Taxonomy timing requirements as well.

- **Small to mid-size gas turbines**
  Validate on actual equipment at Takasago Hydrogen Park in preparation for commercialization of hydrogen gas turbines by 2025, meeting the EU Taxonomy deadline.

- **Heavy duty gas turbines**
  Development of 30% mixed hydrogen firing technology was completed in 2018. Validation will be performed at Takasago Hydrogen Park in the lead up to commercialization in 2025.
  Forecasted to achieve 100% hydrogen firing by 2030 and meet the EU Taxonomy requirements a full 5 years before the deadline.
Nuclear Power

Carbon-free, large-scale power source
Nuclear power is a stable power source, which does not emit CO₂ during operation and also is not affected by weather. Therefore, we believe it will be essential to the achievement of a Carbon Neutrality.

- **Restart existing plants and complete the nuclear fuel cycle**
  Currently focusing on restarting existing plants, building Specialized Security Facilities*, and completing the nuclear fuel cycle

- **Develop a next-generation light water reactor**
  Develop a next-generation light water reactor with further improvements to safety, aiming for commercialization in the mid-2030s

- **Develop future reactors and fusion reactors**
  Develop and commercialize small modular reactors, high temperature gas-cooled reactors, and fast breeder reactors to satisfy the diversifying market needs of the future

High-volume, stable, carbon-free hydrogen production using high temperature gas-cooled reactors
Contribute to meeting decarbonization and hydrogen use needs of various industries including steelmaking by achieving high-volume, stable hydrogen production with high temperature gas-cooled reactors

*Specialized Security Facilities: Isolated, large-scale facilities used to safely shut down a reactor in the event of such security incidents as airplane strikes or terrorist attacks
Achieved world’s first regularly scheduled flight* powered by SAF

Sustainable Aviation Fuel (SAF) produced from wood biomass

- **Integrated biojet fuel manufacturing technology**
  
  Established by MHI, JERA, Toyo, and JAXA under contract from NEDO**

- **Validated in a pilot plant**
  
  Built a pilot plant and validated the achievability and efficacy of a gasifier with processing capacity of 0.7 ton/day and a gas production output of approx. 1,000 Nm³/day during FY2017-2020.

- **Adaptable to any region**
  
  Achieved an SAF production process using captured CO₂ including from DAC

*Outline of domestic regularly scheduled flight powered by SAF produced from wood pulp:
- Date: June 17, 2021
- Flight: JAL 515
- Route: Tokyo-Haneda to New-Chitose (Japan domestic)
- Aircraft: Airbus A350-900

**NEDO: New Energy and Industrial Technology Development Organization**
Modular CO₂ Capture Equipment

Shipped first production unit in FY2021
Fill out the product lineup by FY2023
Commercialize units for ships, gas engines, waste incinerators and others

- **Proprietary CO₂ capture technology**
  Extensive commercial experience and high capture rate (over 90%) for chemical and thermal power plants

- **Expand equipment lineup (0.3-200t/day)**
  Develop equipment targeting not only large but also small- and medium-sized emission sources to diversify CO₂ recovery demand

- **Modularize and standardize**
  Development of low-cost general-purpose equipment aiming to reduce size (70% reduction in installation area) and minimize on-site construction (75% reduction compared with conventional equipment)

- **Remote monitoring and O&M**

* CaaS (CO₂ Capture as a Service): A business covering all processes of CO₂ capture, collection, storage and conversion/utilization
Current research will transition to the next phase by 2023. Will continue to add new research areas.

2021 MTBP

Future MTBPs

Scope 1&2
Scope 3+ reductions from CCUS

Energy Management Systems
Development/Validation at YHH
Commercialization

Carbon Neutral Factories
Development/Investment
Mihara Carbon Neutral Factory/
Roll out to other machinery works/Commercialization

Hydrogen Production Equipment
Development
Sequential validation of next-generation hydrogen production tech./Commercialization

Hydrogen Gas Turbines
Development
Small mid-size: 100% H₂ firing
Heavy duty: 50% mixed firing

Takasago Hydrogen Park
Development/Investment
Heavy duty: 100% H₂ firing/
Commercialization

Nuclear Power
Restarts/Specialized Security Facilities/Fuel cycle
Next-Generation Light Water Reactor/
Small Modular Reactor/
High Temp. Gas Cooled Reactor

Biomass Gasifier
Pilot plant validation testing/Feasibility studies
Commercialization

Modular CO₂ Capture Equipment
Development/Expand lineup
Commercialization

Japan & other countries achieve Net Zero
2040: Achieve Net Zero

50% reduction (compared to 2014 levels)
50% reduction (compared to 2019 levels)
Summary
Seize business opportunities and revolutionize business models through Carbon Neutrality initiatives

2030 Business Size (billion yen)

<table>
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<tr>
<th>FY20</th>
<th>FY23</th>
<th>FY30</th>
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<tbody>
<tr>
<td>¥300</td>
<td>¥700</td>
<td>¥500</td>
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**Energy Transition**

- Energy/Environment
- New Mobility & Logistics
- Social Infrastructure
- Aircraft, Defense & Space

**Carbon Cycle**

Waste, biomass $\rightarrow$ Carbon neutral fuels

**Factory Decarbonization**

Roll out from in-house $\rightarrow$ customer facilities

**Hydrogen Solutions Ecosystem**

Water electrolysis $\rightarrow$ Turquoise hydrogen, etc.

**CO₂ Solutions Ecosystem**

Large scale $\rightarrow$ Modular $\rightarrow$ CaaS/CCUS business

*Figures above do not include revenue from renewal/decarbonization of H₂ gas turbines, Nuclear Power, or other existing businesses, or New Mobility & Logistics

2040 Achieve Net Zero
Philosophy and Vision for Achieving a Carbon-Free World

Our Principles

- We deliver reliable and innovative solutions that make a lasting difference to customers and communities worldwide
- We act with integrity and fairness, always respecting others
- We constantly strive for excellence in our operations and technology, building on a wide global outlook and deep local insights

MISSION NET ZERO
Enable coexistence among diverse industries with MHI Group’s wide range of products and services

2040 Net Zero
Scope 1&2
Scope 3 + reductions from CCUS

Balance environmental and economic value
Achieve a sustainable, Carbon Neutral society
**Actively Pursuing Climate-Related Disclosures and ESG Finance**

**ESG Finance**

- MHI Group will disclose two climate change scenarios in accordance with the TCFD framework (scheduled for April 2022)

- Plans to issue transition bonds (FY2022)
  Selected as model example for the Japan Ministry of Economy, Trade and Industry’s 2021 Climate Finance Model Projects (March 17, 2022)

- Issued green bonds for two consecutive years
  FY2020: 25 billion yen, FY2021: 15 billion yen

- Executed positive impact finance loan agreement (Amount: 2 billion yen, Date of execution: March 14, 2022)
MOVE THE WORLD FORWARD