MUFG
Mitsubishi UFJ Trust and Banking

Transition Technologies Across Eight Key Sectors: A Sectoral Analysis

Joint Research Annual Report 2025
Hokkaido University and Mitsubishi UFJ Trust and Banking Corporation

Table of Contents

Introduction

Addressing climate change extends beyond reducing environmental impacts; it is closely linked to corporate sustainability, industrial transformation, and medium- to long-term investment decisions. As global decarbonization efforts advance, careful, multidimensional consideration is required regarding technology choices, business operations, and capital allocation throughout the transition process.

In many sectors, rapid and uniform decarbonization remains difficult, making phased and sector-specific approaches essential. As a result, decarbonization pathways themselves have become a key focus, requiring realistic assessment based on technological feasibility and conditions for social implementation.

In Asia, evolving taxonomies and sustainable finance frameworks are reshaping the investment environment for decarbonization-related technologies and businesses. However, differences in policy objectives, industrial structures, and energy systems across countries lead to diverse approaches. This underscores the importance of systematically understanding the characteristics and deployment conditions of individual technologies and adopting a multi-faceted perspective on transition pathways.

Transition technologies—such as CO_2 capture, hydrogen and ammonia, methanation, biomass, and energy storage—vary widely in technological maturity, cost structures, infrastructure requirements, and institutional prerequisites. Their roles differ by sector, making case-specific assessment essential.

For financial institutions and investors, this requires consideration not only of short-term economic performance but also of medium- to long-term emissions reduction potential, business continuity, and growth prospects, supported by a clear understanding of technological constraints and assumptions.

In Japan, policy frameworks toward achieving carbon neutrality by 2050 have been strengthened through measures such as the GX Promotion Act and the development of transition finance instruments, contributing to an enabling environment for the deployment of decarbonization technologies.

At the same time, rising geopolitical risks and uncertainties in energy supply have reinforced the need to simultaneously address energy security and the continuity of economic activity in advancing decarbonization, highlighting the importance of collaboration and knowledge-sharing across industry, academia, government, and financial institutions.

Against this backdrop, this report aims to organize the current landscape and key issues surrounding transition technologies, clarify their roles across major sectors, and identify challenges toward commercialization. By integrating academic expertise from Hokkaido University with practical perspectives from financial institutions, it seeks to provide a structured foundation for informed discussion and decision-making among stakeholders.

Executive Summary

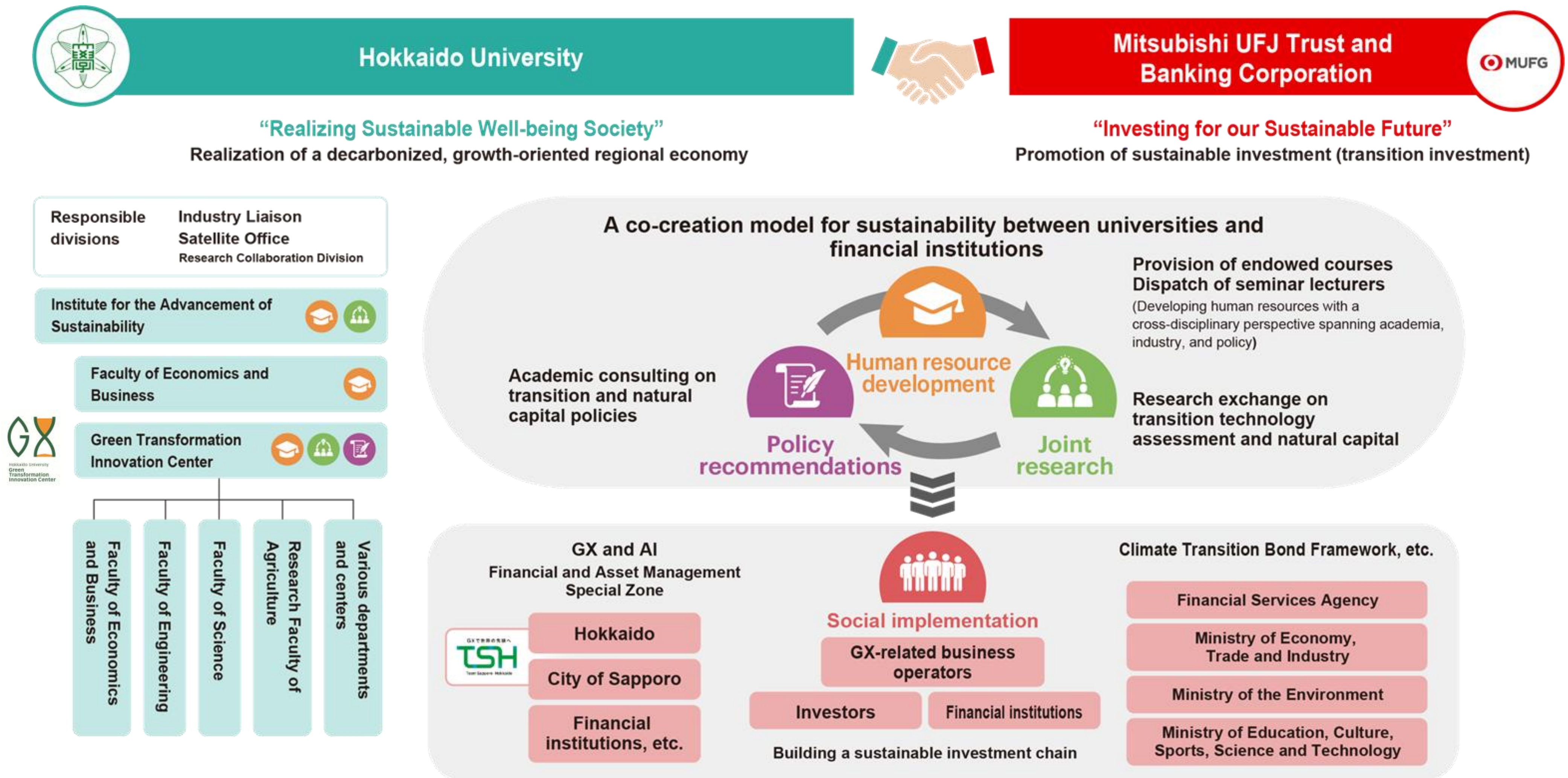
- This report aims to provide a systematic overview of the relationship between decarbonization technologies (transition technologies) and key sectors, with a focus on the sectors undergoing the transition, in order to facilitate a holistic understanding of their technical feasibility, commercialization challenges, and future positioning.
- Specifically, the report examines technologies such as CO_2 capture, hydrogen and ammonia, methanation, biomass, and energy storage, combining academic and technical insights from Hokkaido University with sector analysis and practical perspectives from financial institutions.
- By visualizing the relationship between technologies and sectors, the report enables cross-sector comparison and analysis. Through this framework, it aims to serve as a catalyst for constructive engagement with investee companies and a wide range of stakeholders, including policymakers.

Sector	Major Related technologies		Summary	Page
Steel	Hydrogen and Ammonia	CO_2 capture	It is important to pursue a dual-track approach, combining the utilization of existing facilities based on blast furnaces with transformational technologies such as hydrogen-based direct reduction.	8
Chemicals	Hydrogen and Ammonia Biomass	CO_2 capture	Given the co-production structure of the chemical industry, it is necessary to advance energy transition and carbon circulation in an integrated manner.	10
Power	Hydrogen and Ammonia	CO_2 capture	Ensuring a stable supply as a fundamental prerequisite, a realistic transition to decarbonization, aligned with policy timelines, is essential.	12
Gas	Methanation	Hydrogen and Ammonia	As social infrastructure supporting heat demand, fuel switching and the development of supply networks should be promoted from a long-term perspective.	14
Oil	Biomass	Hydrogen and Ammonia	While maintaining stable supply functions, decarbonization of refining processes and a shift toward decarbonized fuels are needed.	16
Pulp and Paper	CO_2 capture	Biomass	In addition to energy efficiency and fuel switching, long-term CO_2 uptake and sequestration leveraging forest resources is a key strength.	18
Cement	CO_2 capture	Hydrogen and Ammonia	Addressing both process- and energy-related emissions is essential, resulting in particularly high decarbonization challenges.	20
Automobiles	Energy storage Hydrogen	Biomass	Reducing emissions during vehicle operation requires not only electrification but also the simultaneous decarbonization of electricity and fuels.	22

Joint Research Structure

Introducing an ecosystem that integrates technology, economics, and policy into the market to foster a sound sustainability industry

This initiative is a joint research project positioned as one of several initiatives implemented under a comprehensive partnership between Hokkaido University and Mitsubishi UFJ Trust and Banking Corporation. By integrating the research and education functions of the university with the practical expertise of the financial institution, and by advancing human resource development, policy engagement, and social implementation in an integrated manner, the initiative aims to contribute to the realization of sustainable society through sustainable investment (including transition investment) and the fostering of a sustainability industry.



Overview of Transition Technologies and Sector Analysis by Eight Key Sectors

The eight key sectors analyzed in this report correspond to the sectors for which Japan's Ministry of Economy, Trade and Industry (METI) has formulated roadmaps for promoting transition finance.

Steel Sector Decarbonization by hydrogen utilization and electrification

Summary of Technology

Hydrogen and Ammonia

■ Hydrogen-based blast furnace ironmaking

This technology reduces CO_2 emissions by partially replacing coke used as a reducing agent in existing blast furnaces with hydrogen and increasing the hydrogen reduction ratio. Under the national COURSE50 project and its successor, Super COURSE50, hydrogen sourced both inside and outside the steelworks is utilized for reduction ironmaking, while CO_2 contained in exhaust gases generated within the steelworks is captured and reused. Through these measures, it is possible to reduce CO_2 emissions compared with conventional blast furnace operations. From a technical perspective, a key challenge is that hydrogen reduction is an endothermic reaction, making it difficult to maintain sufficiently high temperatures inside the blast furnace. With regard to commercialization, while the use of existing blast furnaces helps limit upfront capital investment, securing a stable supply of low-cost green hydrogen remains critical.

■ Hydrogen based direct reduction ironmaking

This technology produces reduced iron from iron ore using hydrogen in a direct reduction furnace. As no CO_2 is emitted during the reduction process and only water is generated, it is regarded as a key enabler of decarbonization. A major technical challenge is that the supply of high-grade iron ore suitable for direct reduction is limited. When lower-grade iron ore is used, issues arise with productivity, operational stability, and product quality. In addition, because hydrogen reduction is an endothermic reaction, an external heat supply is required to maintain the temperature inside the furnace. Toward commercialization, significant upfront capital investment is needed for new direct reduction furnaces, along with the securing of a stable and cost-effective supply of green hydrogen and renewable electricity.

Others

■ Large Electric Arc Furnaces (EAFs)

Electric arc furnaces (EAFs) melt steel scrap using electricity and have traditionally been used primarily to produce commodity-grade steel. However, the deployment of large EAFs enables production efficiencies comparable to blast furnaces as well as the manufacture of higher-grade steel products. Because EAFs do not involve an iron ore reduction process, they have the potential to significantly reduce CO_2 emissions compared with conventional blast furnace routes, depending on the power generation mix. The scale of emissions reduction is highly sensitive to the extent to which nuclear and renewable electricity can be utilized. Key technical challenges include the removal of impurities contained in steel scrap and the scaling up of EAF facilities. Toward commercialization, substantial upfront capital investment for large-scale equipment is required, along with the ability to secure large volumes of high-quality scrap.

Researcher Analysis

Structure and Key Features of the Steel Industry

The steel industry is a core materials industry that supplies steel products for a wide range of applications, including automobiles, construction, shipbuilding, and industrial machinery. Steel production is broadly divided into two main processes: the blast furnace route, which reduces iron ore using coke by removing oxygen from the ore, and the electric arc furnace (EAF) route, which uses steel scrap as feedstock and does not involve a reduction process. In Japan, 74% of crude steel production in fiscal year 2024 was produced via the blast furnace route, while 26% was produced using EAFs. Compared with the EAF route, the blast furnace route emits larger volumes of CO_2 during the reduction process. However, it offers advantages in terms of energy efficiency, productivity, and product quality. In particular, high strength steel and electrical steel sheets are widely used across industries—especially in the automotive sector—and play a key role in underpinning Japan's industrial competitiveness.

CO_2 Emissions from the Steel Industry

CO_2 emissions from the steel industry totaled 131 million tonnes in FY 2023, accounting for 13% of Japan's total emissions and representing the largest share—39%—within the industrial sector. More than 80% of these emissions originate from the blast furnace route, with large volumes of CO_2 generated during the reduction of iron ore using coke. At the same time, Japan's steel industry has achieved world leading energy efficiency in both blast furnace and EAF operations through the widespread adoption of energy saving technologies, including the utilization of waste heat and by product gases.

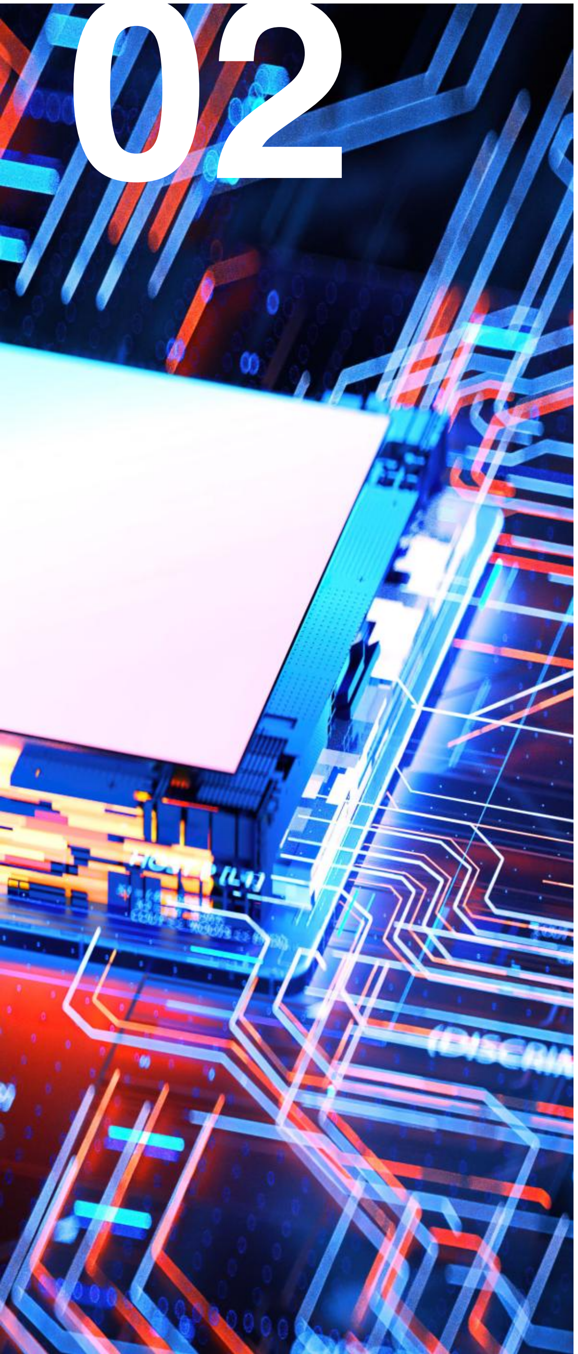
CO_2 Emission Reduction Targets and Actuals in the Steel Industry

The Japan Iron and Steel Federation has set CO_2 emissions reduction targets (Scope 1 and 2) for the steel industry, aiming for a 30% reduction by fiscal year 2030 compared with FY2013, as an interim target toward achieving carbon neutrality by FY2050. As of fiscal year 2024, actual emissions had been reduced by 25.8% compared with FY2013. However, CO_2 emissions per tonne of crude steel at the three major blast furnace steelmakers have remained broadly flat since FY2021, indicating that recent reductions have been driven largely by declines in crude steel production. Reflecting weakening domestic demand, production expansion in China and India, and ongoing decarbonization efforts, the number of blast furnaces in operation in Japan had fallen to fewer than 20 by the end of fiscal year 2024.

Carbon Neutrality Pathways and Key Technologies in the Steel Sector

To achieve carbon neutrality by FY2050, the steel industry needs to pursue a dual-track approach: advancing the development of hydrogen based direct reduction ironmaking as a long-term solution that eliminates CO_2 emissions, while simultaneously promoting near-term decarbonization technologies that leverage existing assets. Even with these technological pathways, a certain level of CO_2 emissions is unavoidable. Accordingly, the parallel deployment of CCUS (carbon capture, utilization, and storage) will also be required. In addition, the development of a stable and cost-effective supply of green hydrogen and electricity, as well as the formation of a green steel market, will be essential. The three technologies highlighted in this analysis are 1) large electric arc furnaces, 2) hydrogen-based blast furnace ironmaking, and 3) hydrogen based direct reduction ironmaking.

Chemical Sector Approaches toward the Energy Transition and Carbon Circulation



Summary of Technology

Hydrogen and Ammonia

■ **Energy Transition**

Looking at CO_2 emissions by sector in Japan, the chemical sector accounts for a relatively high share among all industrial sectors, following the steel and non-ferrous metals industries. In addition to energy-related emissions, the chemical industry also generates non-energy-related emissions arising from the use of feedstocks such as naphtha.

Rather than relying solely on electricity supplied from the power grid, the chemical industry operates captive power plants and makes extensive use of low-cost fuels such as coal.

There is a need to transition electricity and heat sources used in manufacturing processes from fossil fuels to decarbonized energy sources, including electricity generated from solar, wind, and nuclear power, as well as CO_2-free hydrogen and CO_2-free ammonia. In practice, while efforts are underway to commercialize innovative process technologies such as ammonia-heated naphtha crackers, attention is also focused on whether continued capital investment and the adoption of technologies aimed at higher efficiency and energy savings can deliver steady reductions in CO_2 emissions.

CO_2 Capture

■ **CCS · CCU**

CCS (Carbon dioxide Capture and Storage) is a technology that reduces CO_2 emissions released into the atmosphere by separating and capturing CO_2 emitted from sources such as power plants and chemical facilities, and injecting it deep underground for storage in stable geological formations. CCU (Carbon dioxide Capture, Utilization) is a technology that captures CO_2 and utilizes the separated and stored CO_2 as a resource.

In some existing chemical processes, the introduction of CO_2 capture and storage (CCS) technologies is being considered as a technically and economically viable means of addressing emissions from industrial processes. However, high capital and operating costs, as well as the availability of suitable storage sites, remain significant challenges. For CO_2 utilization technologies (CCU), improvements in energy efficiency and cost reduction are key issues, and at present, many CCU technologies have not yet reached the stage of commercial deployment.

Biomass

■ **Chemical Recycling**

Chemical recycling is a recycling technology that chemically breaks down used plastics and converts them back into their original chemical components for reuse. The Japanese chemical industry is focusing on the development of carbon recycling technologies, and efforts to transition toward business models based on a circular carbon economy are of significant social and economic importance, both in light of Japan’s limited domestic resources and from the perspective of climate change mitigation.

Although the EU has taken the lead in promoting policies toward a circular economy, legal frameworks are also being developed in Japan to establish a growth-oriented circular economy, in line with the GX strategy. Although chemical recycling technologies have advanced, key challenges remain, including the development of processing technologies capable of handling a wide variety of waste plastics such as mixed, composite, and contaminated materials, the scaling up of processing capacity, and the development of efficient processes.

Researcher Analysis

Industrial Structure and Key Characteristics of the Chemical Industry

The chemical industry supports a wide range of other industries, including the automotive and medical sectors, through a supply chain centered on naphtha, a byproduct of crude oil refining, providing products that range from commodity materials such as polyethylene to advanced materials such as those used in semiconductors. A key characteristic of the chemical industry is that multiple products are often produced simultaneously through co-production processes, meaning that changes in a single process can affect not only that product but also other downstream products.

Strategies of Japanese Companies Based on Technological Capabilities

Amid global restructuring in the chemical industry, the position of Japanese companies is undergoing significant change, with a shift away from scale-driven strategies.

Japanese chemical companies are increasingly focusing on functional chemicals—high value-added products designed for specific properties such as photosensitivity, ferromagnetic properties, high electrical conductivity, insulating properties, heat shielding properties, and catalytic functionality. Although individual market sizes are relatively small, Japan maintains a strong global presence, holding shares exceeding 60% in more than 70 materials, including in markets with a scale of approximately JPY 100 billion.

Building on decades of accumulated technological expertise and close collaboration with downstream industries, Japanese companies have developed strong competitive advantages in functional materials. As demand for such materials is expected to expand in the transition toward carbon neutrality, further strengthening technological capabilities and accelerating efforts to capture global markets will be essential.

To expand their presence in global markets, Japanese chemical companies are increasing their share in advanced and innovative materials. In addition to applications in mobility and electronics such as semiconductors, further expansion is expected in healthcare, medical and welfare equipment, and bio-related products, where demand is projected to grow through cross-industry and cross-material collaboration.

Structural Changes in Supply Chains

Amid moves across countries to build supply chains within regional economic blocs, there is a growing need to develop location strategies for advanced and supply chain critical technologies—such as semiconductor materials—from an economic security perspective. In particular, disruptions in supply from chemical manufacturers can have significant impacts on the broader economy and society. In recent years, even in the materials industry—where initiatives had previously lagged—venture companies centered on innovative digital technologies have begun to attract attention. As the development of such ventures progresses, corporate efforts to actively leverage them are also gaining momentum, and future trends are drawing increasing attention.

Power Sector Transition Scenarios for Balancing Stable Supply and Decarbonization

Summary of Technology

Hydrogen and Ammonia

■ Ammonia Co-firing and Mono-firing

Ammonia co-firing and mono-firing are power generation technologies in which part or all of the fuel used in coal-fired power plants is replaced with ammonia, which does not emit CO_2 during combustion. These technologies enable CO_2 emissions to be reduced while retaining existing thermal power generation assets. In addition, they can leverage existing ammonia-related infrastructure for production, transportation, and storage, which has been developed primarily for fertilizer use. Toward higher co-firing ratios and full ammonia firing, technical challenges remain, including increased NOx emissions in exhaust gases, potential declines in power generation efficiency due to changes in the radiative properties of combustion gases, and ignition instability. In addition, safety considerations are required given the toxicity of ammonia. The government aims to support technology development with the goal of achieving 50–60% ammonia co-firing in the late 2030s. For 20% ammonia co-firing, a large-scale demonstration has been conducted at JERA's Hekinan Thermal Power Station, and a technical pathway toward implementation is becoming clearer.

■ Hydrogen Co-firing and Mono-firing

Hydrogen co-firing and mono-firing are power generation technologies in which part or all of the fuel used in LNG-fired power plants is replaced with hydrogen, which does not emit CO_2 during combustion. By utilizing existing gas turbine power generation equipment, these technologies enable reductions in CO_2 emissions. At present, key challenges include the high production costs of green hydrogen, as well as the substantial investment requirements for building hydrogen supply chains—envisioning overseas production—together with the development of transportation and storage infrastructure. In addition, technical challenges remain in managing increases in NOx emissions and suppressing combustion instabilities, both of which arise from the high reactivity of hydrogen. The government has set a target of commercializing 30% hydrogen co-firing in gas-fired power generation in the late 2030s, while also aiming to reduce hydrogen supply costs to a level comparable to fossil fuels by 2050. In the private sector, JERA has indicated that it aims to begin commercial operation of hydrogen co-firing power generation from the early 2030s.

CO_2 Capture

■ CCUS

CCUS, which captures, utilizes, and stores CO_2 emitted from power plants, is positioned as an essential technology for simultaneously ensuring stable supply of energy and achieving decarbonization.

However, toward deployment, a number of challenges remain, including further reductions in the costs of CO_2 capture, the development of long-distance CO_2 transport networks and underground storage sites, improvements in conversion efficiency, and gaining acceptance from local communities. The government plans to promote the introduction of CCUS by considering support schemes to encourage investment and by advancing technology development aimed at cost reduction.

In parallel, Electric Power Development Co., Ltd. (J-POWER) and Kyushu Electric Power are planning an international collaboration project to capture CO_2 from flue gas at thermal power plants and store it offshore Malaysia. In addition, Hokkaido Electric Power, in cooperation with IHI, is advancing a demonstration project for large-scale CO_2 capture facilities for coal-fired power generation.

Researcher Analysis

Balancing Decarbonization and Stable Power Supply

Approximately 40% of Japan's CO_2 emissions consist of indirect emissions from electricity use, making the decarbonization of the power sector a policy priority of critical importance for advancing overall emissions reductions. At the same time, growing demands for energy security—driven by heightened geopolitical and natural disaster risks—as well as rising electricity demand associated with the expansion of data center construction are making decarbonization efforts in the power sector increasingly challenging. With fossil fuel-based generation still accounting for more than 60% of total electricity output in Japan, substantial investment will be required to advance decarbonization through a transformation of the power mix. This also makes the development of infrastructure—such as transmission and distribution networks and energy storage systems—essential to support the large-scale integration of renewable energy. Under these constraints, in order to balance a stable power supply with decarbonization, the power industry will need to prioritize near-term efforts that leverage existing technologies, including the expansion of renewable energy in coexistence with local communities and the utilization of nuclear power based on assured safety and public understanding.

Toward the Practical Deployment of Transition Technologies

In the power sector transition roadmap, a range of technologies are currently positioned as promising options for achieving long-term decarbonization. These include hydrogen, ammonia, and biomass co-firing and mono-firing; the decarbonization of thermal power generation through the use of CCUS; next-generation solar cells; floating offshore wind power; next-generation geothermal power generation; existing nuclear power plants; and next-generation advanced nuclear reactors. For the social deployment of these transition technologies, companies need to strengthen their efforts across a range of factors. These include not only the technical feasibility and maturity of the technologies themselves, but also the long-term stability of fuel supply (in terms of price, quality, and volume), the certainty of power offtake agreements, plans for equipment maintenance and refurbishment, transparency in emissions reduction effects supported by third-party certification, potential risks from future changes in environmental regulations, and the status of dialogue with local communities. Addressing these issues is essential to enhancing the credibility of long-term business plans.

Aligning Power-Sector Strategies with National Energy Policy

The Seventh Strategic Energy Plan, released in February 2025, sets out a policy to fundamentally strengthen the supply capacity of decarbonized power sources by enhancing the predictability of investment returns. In particular, long-term policy support is expected for technology areas in which Japan can demonstrate international competitiveness, such as next-generation solar cells (including perovskite solar cells). The government has made clear its position that decarbonization in the power sector should be pursued in an integrated manner with national energy policy. For power companies in Japan, aligning their business strategies and decarbonization plans more closely with national energy policy is increasingly seen as essential to enhancing the credibility of their business plans and the feasibility of their decarbonization strategies.

Gas Sector Advancing Decarbonization by Leveraging Existing Infrastructure

Summary of Technology

Methanation

■ Sabatier Methanation

Sabatier methanation is a technology that produces synthetic methane (CH_4) by reacting CO_2 with hydrogen. With a high level of technological maturity, it offers the advantage of enabling decarbonization by leveraging existing city gas infrastructure. In addition, it is regarded as one of the most promising utilization pathways for captured CO_2. While technical challenges remain—such as reduced energy efficiency due to the combination of water electrolysis and methanation, as well as difficulties in thermal management and catalyst degradation caused by the highly exothermic reaction—the large-scale deployment of methanation also requires substantial volumes of hydrogen, making the reduction of future green hydrogen procurement costs another critical issue. The government roadmap aims to introduce methanation at a commercial scale in the 2030s. At present, INPEX and Osaka Gas are collaborating on demonstration projects involving the injection of synthetic methane into gas pipelines using large-scale methanation systems, while also conducting business viability assessments for future scale-up.

■ Biomethanation

A biomethanation technology produces biomethane by harnessing a natural process in which microorganisms convert CO_2 and hydrogen into methane. It can be used with existing gas infrastructure and, unlike the Sabatier reaction, operates at ambient temperature and low pressure, reducing equipment degradation and safety-related costs. However, as a biological process, scaling up and increasing reaction speed remain challenges for commercialization. In addition, lowering the future cost of green hydrogen will be critical. The government aims to demonstrate operation at a commercial-scale level of at least 600 Nm^3/day by 2030, along with the use of the produced gas in existing city gas systems, and pilot demonstrations have already been conducted.

Hydrogen and Ammonia

■ Utilization of Hydrogen

Hydrogen production and its direct utilization—such as through water electrolysis, overseas transportation, the development of domestic hydrogen supply networks, and applications in industrial furnaces and fuel cells—are positioned in the government's technology roadmap as key initiatives for decarbonizing the gas sector. While hydrogen offers advantages such as high energy efficiency and the absence of CO_2 emissions during combustion, a major challenge lies in the substantial societal costs required for scaling up green hydrogen procurement, developing supply infrastructure, and converting end-user combustion equipment. In addition to providing support for the development of hydrogen supply chains—including pipelines and storage tanks—the government is also establishing support schemes based on the price gap between fossil fuels and hydrogen. Through these measures, it aims to promote the long-term utilization of hydrogen as part of its decarbonization efforts.

Researcher Analysis

Technical and Economic Challenges of Gas Sector Decarbonization

Approximately 60% of energy consumption in Japan’s residential and industrial sectors is attributable to heat demand, with gas serving as a core energy source that underpins social infrastructure. At the same time, CO_2 emissions originating from city gas account for around 10% of total emissions, making the gas sector a critical area that must be addressed in order to achieve Japan’s decarbonization goals. More than 80% of lifecycle emissions from city gas arise at the combustion stage. In addition, there are industrial sectors—particularly the steel and chemical sectors—that require high-temperature heat and for which electrification remains difficult. As a result, over the long term, it will be necessary to decarbonize gas itself through fuel switching to hydrogen, synthetic methane, and other alternatives. Given the technical hurdles associated with fuel switching and the substantial societal costs involved, including infrastructure development, the decarbonization of the gas sector is regarded as more challenging than that of the power sector.

Establishing Decarbonization Technologies and Achieving Cost Reductions over the Long Term

For the decarbonization of the gas sector, technology development aimed at scaling up synthetic methane, hydrogen, and green LPG will be particularly important. To advance the social deployment of these technologies, enhancing the credibility of future cash flow projections will be essential. This will require careful consideration of factors such as the maturity of energy technologies, price stability in the procurement of inputs including renewable electricity and CO_2, the certainty of gas demand and sales contracts, transparency regarding decarbonization impacts, and the sustainability of policy support. Japan’s Seventh Strategic Energy Plan positions the transition from LNG and natural gas to synthetic methane as a key measure for decarbonizing the gas sector, and sets targets such as pipeline injection of around 1% by fiscal year 2030, as well as the establishment of enabling technologies that would allow the large-scale deployment of methanation. The clarity of the policy support framework is viewed as a favorable factor for advancing the social deployment of these technologies.

Near Term Measures for Emissions Reductions

Decarbonizing gas itself will require time. In the meantime, steady emissions reductions can be achieved by promoting energy efficiency and efficiency improvements in heat use, as well as fuel switching from coal and oil to LNG, which emits relatively less CO_2 during combustion. Concrete measures include the effective use of cryogenic cold energy from LNG transport, reductions in fuel consumption through high-efficiency burners, and improved heat utilization via distributed energy systems such as cogeneration and fuel cells. Advancing low-carbon measures in this way can also help reduce the social costs associated with the future deployment of innovative decarbonization technologies.

Oil Sector Introduction of Decarbonized fuels and Assessment of Biofuel Supply Chains

Summary of Technology

Biomass

■Biofuels

Biofuels are produced from feedstocks such as plants, used cooking oil, and waste materials. Because these feedstocks absorb CO_2 from the atmosphere during their growth or biological processes, biofuels are regarded as carbon neutral fuels. Examples of biofuels currently used in Japan include bioethanol, which serves as a gasoline substitute and is produced mainly from corn and sugarcane, with most of the supply imported. By contrast, biodiesel fuel used as a substitute for diesel is promoted primarily through locally based initiatives, in which used cooking oil and other feedstocks are collected and refined by local governments and used as fuel for municipal buses and waste collection vehicles. An examination of CO_2 emissions by sector in Japan shows that the transport sector accounts for a high share, following the industrial sector. Accordingly, it is important to expand the introduction of biofuels and to achieve carbon neutrality in liquid fuels through the use of biofuels and synthetic fuels.

Biomass/ Hydrogen and Ammonia

■SAF

In the international aviation sector, a stringent target was adopted at the ICAO Assembly in October 2022 to limit CO_2 emissions from 2024 onward to no more than 85% of 2019 levels. Against the backdrop of international regulations aimed at reducing CO_2 emissions in the aviation sector, demand is increasing for sustainable aviation fuel (SAF) as an alternative to conventional jet fuel. The “Clean Skies for Tomorrow Coalition,” an initiative of the World Economic Forum aimed at accelerating the adoption of SAF, has declared a target to increase the share of SAF in total aviation fuel use worldwide to 10% by 2030. The oneworld airline alliance has announced a collective commitment under which each member airline aims to replace 10% of the fuel it uses with SAF. In addition, alcohol to jet (ATJ) technology enables bioethanol to be converted into jet fuel, allowing it to be used as a SAF feedstock.

Others

■Natural Gas and LNG (Low-Carbon Energy)

Natural gas is currently used mainly as fuel for thermal power generation and as city gas for households, and is also utilized as a feedstock for the production of hydrogen, which is attracting attention as a next generation energy source. Compared with coal and oil, natural gas has the feature of emitting lower levels of environmental pollutants, and is therefore gaining attention as an energy resource toward the realization of carbon neutrality. The global market for LNG is on an upward trajectory, and developments in LNG production projects are a key factor in assessing the future outlook for the LNG market. While a number of large scale projects are planned, rising costs and interest rates in recent years, together with difficulties in securing labor and materials, have raised concerns over whether these projects can be launched smoothly.

Researcher Analysis

Challenges Facing the Oil Sector

Oil remains an indispensable energy source for daily life and economic activity, and, given its portability and operational flexibility, serves as a reliable energy source in times of disaster. Against the backdrop of rising geopolitical risks, including the invasion of Ukraine and conflicts in the Middle East, the oil industry faces the difficult challenge of balancing decarbonization with the need to ensure energy security. Japan's energy policy positions natural gas and LNG as "practical transitional fuels." At the same time, as they are still fossil fuels, it is necessary over the medium to long term to steadily advance the transition toward a greener and more sustainable energy system.

Decarbonization of Oil Refining and Fuel Transition

Achieving carbon neutrality in the oil sector requires (1) the decarbonization of crude oil processing, and (2) the decarbonization of end-use combustion through a shift to decarbonized fuels.

(1) With regard to crude oil processing, energy efficiency improvements have already been implemented extensively, raising the question of how much additional reduction potential remains. While CO_2 capture technologies are advancing, significant challenges remain, including energy consumption during the capture process, the safety of long-term storage, and the availability of suitable storage sites.

(2) A shift to low and decarbonized fuels mainly involves the following options. Hydrogen and ammonia are expected to play an important role; however, their social deployment will require the use of overseas hydrogen sources to ensure stable and large scale supply, the establishment of domestic hydrogen production infrastructure, and the expansion of demand side utilization. In addition, the use of carbon neutral biofuels derived from plants and waste materials is expanding globally, including bioethanol as a gasoline substitute and biodiesel as a diesel substitute.

Development of Fuel Supply Systems

At present, the introduction of sustainable aviation fuel (SAF) is required to achieve the ICAO framework for reducing CO_2 emissions. Against this backdrop, efforts to develop production technologies and to establish SAF supply chains are being actively pursued in many countries. In January 2026, the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure, Transport and Tourism announced a policy under which users would bear a portion of the costs incurred by airlines for the purchase of SAF. While the specific mechanism will be examined going forward, this policy development is expected to support capital investment by oil refiners aimed at expanding SAF supply capacity in response to growing demand. Efforts to optimize fuel supply functions—such as restructuring refineries and service stations—can contribute to decarbonization, while also requiring due consideration for impacts on regional economies and employment as part of a just transition.

Pulp and Paper Sector Decarbonization of Manufacturing Processes and Utilization of Forest

Summary of Technology

CO_2 Capture

■ **CO_2 Uptake from the Atmosphere (Fast-Growing Trees and Elite Trees)**

In the pulp and paper industry, which owns forest resources used as raw materials, efforts are underway to capture and sequester atmospheric CO_2 through the development and afforestation of fast growing tree species, such as fast growing trees and elite trees. By increasing CO_2 uptake per unit of forest area—by a factor of 1.5 or more—these initiatives are expected to contribute to the achievement of carbon neutrality across society as a whole. While direct CO_2 sequestration effects can be expected, the expansion of specific tree species may increase vulnerability to pests and climate change and may also pose potential risks to water resources and ecosystems. At the same time, the creation of environmental value through CO_2 uptake and sequestration, together with the contribution to the stable securing of raw material supply over the long term, can be regarded as a strength that leverages the business characteristics of the pulp and paper industry.

Others

■ **Kiln Electrification**

In pulp production, the calcination process is a key process in which limestone is heated to temperatures of approximately 900–1,000°C. By replacing the heat source of kilns used in this process from fuel oil or natural gas with electricity, it is possible to reduce emissions. While this approach enables the reduction of combustion related emissions, it does not reduce process related emissions arising from the chemical reaction of limestone. Electrifying high temperature processes presents a high level of technical difficulty and requires compatibility with existing production processes. As a result, technical challenges remain at the current stage. In addition, the availability of sufficient volumes of renewable electricity is a prerequisite, and the development of future power procurement frameworks and the stabilization of electricity costs also remain challenges. At the same time, the potential for substantial emissions reductions represents a key strength.

■ **Electrification of Paper Machine Dryers**

In the papermaking process, drying equipment is used to remove moisture from pulp in the production of paper. Since pulp entering the drying stage contains approximately 99% moisture, water must be removed through mechanical dewatering and the application of heat. Key challenges include the need to secure large volumes of renewable electricity and the relatively low level of technological maturity of electric drying systems, particularly with respect to integration into existing paper machines and potential impacts on product quality. While the potential for emissions reductions is significant, further reductions can be achieved by combining the electrification of drying equipment with process level efficiency improvements. In the drying stage, such complementary technologies include dry sheet forming, which reduces energy consumption by using air instead of water, and high efficiency press technologies that lower heat demand during drying through the application of heat assisted pressing.

Researcher Analysis

The Pulp and Paper Industry's Role in Net Zero

The pulp and paper industry is a foundational industry that supplies essential everyday products—such as newspapers, cardboard, and tissue paper—at low cost and in a stable manner, using raw materials derived from forest resources. Through high levels of waste paper collection and recycling, the industry also contributes to the development of a circular economy. By contrast, the pulp and paper industry requires substantial amounts of heat and electricity in its manufacturing processes and is the fourth largest source of CO_2 emissions among Japan's manufacturing sectors. As a result, the industry is expected to play an important role in achieving Japan's net zero target through emissions reductions. Compared with the cement industry—where process related emissions arising from limestone decomposition are unavoidable—the pulp and paper industry has relatively greater technological flexibility for decarbonization. However, unlike Europe and North America, where abundant forest resources enable the low cost use of biomass fuels, Japan faces different resource constraints, making it necessary to pursue decarbonization approaches tailored to domestic conditions.

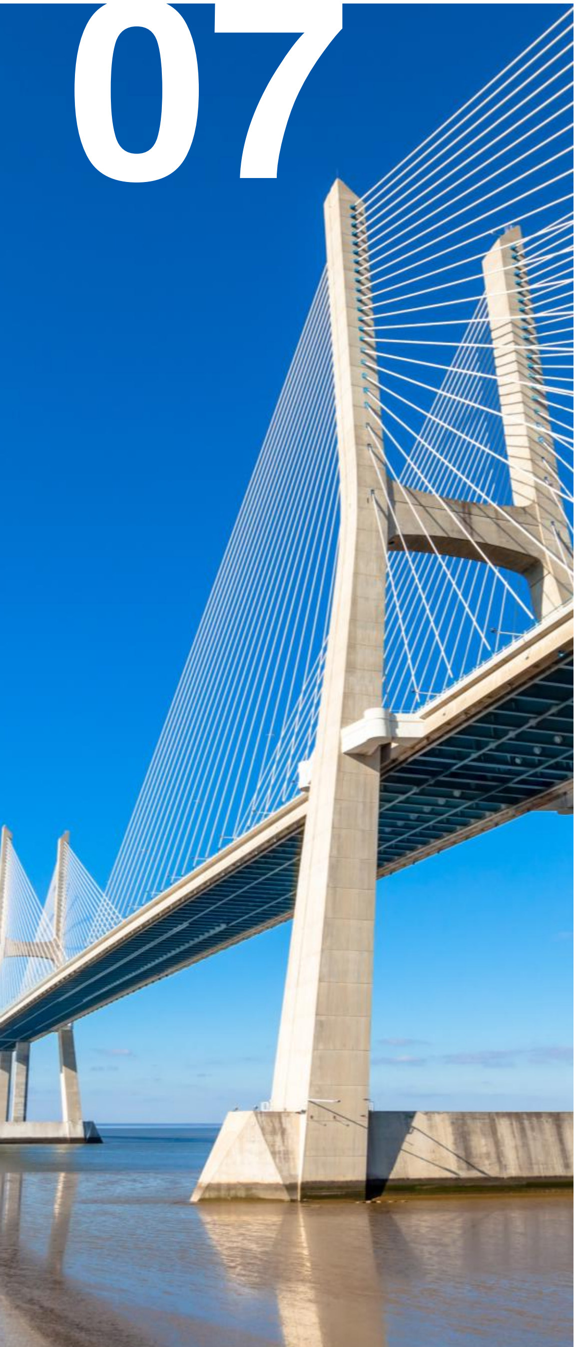
Advancing Energy Efficiency and Fuel Switching

The Japan Paper Association identifies the introduction of energy efficient equipment and technologies, as well as increasing the share of renewable energy—including hydropower, solar, wind, geothermal, and biomass—as key measures for decarbonization. In practice, Oji Holdings, a major industry player, plans to continue reducing its energy intensity by more than 1.0% on a five year average basis, while increasing the share of renewable energy use to over 60%. Through these measures, the company aims to decommission eight coal fired boilers by fiscal year 2030, out of a total of 16 coal fired boilers operating in Japan as of fiscal year 2018. The government's technology roadmap identifies several measures as important initiatives, including energy recovery from waste, the deployment of cogeneration systems, and the introduction of energy management systems. In addition, efforts are also underway to reduce emissions associated with the transportation of raw materials.

Innovative Technologies and Long-Term Industry-Based Initiatives

The pulp and paper industry's vision for addressing climate change sets out a long-term policy to promote the commercialization of innovative technologies related to papermaking processes. These include the electrification of paper machine dryers and kilns, improvements in drying efficiency through reduced moisture content at the press stage, the development of high-efficiency pulp production methods, and the development of energy-efficient black liquor concentration equipment. For these technologies to be successfully deployed at scale, greater clarity is required regarding operational risks associated with integration into existing production lines, potential impacts on product quality such as strength, the costs of equipment modifications, and the long term burden of maintenance and repairs. In the pulp and paper industry, expanding the uptake and sequestration of CO_2 through the cultivation and management of forest resources used as raw materials also represents an important initiative. Specifically, Oji Holdings plans to capture and sequester, through its forest assets, an amount of CO_2 equivalent to 50% of its emissions in fiscal year 2018 by fiscal year 2040. In addition, the production of biochemical products and biofuels from raw pulp represents a strategic approach that leverages the business characteristics of the pulp and paper industry to contribute to broader decarbonization efforts.

Cement Sector Addressing Decarbonization from a Long-Term Perspective



Summary of Technology

CO_2 Capture

■ Utilization of Captured CO_2 through Carbonation (CCUS)

CO_2 generated from rotary kilns during high-temperature calcination of cement raw materials is captured and used to produce carbonates, which are then processed into synthetic limestone. This synthetic limestone can be reused as a raw material. This approach is expected to reduce process-related CO_2 emissions, which account for approximately 60% of total emissions in the cement sector. Meanwhile, toward commercial deployment, long-term efforts are required to address technical challenges, including improving the stability and efficiency of CO_2 capture and carbonate production processes, ensuring the quality of cement products, and integrating the processes with existing facilities and enhancing equipment durability. With support from national policy initiatives, Sumitomo Osaka Cement and Taisei Corporation are currently working on the development of a CO_2-capturing cement manufacturing process using carbonation technology.

Hydrogen and Ammonia

■ Use of Hydrogen and ammonia

By using hydrogen and ammonia as fuels in rotary kilns during the raw material calcination process, energy-related CO_2 emissions can be reduced. These fuels enable high-temperature combustion and are highly compatible with existing facilities. According to the Cement Association's long-term vision, the co-firing ratio of zero-emission fuels such as hydrogen, ammonia, and synthetic methane is targeted to increase to 50% by 2050. Meanwhile, ensuring a stable supply of fuels and controlling costs remain major challenges, and achieving commercialization will require long-term contracting for hydrogen and ammonia as well as the development of supply chains. UBE Mitsubishi Cement is conducting a commercial-scale demonstration at its Ube plant, using ammonia as a source of thermal energy.

Others

■ Reduction of the Clinker Ratio

To reduce the use of clinker, a cement raw material that emits large amounts of CO_2 during production, gypsum, blast furnace slag, and other materials are used as blending components. The cement industry's long-term vision aims to reduce the clinker ratio from 0.85 to 0.825 by 2050. While the technology is mature and does not require large-scale facility modifications, increasing the use of blending materials poses risks to product quality and compliance with cement standards, and ensuring a stable supply of raw materials remains a challenge. In addition, maintaining current unit usage levels of waste materials is also required. The Japan Cement Association is organizing demonstration data for a revision of JIS to raise the allowable share of minor constituents in ordinary Portland cement from 5% to 10%.

Researcher Analysis

Decarbonization Challenges in the Cement Industry

Cement is an essential construction material that supports social infrastructure. In Japan, where investments in disaster prevention and the replacement of aging infrastructure are expected, ensuring the quality and stable supply of cement products will remain indispensable. The cement industry also contributes to the circular economy by accepting and utilizing waste materials. At the same time, the sector is a high-emitting one, accounting for approximately 4% of Japan's total greenhouse gas emissions. In addition to unavoidable process-related CO_2 emissions arising from the decarbonation reaction of limestone, which is used as a raw material, the industry also generates significant energy-related CO_2 emissions due to its reliance on fossil fuels for high-temperature calcination at around 1,450°C during the manufacturing process. In the cement sector, emissions arise from both manufacturing processes (accounting for roughly 60%) and energy use (around 40%), and both must be addressed, making decarbonization more challenging than in many other sectors.

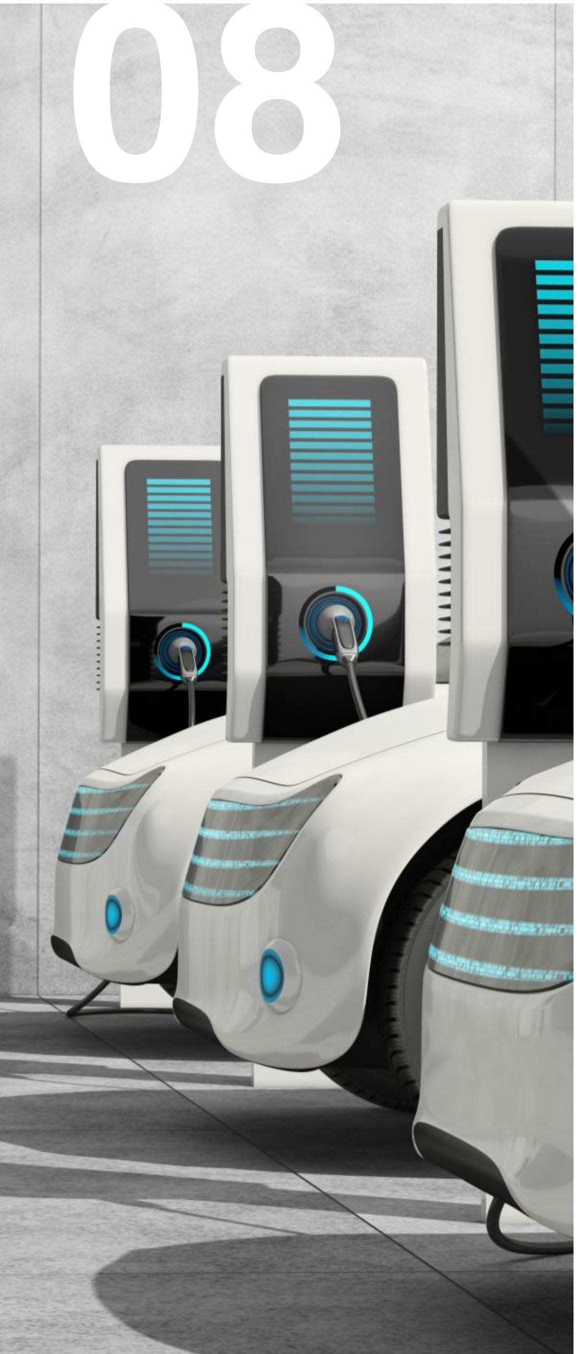
Near-term Measures for Emissions Reduction

For near-term emissions reductions, the continued deployment of energy-efficient equipment and fuel switching to renewable energy, natural gas, and biomass will be key. In addition, the use of waste as fuels and raw materials, as well as lowering combustion temperatures through the use of mineralizers, is expected to deliver early emissions reduction benefits. Sumitomo Osaka Cement has announced plans to reduce energy-related CO_2 emissions intensity by 30% from fiscal 2005 levels by fiscal 2030 through improving fossil fuel substitution rates, enhancing thermal efficiency, and reducing electricity consumption. In assessing these measures, it is necessary to consider operating cost competitiveness while also taking into account operational stability, potential impacts on product quality, and prospects for meeting safety regulations and obtaining relevant certifications.

The Need for Long-Term Development of Innovative Technologies

The development of decarbonization technologies in the cement sector is expected to require a long time and will depend on progress in broader social systems in other sectors, including the deployment of decarbonized power sources, hydrogen supply infrastructure, and CCUS. In addition, Japan faces country-specific conditions, such as frequent natural disasters that necessitate high-strength construction materials. While companies are expected to continue reducing clinker ratios and promote the co-firing of zero-emission fuels such as hydrogen, ammonia, and synthetic methane to cut energy-related emissions, it is widely considered difficult to eliminate process-related emissions entirely. As a result, continued efforts to develop CO_2 capture technologies for cement production processes and to advance the future commercialization of CCUS will be indispensable for decarbonizing the industry. The government will also need to maintain ongoing support for the development of such innovative technologies.

Automotive Sector Future Technology Pathways



Summary of Technology

Energy Storage

■ High-performance batteries, including all-solid-state batteries

All-solid-state batteries are next-generation batteries that replace the organic liquid electrolytes used in conventional lithium-ion batteries with solid electrolytes. They are expected to offer superior safety, driving range, and durability compared with current lithium-ion batteries, and are regarded as a key technology for accelerating the adoption of battery electric vehicles (BEVs). The non-frammable nature of solid electrolytes can reduce the risk of thermal runaway and suppress undesired side reactions. Moreover, lithium metal anodes offer the potential for substantially higher energy density. CO_2 emissions may also be reduced through improved energy efficiency resulting from lighter battery packs. Major technical challenges include reducing interfacial resistance at solid electrolyte/electrode interfaces, stabilizing lithium metal anodes, and improving the ionic conductivity of solid electrolytes to enable fast charging. Furthermore, commercialization will require reductions in materials and manufacturing costs, including through economies of scale, as well as the expansion of charging infrastructure.

■ Fuel Cell Vehicles

Fuel cell vehicles (FCVs) generate electricity from hydrogen via electrochemical reactions and use this electricity to drive an electric motor. Hydrogen stored in onboard high-pressure tanks reacts with oxygen in the air within a fuel cell stack to generate electricity. Although fuel cell passenger cars and buses are already commercially available, widespread adoption has been limited by high vehicle costs and the insufficient availability of hydrogen refueling stations. When powered by green hydrogen, FCVs produce zero CO_2 emissions during operation and emit only water. The high energy density of hydrogen and short refueling time of FCVs make them particularly suitable for long-distance and heavy-duty transport, including commercial vehicles. Key technical challenges in reducing vehicle costs include lowering the costs of fuel cell stacks that use expensive platinum catalysts and high-pressure hydrogen tanks made from carbon fiber–reinforced plastics. Wider commercialization will also require low-cost hydrogen supply, and the expansion of hydrogen refueling stations. Accordingly FCV adoption is expected to progress first in the commercial vehicle sector.

Biomass

■ Biofuels, including E10 and E20, and Synthetic Fuels

E10 and E20 are fuels in which bioethanol is blended with gasoline at ratios of 10% and 20%, respectively, while e fuels are decarbonized fuels produced by synthesizing hydrogen and CO_2. Both can utilize existing internal combustion engines and fuel infrastructure. CO_2 emissions can be reduced with E10 and E20, while e fuels offer the potential for substantial emissions reductions. Bioethanol production technologies are well established, and bioethanol is already blended into gasoline and used in conventional vehicles in many countries. From a technical perspective, E10 can be applied to existing vehicles in Japan, whereas E20 requires measures to address risks such as component degradation caused by ethanol's hygroscopic and corrosive properties. For e fuels, adaptation to changes in fuel properties resulting from the synthesis process is required. For commercialization, securing agricultural land for biofuel feedstock production, as well as developing supply systems for large volumes of green hydrogen and electricity and reducing costs for synthetic fuels, will be required.

Researcher Analysis

Structure and Current Status of Japan's Automotive Industry

Japan's automotive industry is a core sector of the national economy. It encompasses automobile manufacturers, parts suppliers, and sales and service companies, and supports a broad range of related industries, including steel, non-ferrous metals, petrochemicals, and semiconductors. Automobiles generate the largest trade surplus among individual product categories and underpin the country's industrial competitiveness. In recent years, the industry has entered a period of structural transformation driven by decarbonization and technological innovation, particularly electrification and autonomous driving. As of the end of 2024, Japan had 78.7 million four-wheeled vehicles in operation. In 2024, domestic vehicle production and sales amounted to 8.2 million and 4.4 million units, respectively. The average service life for passenger cars was 13.3 years. Although BEVs and FCEVs together represented only about 3% of annual passenger car sales, electrified vehicles, including HVs, accounted for more than 60%.

CO_2 Reduction Targets and Progress in the Automotive Industry

JAMA has set a policy goal of achieving carbon neutrality across the entire vehicle life cycle by fiscal year 2050. Many automobile manufacturers have adopted similar targets, including carbon neutrality across Scope 1, Scope 2, and Scope 3 emissions by 2050, as well as interim targets. Under Japan's Plan for Global Warming Countermeasures, the transport sector is required to reduce CO_2 emissions by 35% by fiscal year 2030 and by 64–82% by fiscal year 2040, compared with fiscal year 2013 levels. In fiscal year 2024, emissions totaled 180 million tonnes, representing a reduction of only 16%, indicating that emissions reductions will need to accelerate to meet these targets.

CO_2 Emissions from the Automotive Industry

Automobiles emit substantially more CO_2 during the use phase than during manufacturing. In fiscal year 2024, automobiles accounted for 160 million tonnes of the transport sector's total CO2 emissions of 187 million tonnes, corresponding to approximately 16% of Japan's total emissions. For the eight major Japanese automobile manufacturers, more than 99% of total emissions are classified as Scope 3 emissions. Within these Scope 3 emissions, product use, such as vehicle operation (Category 11), accounts for 81%, while purchased goods and services (Category 1) account for 17%. According to life cycle assessment (LCA) analyses by the Japan Automobile Manufacturers Association (JAMA), under Japan's current power generation mix, which has a relatively low share of renewable energy, the difference in CO_2 emissions among hybrid vehicles (HVs), battery electric vehicles (BEVs), and fuel cell electric vehicles (FCEVs) remain limited. Therefore, achieving carbon neutrality in the automotive industry requires not only vehicle electrification but also the simultaneous decarbonization of the power supply.

Carbon Neutrality Pathways and Key Technologies in the Automotive Sector

Japanese automobile manufacturers are pursuing carbon neutrality through a "multi-pathway strategy," which offers a range of vehicle powertrains tailored to regional energy characteristics. This strategy encompasses both electrification, through the use of batteries and hydrogen, and improvements in the efficiency of internal combustion engines through the use of biofuels and synthetic fuels. Within this framework, particular attention is being paid to three key technologies. First, all-solid-state batteries for battery electric vehicles (BEVs) are expected to enhance safety, driving range, and durability. Second, fuel cell vehicles (FCVs), primarily for commercial applications, which use hydrogen as an energy carrier. The third is the wider adoption of vehicles compatible with biofuel-blended gasoline, such as E10 and E20, as well as synthetic fuels.

In Closing

This report has examined key decarbonization technologies in the transition phase ("transition technologies")—including CO_2 capture, hydrogen and ammonia, methanation, biomass, and energy storage—in the context of achieving net zero by 2050. It has organized the technical challenges associated with their commercialization and considered the implications for financial institutions engaging in these technologies and related sectors.

Transition technologies vary significantly in technological maturity, cost structures, institutional prerequisites, and levels of uncertainty. As reaffirmed through this study, assessments based solely on short-term economic rationality are insufficient; instead, evaluations must reflect the characteristics of each technology and its stage of deployment.

From a medium- to long-term perspective, however, these technologies may contribute to emissions reduction, industrial transformation, and energy supply, and—under certain conditions—offer new business opportunities and growth potential. Financial institutions should therefore assess risks and opportunities in an integrated manner and adopt a phased approach to financing and engagement.

This report has also benefited from combining academic expertise from Hokkaido University with practical perspectives from financial institutions, enhancing understanding of technological feasibility, constraints, and future potential. Such collaboration provides a valuable foundation for more structured evaluation and practical application.

Ongoing dialogue with a wide range of stakeholders—including policymakers, investee companies, and institutional investors—will be essential to bridging differences in expectations across finance, technology, and policy. As institutional frameworks continue to evolve, shared understanding and phased, realistic transition pathways will remain critical.

While advancing decarbonization requires simultaneously addressing energy security and the continuity of economic activity, collaboration among academia, financial institutions, and policymakers will enable more practical approaches to transition.

This research is expected to serve not only to deepen understanding of decarbonization technologies but also as a common foundation for investment decisions, engagement, and policy discussion. Through continued dialogue and collaboration, it aims to contribute to sustainable economic development while delivering value to beneficiaries.

Profiles of Joint Research Members

Profiles of Joint Research Members

Vice President, Dean of the Faculty of Engineering, and Director of the Green Transformation Innovation Center, Hokkaido University

Professor
Hiroki Habazaki

Division of Environmental Engineering, Faculty of Engineering, Deputy Director, Green Transformation Innovation Center, Advisor to the President, Executive Director, Carbon Neutrality Division, Institute for the Advancement of Sustainability, Hokkaido University

Professor Kazuei Ishii

Division of Applied Chemistry, Faculty of Engineering, Hokkaido University

Professor
Ryuji Kikuchi

Graduate school of engineering, Hokkaido University

Professor
Ryoma Kitagaki

Research Group of Forest Science, Research Faculty of Agriculture, Hokkaido University

Lecturer
Hideyuki Saito

Faculty of Economics and Business, Hokkaido University

Associate Professor
Ryuta Sakemoto

Division of Applied Chemistry, Graduate School of Engineering, Hokkaido University

Associate Professor
Shohei Tada

Division of Mechanical and Aerospace Engineering, Faculty of Engeering, Hokkaido University

Professor
Yutaka Tabe

Faculty of Engineering, Hokkaido University

Associate Professor
Naoto Tsubouchi

Center for Advanced Research of Energy & Materials, Faculty of Engineering, Hokkaido University

Professor
Takahiro Nomura

Faculty of Environmental Earth Science, Hokkaido University

Professor
Shinichiro Noro

Faculty of Engineering, Hokkaido University

Professor
Nozomu Hashimoto

Department of Chemistry, Faculty of Science, Hokkaido University

Professor
Masaki Matsui

Division of Applied Chemistry, Faculty of Engineering, Hokkaido University

Professor
Kenichiro Matsumoto

Sustainable Investment Division Mitsubishi UFJ Trust and Banking Corporation

Executive Researcher
Katsuyuki Nakai (bottom center)

Senior Researcher
Masaki Masuda (bottom left)

Ayano Murakoshi
(top right)

Senior Researcher
Toshihiko Nito (bottom right)

Hiroto Kimura
(top center)

Shusui Ishizuka (top left)

Important notice

- The contents of this document were prepared for the purpose of providing general information to the customer. It is not a solicitation or an offer to buy or sell any securities or financial products.
- This material has been prepared based on certain assumptions and on information obtained from publicly available sources, including integrated reports, earnings presentation materials, and other disclosures published by government ministries and agencies, governmental and quasi-governmental bodies, national research institutes, industry associations, and corporations. Certain portions of this material incorporate the Company's own compilation, analysis, and estimates. While the information contained herein is based on sources that the Company believes to be reliable as of the date of preparation, the Company does not represent or warrant, expressly or impliedly, the accuracy, completeness, currency, usefulness, feasibility of the realization of any forward-looking statements, or fitness for any particular purpose of such information.
- Any views expressed in this document are assumed to be correct at the time of publishing and are subject to change without notice, due to factors including, but not limited to, changes in the economic environment, currency fluctuations, and changes to pension and taxation systems.
- The information and figures provided in this document are analyses and simulations based on past data and assumed values, and do not indicate nor guarantee future performance. Analysis methods, models and simulation models are not necessarily perfect and may be substantially affected by assumed values. Please note that contents and/or information may change without notice after the publishing of this document. (Assumed values include, but are not limited to, analysis methods, models, simulations, and the information laid out in this document.)
- In no event shall Mitsubishi UFJ Trust and Banking be liable for any claims, penalties, losses, damages, or expenses, arising out of in connection with, or as a result of the use of this document by the intended recipient or any third party, including, but not limited to, director or indirect loss, consequential loss or damage. Furthermore, it should be understood that any right to claim damages or losses from intended recipients or any third party against Mitsubishi UFJ Trust and Banking shall be expressly waived.
-

Mitsubishi UFJ Trust and Banking

Tokyo Shiodome Building, 1-9-1,
Higashi-Shinbashi, Minato-ku, Tokyo
105-7322

www.tr.mufg.jp/mufgam-su/