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To Overcome the Constraints Facing Japanese Industry

Overcoming Energy Constraints to Achieve Both Economic Growth and Decarbonization

May, 2025

Industry Research Department
Mizuho Bank

Report worldview: To achieve transformation for Japan’s industry tomorrow, we must overcome the constraints we face

Japan’s industry today

A manufacturing powerhouse, led by the automotive industry

Japan’s industry tomorrow

Captivating the world with a hybrid of products and experiences

Manufacturing industry

<High quality & high functionality product groups> (today)

- Industries with a high level of competitiveness (products, machinery, components, materials) are concentrated in specific areas, consistently creating high quality & high functionality products
- Leading the world with many resource-saving & energy-saving, low carbon products essential for SX/GX

<Exerting presence in high added value fields> (tomorrow)

- Continue to fend off competition from overseas companies in high functionality products, maintaining and increasing global share
- For generic products, where Japanese companies tend to struggle with scale, achieve overall optimization through collaboration or integration with others

Non-manufacturing industry

<Provision of high-level services> (today)

- Providing world-class services in terms of quality, speed, hospitality, and accuracy, at affordable prices
- However, some industries (companies) struggle with low productivity, as well as challenges in marketing, pricing, and earning power

<Improving operational efficiency x high added value> (tomorrow)

- Expecting revitalization of inbound tourism leveraging Japan’s natural, cultural, and culinary resources, as well as expansion of healthcare and senior demand with the aging population
- Advancing automation & labor-saving to enhance operational efficiency and increase added value by focusing human resources on tasks that only people can do

[Key constraints to overcome for transformation]

Comprehensive section (Labor Shortages)

<Labor shortages>

- Lost revenue opportunities in growth industries such as inbound tourism
- Maintaining essential services for daily life, such as healthcare, will become difficult
- Decline in the quality of products and services due to the discontinuation of traditional artisan skills

Scope of this report

<Energy constraints>

- Increasing power demand due to electrification and digitalization
- Greater pressure to reduce CO_2 emissions
- Concerns over stable supply and soaring prices due to rising geopolitical risk

Supplementary discussion

<Resource constraints>

- Mineral resources: Important minerals for reserves, production, and refining are concentrated in specific countries, posing geopolitical risks

etc.

Through overcoming these constraints, Japan can challenge itself to the creation of new technologies, products, and services, capturing new business opportunities

Note: Japan’s Industry Tomorrow assumes around the year 2050
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Report worldview: Transforming into an ideal state by commercializing products, technologies, and services that address social issues

[To-Be]

Manufacturing industry	Demonstrating presence in high added value fields
Non-manufacturing industry	Improving operational efficiency x high added value

- Manufacturing maintains and enhances its high status through continuously creating new value in advanced parts/materials and other high added value fields
- Non-manufacturing improves productivity by leveraging AI, robots, and more. Humans strengthen earning power of the industry by delivering emotional value

[As-Is]

Manufacturing industry	High quality & high functionality product groups
Non-manufacturing industry	Provision of high-level services

Action

Gap

2025 → **2050**

[Examples of products, technologies, and services created in the process of overcoming constraints]

Labor shortage

- AI (Industry-specific AI)
  - Developing AI tailored to the unique demands of each industry by scaling closed data using federated learning techniques
- Robots
  - Development of standard robots meeting the needs of specific industries
  - Introduction promoted in mainly non-manufacturing sectors by gathering user needs and component technologies
- Autonomous driving
  - Development & manufacturing: Vehicle development & manufacturing, autonomous driving systems
  - Systems: Dispatch systems, remote monitoring systems
  - Services: Remote monitoring, on-site response, maintenance, mobility experience services

Energy constraints

<Reduced energy consumption>

- Optoelectronic devices
  - Suppresses losses during data transmission
- Superconducting cables
  - No electrical resistance, enabling lossless conduction of large currents

→ Increasing electricity demand is a global challenge; if Japan takes the initiative in solving it, it will also help earn foreign currency

<Increasing energy supply>

- Direct hydrogen production
  - Generating hydrogen by electrolyzing water using solar power
- Solar power (perovskite cells)
  - Lighter, more flexible, and with the prospect of improved conversion efficiency over conventional products

→ Expect to provide solutions to countries with energy constraints similar to Japan, and generate income

Source: Compiled by Mizuho Bank's Industry Research Department

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Summary ~ Comprehensive Edition: Energy Constraints

- Japan is a country that is not blessed with energy resources and faces energy constraints in that it "cannot procure energy freely and at low cost". Up to now, Japan has developed its energy supply system based on the concept of S+3E, balancing each element, but changes are expected in the energy supply and demand structure due to increased electricity demand from the progress of electrification and digitalization, and growing pressure to reduce CO2 emissions.
- Assuming that economic growth continues until 2050 while achieving carbon neutrality, and that energy consumption per unit of GDP does not decrease significantly, projections indicate that final energy consumption and electricity demand will increase. If electricity demand increases significantly, strengthening power generation capacity will be required to meet the demand.
- However, it is difficult to meet all electricity demand with renewable energy and nuclear power. The shortfall will require power supply from carbon-neutral thermal power generation, and depending on fuel prices and CCS costs, fuel costs for power generation may increase significantly compared to current levels. To suppress the outflow of national wealth, energy conservation, expansion of decarbonized power source capacity, and reduction of energy costs are required.
- Energy conservation is also of high global interest. Energy consumption characteristics and energy-saving potential differ by sector: for agriculture, forestry, fisheries, and manufacturing, energy efficiency improvement through process transformation and equipment renewal in high-emission industries is important; for the commercial and residential sectors, the introduction of energy-saving equipment and improvement of building and housing energy efficiency are key; and for the transportation sector, improvement of automobile fuel efficiency and modal shift are important. If proactive energy conservation progresses in all sectors, it is estimated that final energy consumption could decrease by approximately 40% in 2050 compared to 2022. It is important to prioritize approaches to sectors with high energy-saving potential, while also exporting accumulated technologies and know-how overseas to generate revenue.
- On the other hand, it is also important to steadily increase the capacity of decarbonized power sources. For the steady expansion of renewable energy, it is important for the public and private sectors to work together to overcome challenges in renewable energy businesses, and improvements in investment predictability and promotion of securing long-term fuel contracts are required for the expansion of decarbonized thermal power. The promotion of cutting-edge technology development and deployment such as perovskite solar cells and floating offshore wind power are also expected.
- It is presumed that if efforts for energy conservation on the demand side and efforts for stable supply of clean energy on the supply side progress simultaneously, the competitiveness of Japanese industry will improve. To achieve both economic growth and decarbonization, the demand and supply sides should be interconnected and Japan as a whole should move toward Japan's industry tomorrow.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Structure of this Report (Table of Contents)

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1. Energy Constraints Facing Japan and Expected Future Challenges

Problem awareness in this paper ~ Japan's energy situation and constraints ~

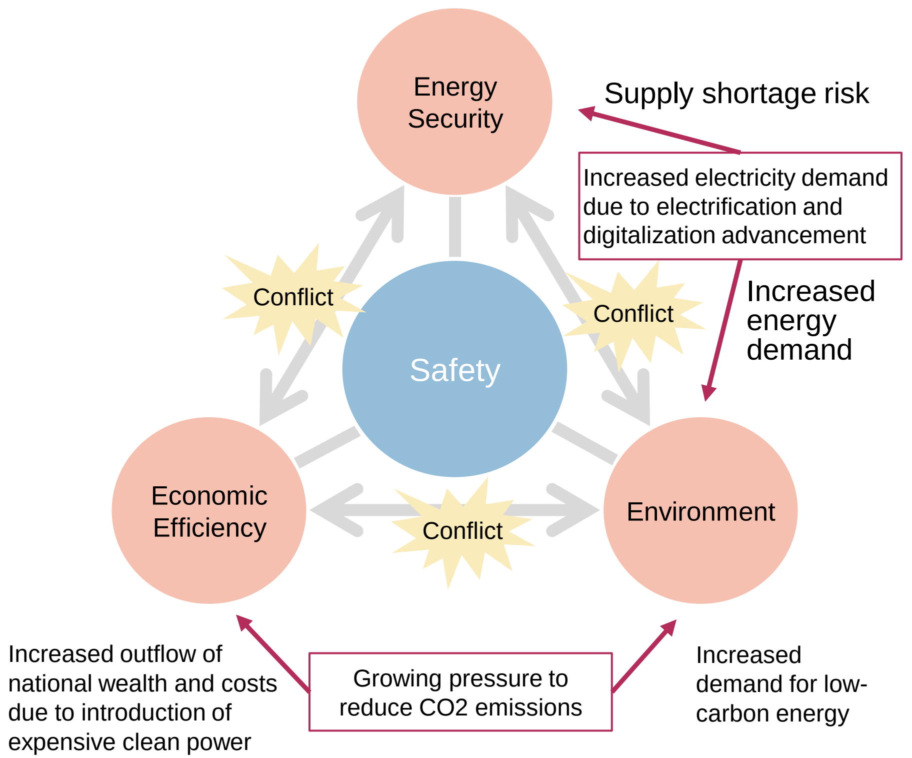
- Japan is an island nation that is not blessed with energy resources such as fossil fuels and renewable energy. In this paper, energy constraints are defined as "the inability to procure energy freely and at low cost."
- Japan has traditionally developed its energy supply system based on the concept of S+3E, balancing each element.
- However, the conflict between each element has intensified due to increased electricity demand from electrification and digitalization advancement, and growing pressure to reduce CO2 emissions.
  - Exploring measures to overcome energy constraints and maintain and strengthen the competitiveness of Japanese industry.

Japan's energy situation compared to other countries

Japan	Not blessed with energy resources such as fossil fuels and renewable energy
	Facing energy constraints (the inability to procure energy freely and at low cost)
	Developing energy supply system based on S+3E concept, balancing each element
US	Abundant domestic production of oil and gas
EU	Abundant renewable energy resources, with power interchange through international interconnection lines possible

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Intensification of conflicts between S+3E elements

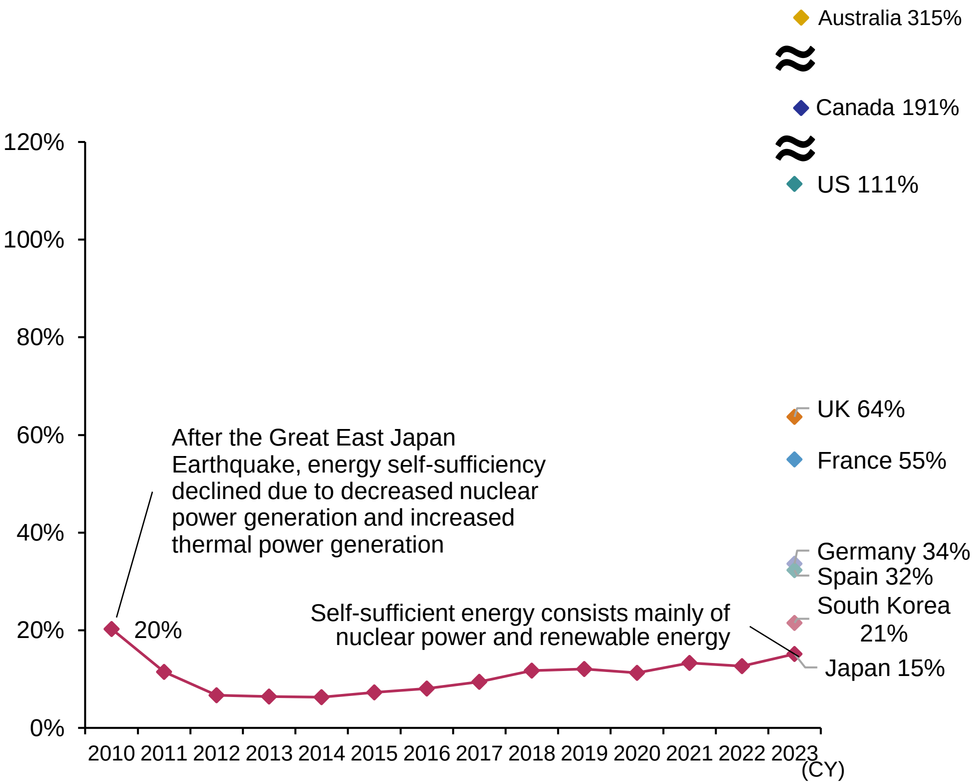


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Japan depends on overseas procurement for much of its energy

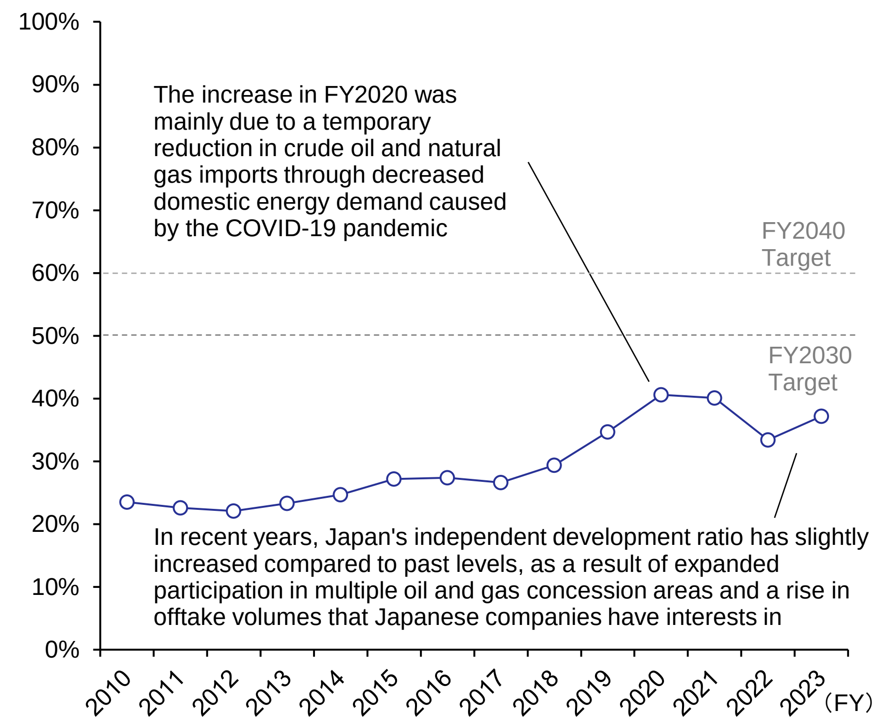
- Japan's current energy self-sufficiency rate is around 15%, relying heavily on overseas procurement.
  - — Particularly after the Great East Japan Earthquake, thermal power generation increased, leading to lower self-sufficiency due to overseas fuel procurement.
- Japan, which lacks natural resources, aims to increase its independent development ratio, targeting 50% by fiscal 2030 and 60% or higher by fiscal 2040.

Energy self-sufficiency rates by country



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on IEA, World Energy Balances

Trends in Japan's independent development ratio



Note: Independent development ratio for oil and natural gas is calculated as the ratio of offtake volumes related to Japanese companies' interests to the total import and domestic production volumes of oil and natural gas

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on data published by Agency for Natural Resources and Energy

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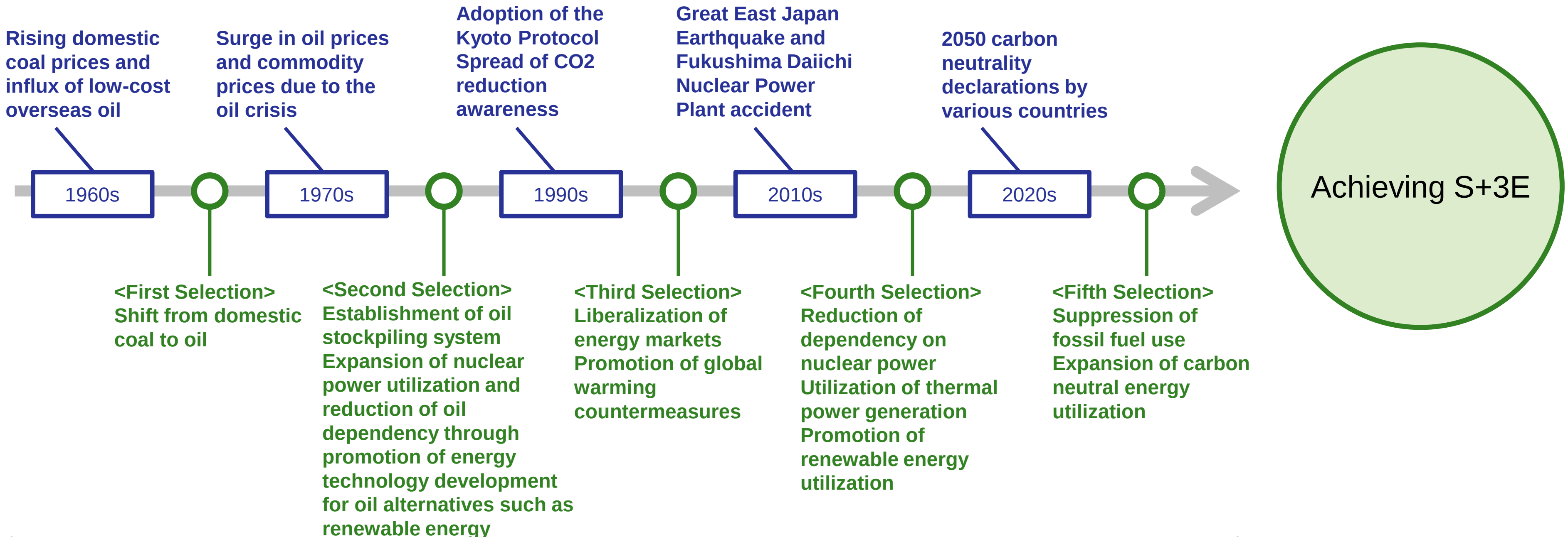
In Japan, various timely measures have been implemented to achieve S+3E

- Looking back at Japan's history, each time energy constraint issues have surfaced, the country has implemented measures to diversify energy sources, achieving a well-balanced approach to enjoying the benefits and mitigating the drawbacks of each energy source.

Major trends in energy selection in Japan



To address issues such as price, stable energy supply, and CO2 emission reduction that surfaced from time to time, Japan achieved a well-balanced approach of enjoying the benefits and suppressing the drawbacks of each energy source through the use of diverse energy sources.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on 1st Energy Situation Council “Changes in the Situation Surrounding Energy Conditions" and Agency for Natural Resources and Energy "Japan's Energy: 150 Years of History"

Element (1) causing changes in energy supply and demand: Increase in electricity demand due to electrification and digitalization progress

- Increased electricity demand is expected due to factors such as increased power consumption at data centers driven by digitalization progress including the spread of generative AI, electrification in industrial sectors, EV adoption, hydrogen production, and increased semiconductor demand.
- If electricity demand increases, a corresponding increase in supply becomes necessary, requiring stable power supply through new construction and expansion of power sources.

Factors that increase electricity demand (examples)

digitalization progress

- ✓ Electricity demand at data centers increases due to digitalization progress such as AI adoption

EV adoption

- ✓ Charging demand increases due to further EV adoption

Progress in electrification in industrial sectors

- ✓ Electricity demand increases due to progress in electrification in industrial sectors, such as expansion of electric furnace utilization in the steel industry and expansion of robots aimed at labor-saving

New construction and expansion of semiconductor plants

- ✓ Semiconductor plant construction is expected in Japan as well due to increased semiconductor demand and growing importance in terms of security
- ✓ Electricity used in semiconductor manufacturing also increases

However...
There are also factors that suppress electricity demand as follows:

- Development of technologies to reduce computational costs and power consumption associated with AI learning and inference (examples: DeepSeek, etc.)
- Business efficiency and energy saving through AI utilization (example: optimization of factory operations and logistics utilizing AI)

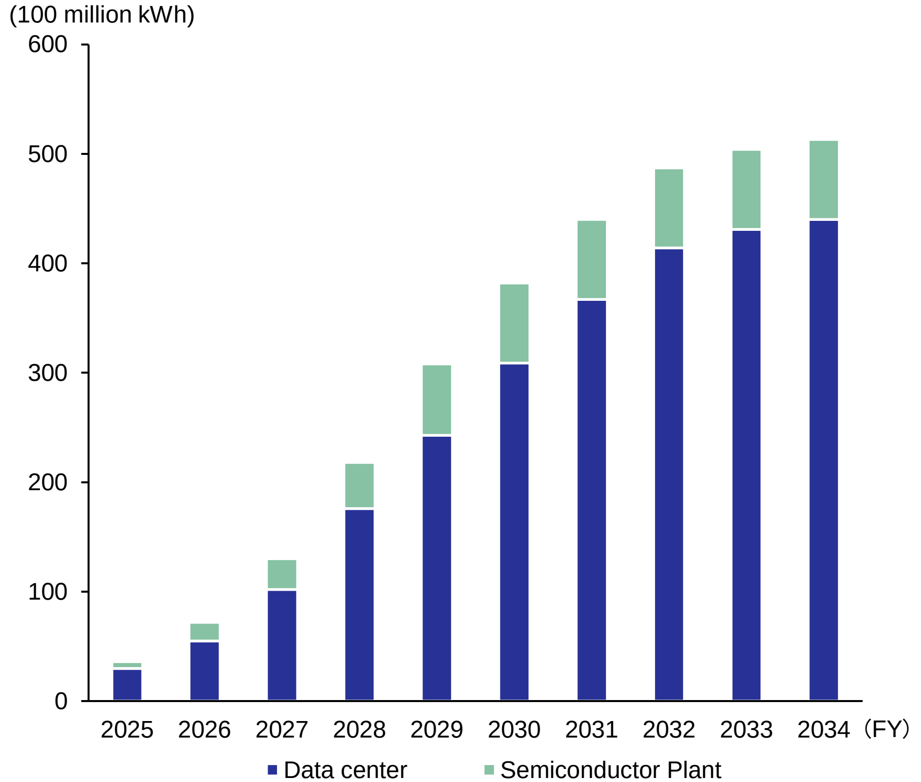
It is necessary to note that uncertain factors exist in electricity demand forecasts

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Particularly, uplift effects on electricity demand due to new construction and expansion of data centers and semiconductor plants is drawing focus

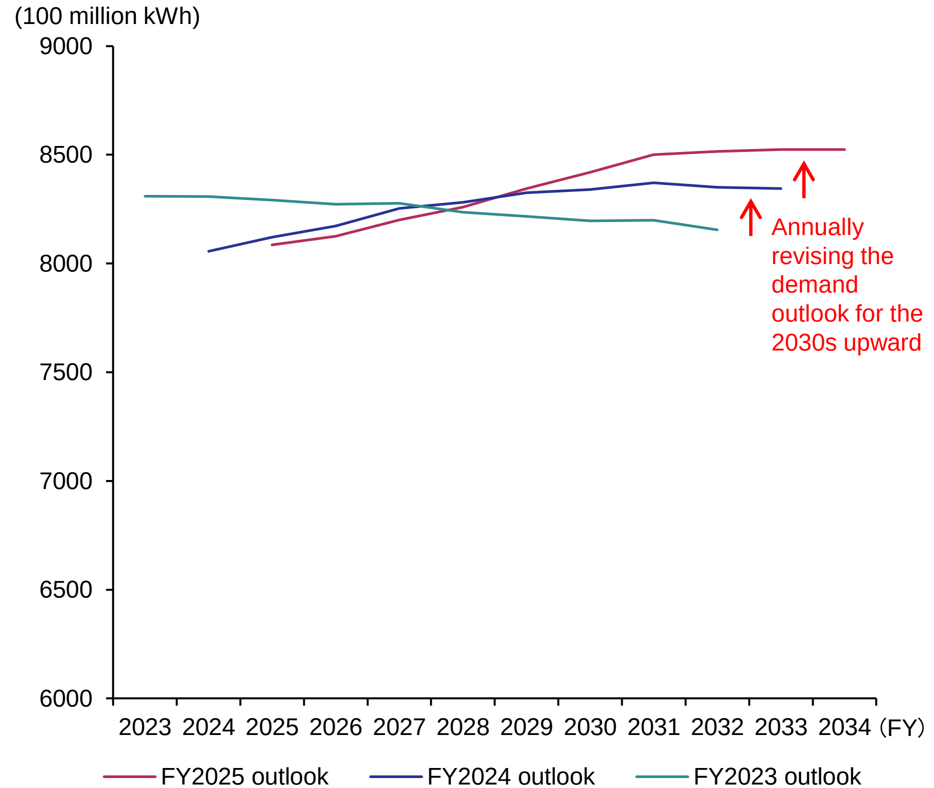
- According to Organization for Cross-regional Coordination of Transmission Operators, Japan, movements of new construction and expansion of data centers and semiconductor plants are individually incorporated into electricity demand, and it is predicted that electricity demand will be pushed up by approximately 50 billion kWh through fiscal year 2034.
- Currently, Organization for Cross-regional Coordination of Transmission Operators, Japan has been annually revising upward the demand outlook for the 2030s, and if movements of new construction and expansion of data centers and semiconductor plants progress further, there is also the possibility that electricity demand may exceed expectations.

Outlook for electricity demand accompanying new construction and expansion of data centers and semiconductor plants



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Organization for Cross-regional Coordination of Transmission Operators, Japan "Demand Assumptions by Nation and Supply Area (FY2025)"

Japan's nationwide electricity demand outlook (end-use)

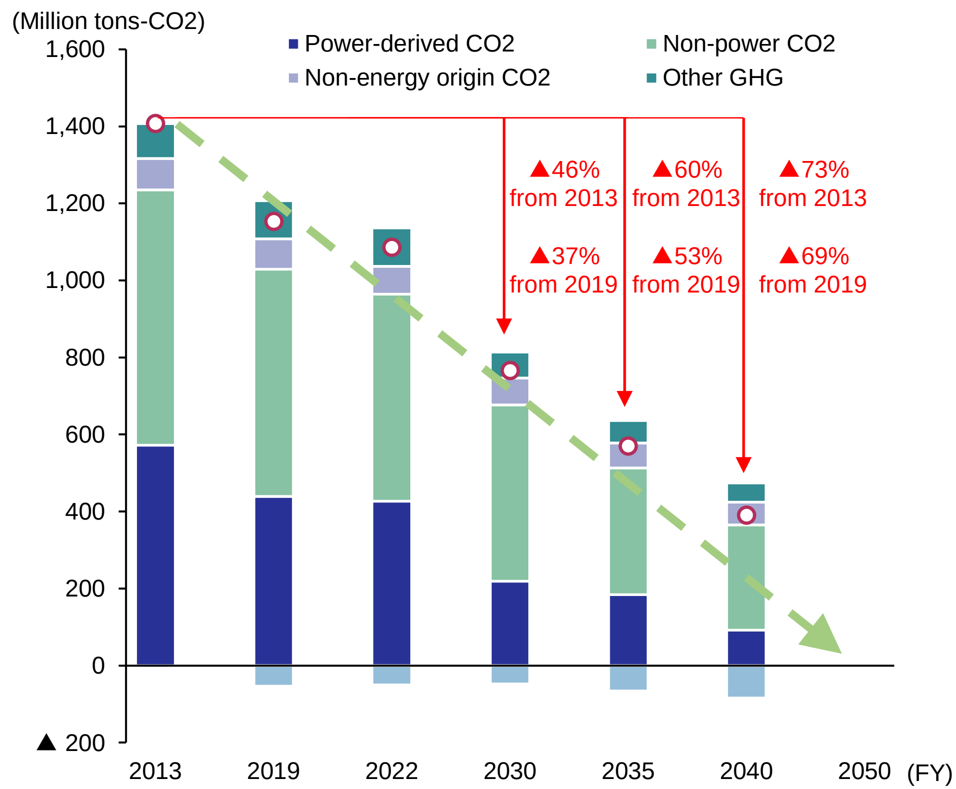


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Organization for Cross-regional Coordination of Transmission Operators, Japan "Demand Assumptions by Nation and Supply Area (FY2023, FY2024, FY2025)"

Element (2) causing changes in energy supply and demand: Increase in CO2 emission reduction pressure

- Japan's GHG emissions have the composition shown in the figure below, and the government has presented a path toward 2035 and 2040.
  - — Clean energy demand necessary for emission reduction across Japan is expected to increase.
- Going forward, government regulations on fossil fuel use and CO2 emissions in Japan are planned to gradually strengthen.

Japan's GHG emission reduction targets



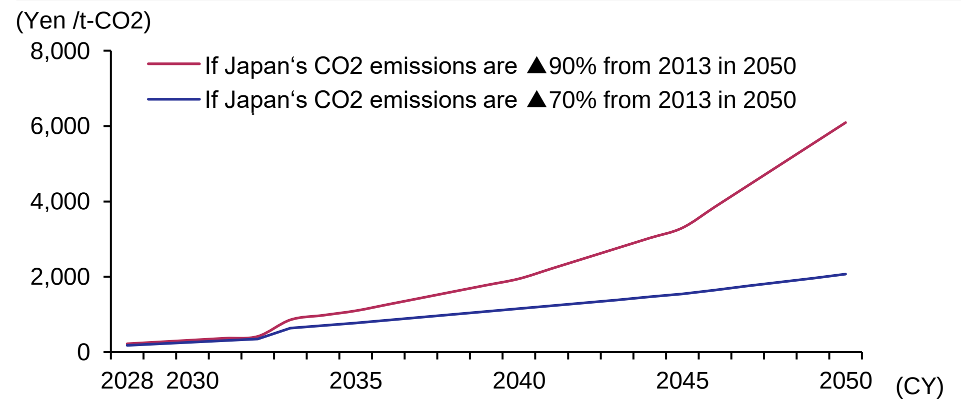
Note: Emissions in 2035 are assumed to be the intermediate value between 2030 and 2040 emission targets. Power-derived emissions are quoted from World Energy Outlook 2023, and reduction contributions from Joint Crediting Mechanism (JCM) are not considered.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on National Institute for Environmental Studies (Greenhouse Gas Inventory Office) materials, Agency for Natural Resources and Energy “Comprehensive Energy Statistics," Ministry of the Environment materials, IEA, World Energy Outlook 2023, etc.

Trends in regulatory strengthening for fossil fuels and CO2

- 2023 GX-ETS pilot operation begins
- 2026 Full-scale operation of emissions trading system
- 2028 Start of carbon levy collection based on CO2 emissions for each fossil fuel
- 2030 Japan as a whole reduces GHG emissions by 46% from 2013 levels (target)
- 2033 Gradual introduction of paid auctions for emission allowances to power generation companies
- 2035 100% electric vehicles for new passenger car sales (target)

Fossil fuel levy unit price outlook

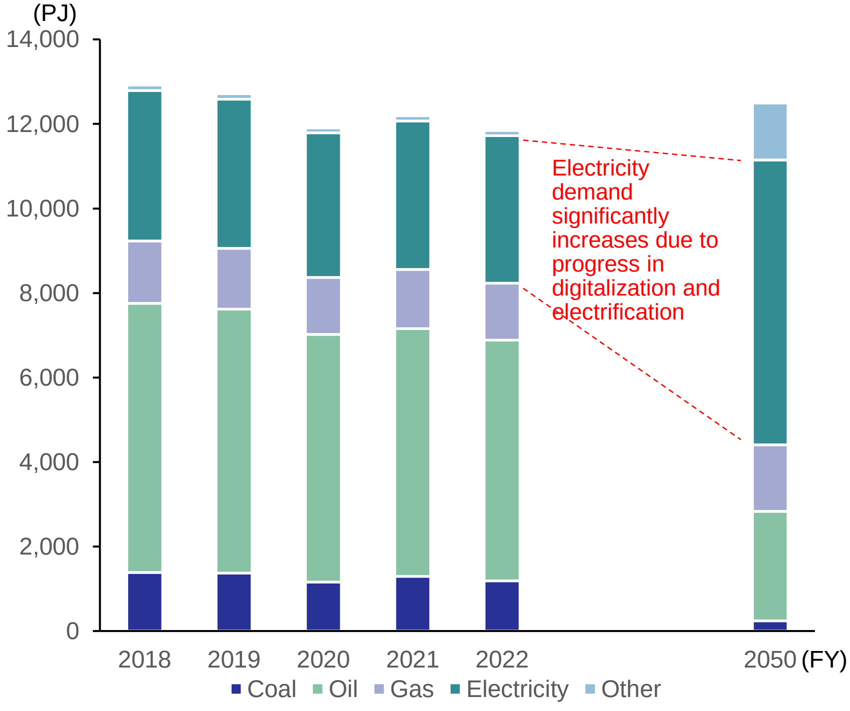


Source: Upper figure compiled by Industry Research Department, Mizuho Bank, Ltd. based on various published information. Lower figure compiled by Industry Research Department, Mizuho Bank, Ltd. based on The Institute of Energy Economics, Japan "Carbon Price Generating 20 Trillion Yen in Revenue"

Without considering energy saving, final energy consumption increases, and electricity demand nearly doubles

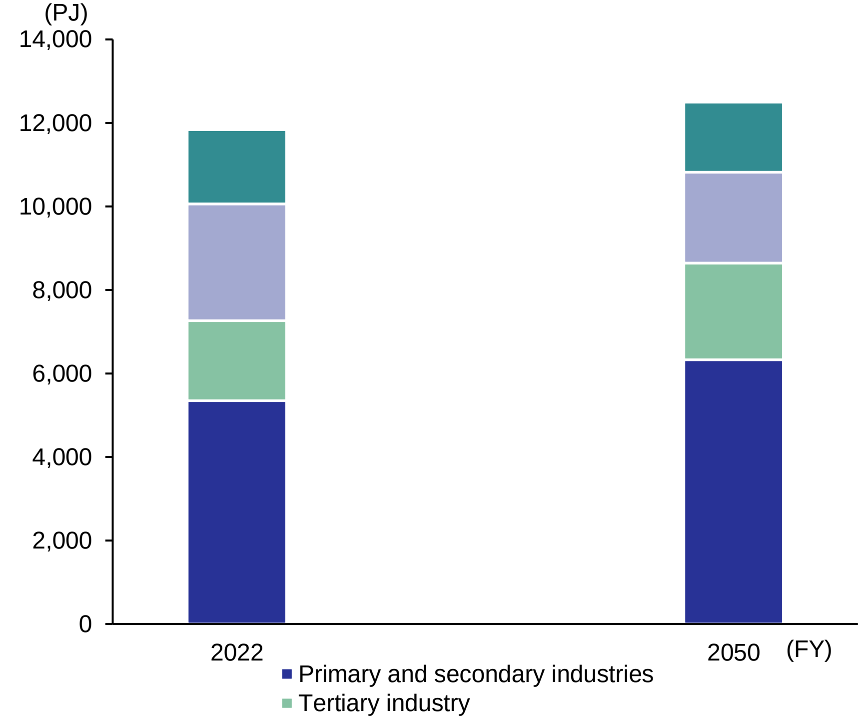
- When assuming continued economic growth as of 2050 and taking carbon neutrality realization as given, if coal, oil, and gas are electrified and energy consumption per GDP unit does not significantly decrease (energy consumption grows in line with GDP growth), the outlook shows that final energy consumption and electricity demand will increase.
- By sector, primary to tertiary industries will see increased energy consumption along with economic growth, while transportation will see decreased energy consumption due to reduced vehicle ownership, and households will see decreased energy consumption due to reduced number of households.

Final energy consumption outlook without considering energy saving effects



Note: FY2050 is a forecast by Industry Research Department, Mizuho Bank, Ltd.
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics" and National Institute for Environmental Studies materials

Final energy consumption outlook by sector without considering energy saving effects

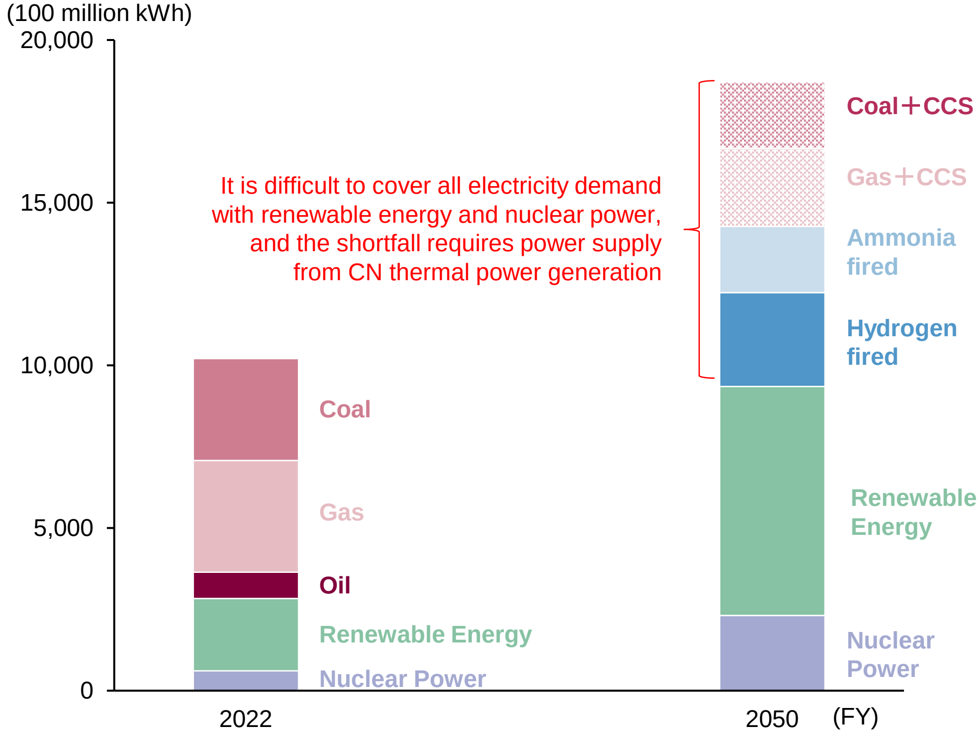


Note: FY2050 is a forecast by Industry Research Department, Mizuho Bank, Ltd.
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics" and National Institute for Environmental Studies materials

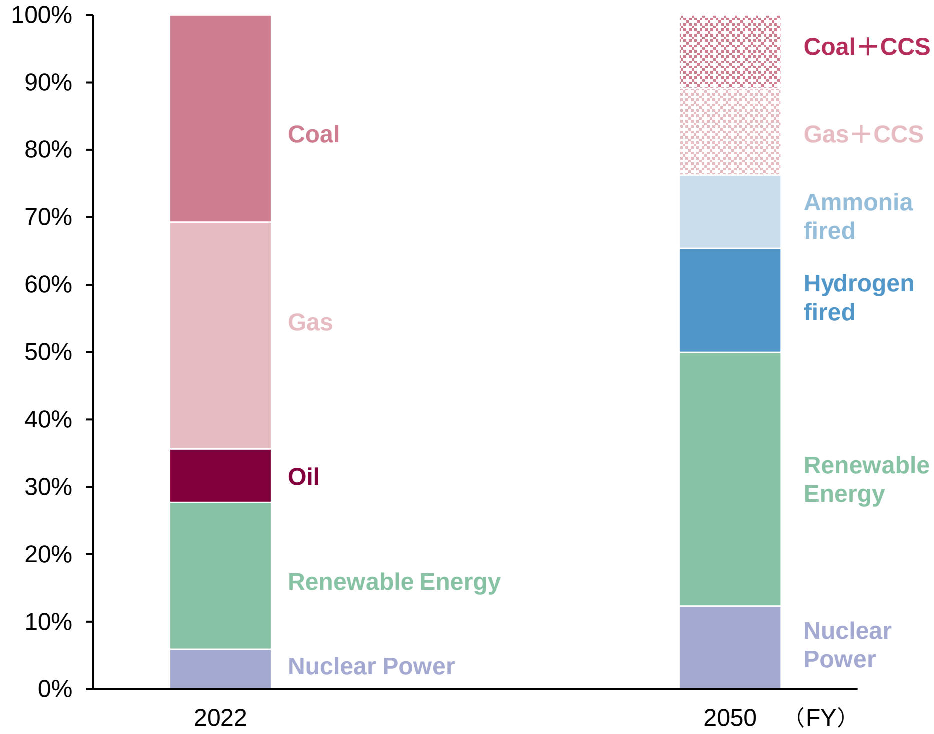
[Mizuho's estimate] When electricity demand significantly increases, it will be supplemented by CN thermal power generation

- When electricity demand significantly increases, strengthening power generation capacity is required to meet the demand.
  - Furthermore, considering the limited suitable sites for renewable energy on Japanese territory and the high barriers to large-scale new construction and expansion of nuclear power generation, it would be difficult to cover all electricity demand with renewable energy and nuclear power even while aiming to reduce CO2 emissions, and the shortfall would require power supply from CN thermal power generation (hydrogen-fired, ammonia-fired, coal + CCS, gas + CCS).
- In that case, CN thermal power generation is predicted to account for approximately 50% of the power source composition in 2050.

Power source composition outlook (absolute amount)



Power source composition outlook (percentage)



Note 1: FY2050 is a forecast by Industry Research Department, Mizuho Bank, Ltd.
Note 2: In this estimate, renewable energy is introduced to the maximum extent, and assuming 60-year operation for nuclear power with all existing power plants operating, the difference is assumed to be covered by CN thermal power generation
Source: Both figures compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics," etc.

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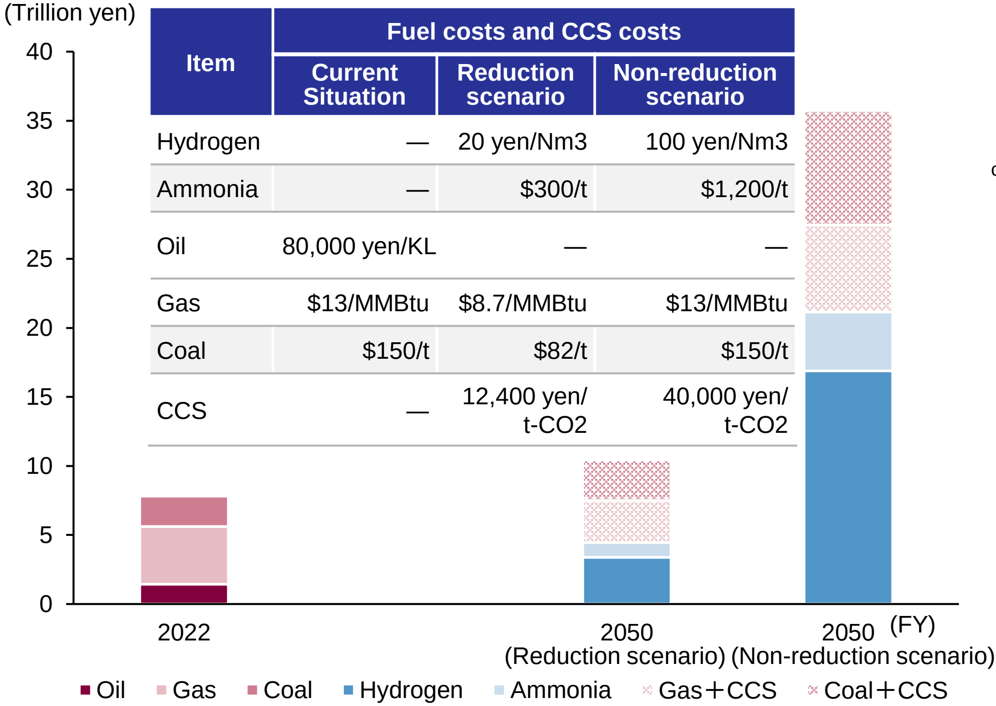
If power supply from CN thermal power generation increases, fuel costs are expected to rise

- To achieve CN while maintaining thermal power supply, hydrogen-fired, ammonia-fired, or CCS addition to gas and coal thermal power is required.
  - While fuel costs may fluctuate depending on hydrogen, ammonia, and CCS prices, fuel costs will increase even in cases where prices decrease.
  - Assuming hydrogen and ammonia are mainly procured from overseas and CO2 storage is also mainly implemented overseas, outflow of national wealth becomes an issue.
- While GDP per unit of energy consumption varies by industry, addressing energy constraints is particularly important for industries where the adverse effects of increased fuel costs are significant.

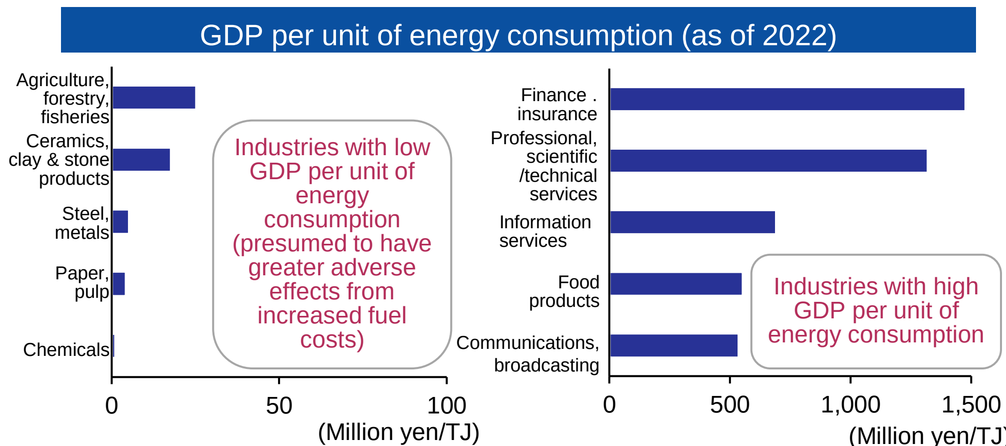
Fuel costs for thermal power generation and CCS cost outlook



Item	Fuel costs and CCS costs		
	Current Situation	Reduction scenario	Non-reduction scenario
Hydrogen	—	20 yen/Nm3	100 yen/Nm3
Ammonia	—	$300/t	$1,200/t
Oil	80,000 yen/KL	—	—
Gas	$13/MMBtu	$8.7/MMBtu	$13/MMBtu
Coal	$150/t	$82/t	$150/t
CCS	—	12,400 yen/ t-CO2	40,000 yen/ t-CO2

Note 1: FY2050 is a forecast by Industry Research Department, Mizuho Bank, Ltd.
Note 2: For hydrogen, ammonia-fired, and CCS, the reduction scenario adopts government price targets, while the non-reduction scenario adopts current prices. For gas and coal, the reduction scenario adopts low prices from IEA outlook, while the non-reduction scenario adopts current prices
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on IEA, World Energy Outlook 2024, various reports

Industrial structure from an energy perspective and approach toward competitiveness strengthening



From an energy perspective, considering industrial competitiveness strengthening...

Increase in the numerator through margin improvement via energy cost reduction and added value improvement through expanded use of decarbonized energy

$$\text{GDP per unit of energy consumption} = \frac{\text{Industry-wide value added}}{\text{Industry-wide energy consumption}}$$

Reduction in the denominator through suppression of energy consumption

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Economic and Social Research Institute, Cabinet Office “Annual Report on National Accounts" and Agency for Natural Resources and Energy "Comprehensive Energy Statistics"

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Overcoming energy constraints becomes the foundation for Japanese industry's winning formula

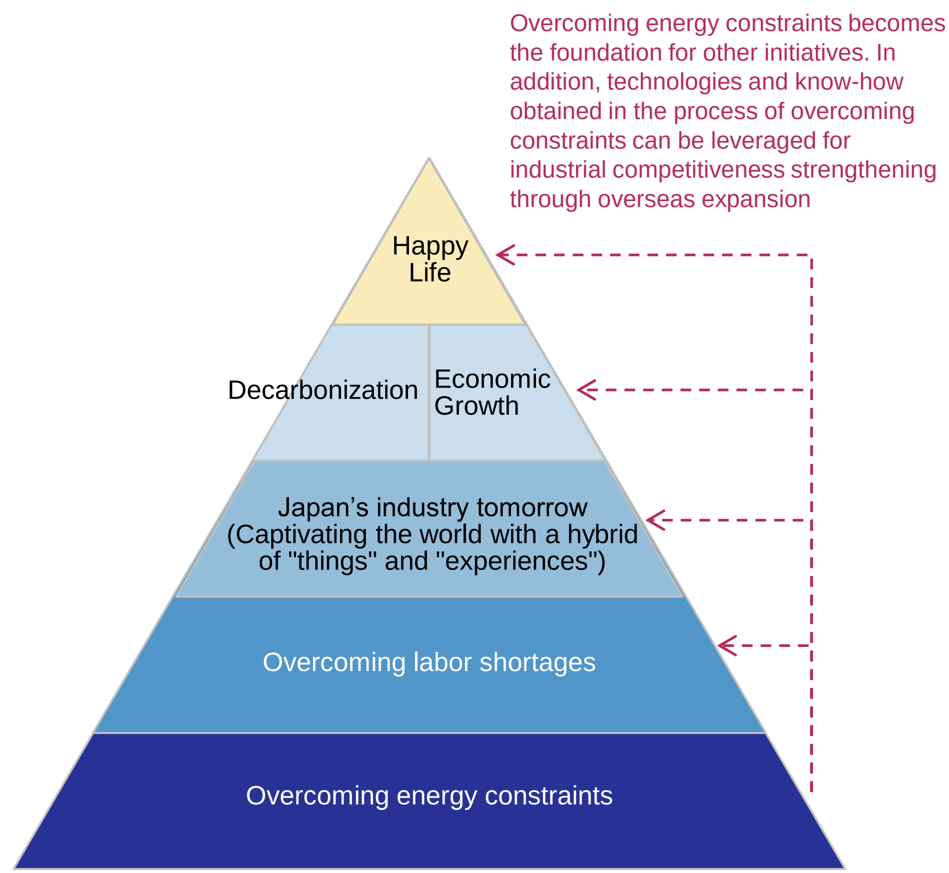
- In Japan, which is constrained by geographical restrictions, to transform to Japan's industry tomorrow and simultaneously achieve economic growth and CN realization, energy saving, expansion of power generation capacity and decarbonization of power sources, and reduction of energy costs are required.
- Energy is the foundation of all corporate activities, and overcoming energy constraints becomes the foundation for Japanese industry to aim for winning formulas. If the technologies and know-how gained in the process of overcoming constraints can be deployed overseas, then this could contribute to strengthening industrial competitiveness.

Direction for addressing energy constraints

	Issues	Considerations
Demand Side	• Implement energy saving to suppress fuel costs and prevent outflow of national wealth	• Where are there opportunities for energy saving? • What policies and systems are needed to promote energy saving?
Supply Side	• Steadily increase power generation capacity while reducing CO2 emissions to maintain stable supply that meets energy demand while aiming to achieve CN	• Where are there opportunities for expanding power generation capacity? • What policies and systems are needed to promote decarbonization of power sources, and what innovative technologies exist?
Supply Side	• Reduce energy costs to maintain industrial competitiveness and realize economic growth	• What technologies exist to suppress energy costs?

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Image of ripple effects from overcoming energy constraints



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

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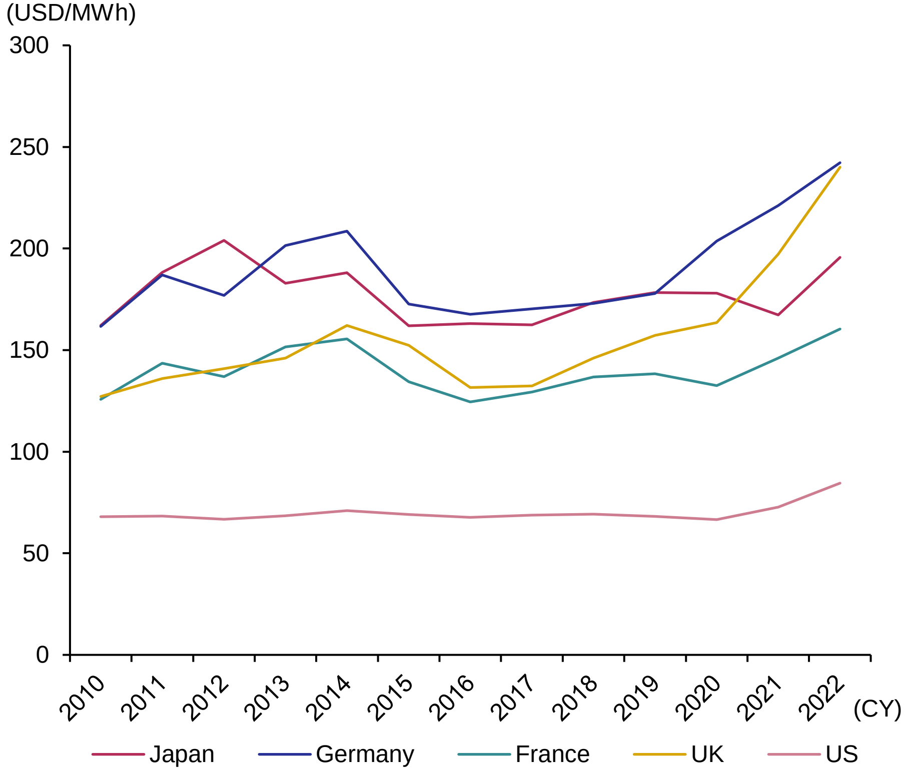
In Germany, soaring energy prices are affecting corporate production activities

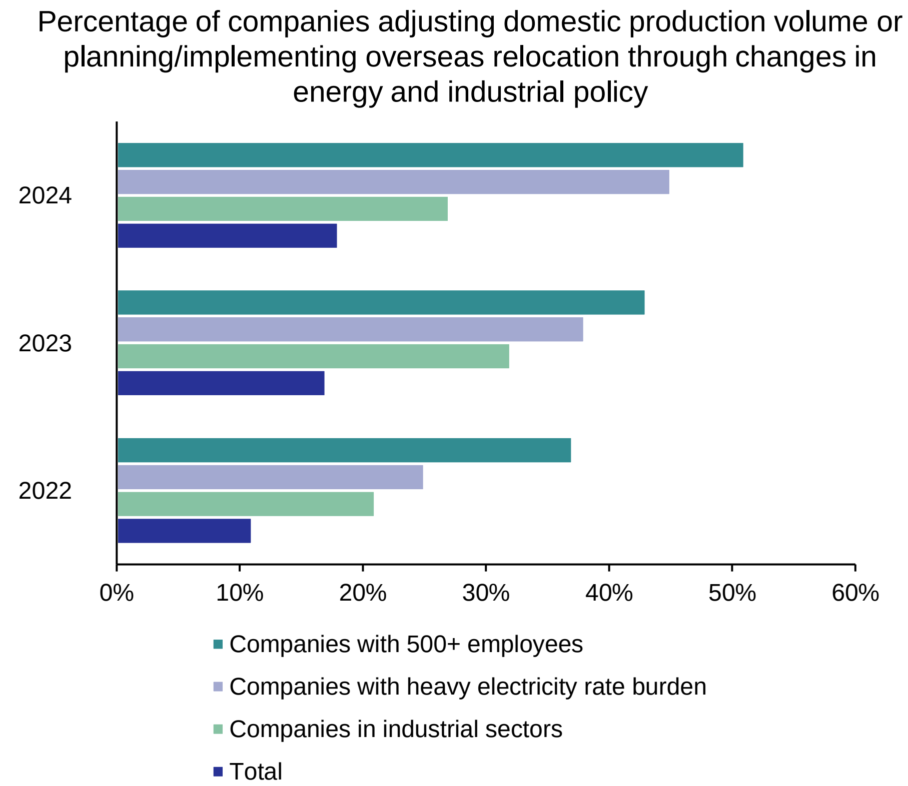
- Due to soaring energy prices triggered by Russia's invasion of Ukraine, electricity rates have risen in Japan and European countries.
  - Increases are particularly notable in Germany and the UK.
- According to a report of German Chamber of Commerce and Industry, soaring energy prices have caused corporate production reduction and a surge in relocation plans, resulting in energy-related location conditions becoming competitively disadvantageous for many German companies.
  - This suggests that when the S+3E balance is disrupted, it deals a blow to industrial competitiveness.

Electricity rate trends in major countries



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on IEA, Energy Prices Taxation Information

Production restrictions and corporate relocation in Germany



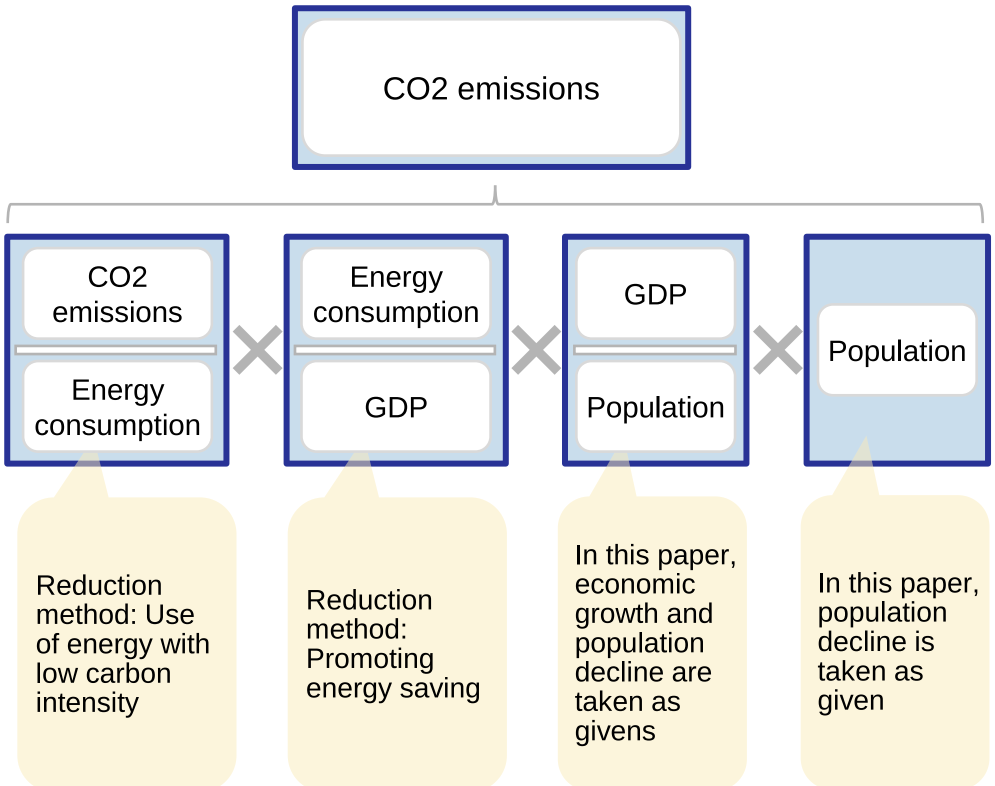
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on German Chamber of Commerce and Industry, Energy Transition Barometer 2024

2. Measures to Promote Energy Conservation

Promoting energy saving simultaneously with energy transition is important for CO_2 emission reduction

- Referring to the Kaya identity presented by Professor Emeritus Yoichi Kaya of the University of Tokyo, it can be understood that promoting energy saving is important for reducing CO_2 emissions, along with promoting the use of energy with low carbon intensity.
- At COP28 held in 2023, over 100 countries including Japan agreed to "triple renewable energy globally and double the rate of energy efficiency improvement by 2030“.
  - — The goal is to achieve annual energy efficiency improvements of 4% or more by 2030.

Kaya identity



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy website

COP28 "Triple renewable energy and double energy efficiency improvement rate" declaration

We, Heads of State and Governments as the Participants in the COP28 Global Renewables and Energy Efficiency Pledge:
(Excerpt)

- Noting that the International Energy Agency and the International Renewable Energy Agency forecast that, to limit warming to 1.5° C, the world requires three times more renewable energy capacity by 2030, or at least 11,000 GW, and must double the global average annual rate of energy efficiency improvements from around 2% to over 4% every year until 2030.

We declare our intent to work collaboratively and expeditiously to pursue the following objectives:
(Excerpt)

- Commit to work together in order to collectively double the global average annual rate of energy efficiency improvements from around 2% to over 4% every year until 2030.
- Commit to put the principle of energy efficiency as the "first fuel” at the core of policymaking, planning, and major investment decisions.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Global Renewables and Energy Efficiency Pledge

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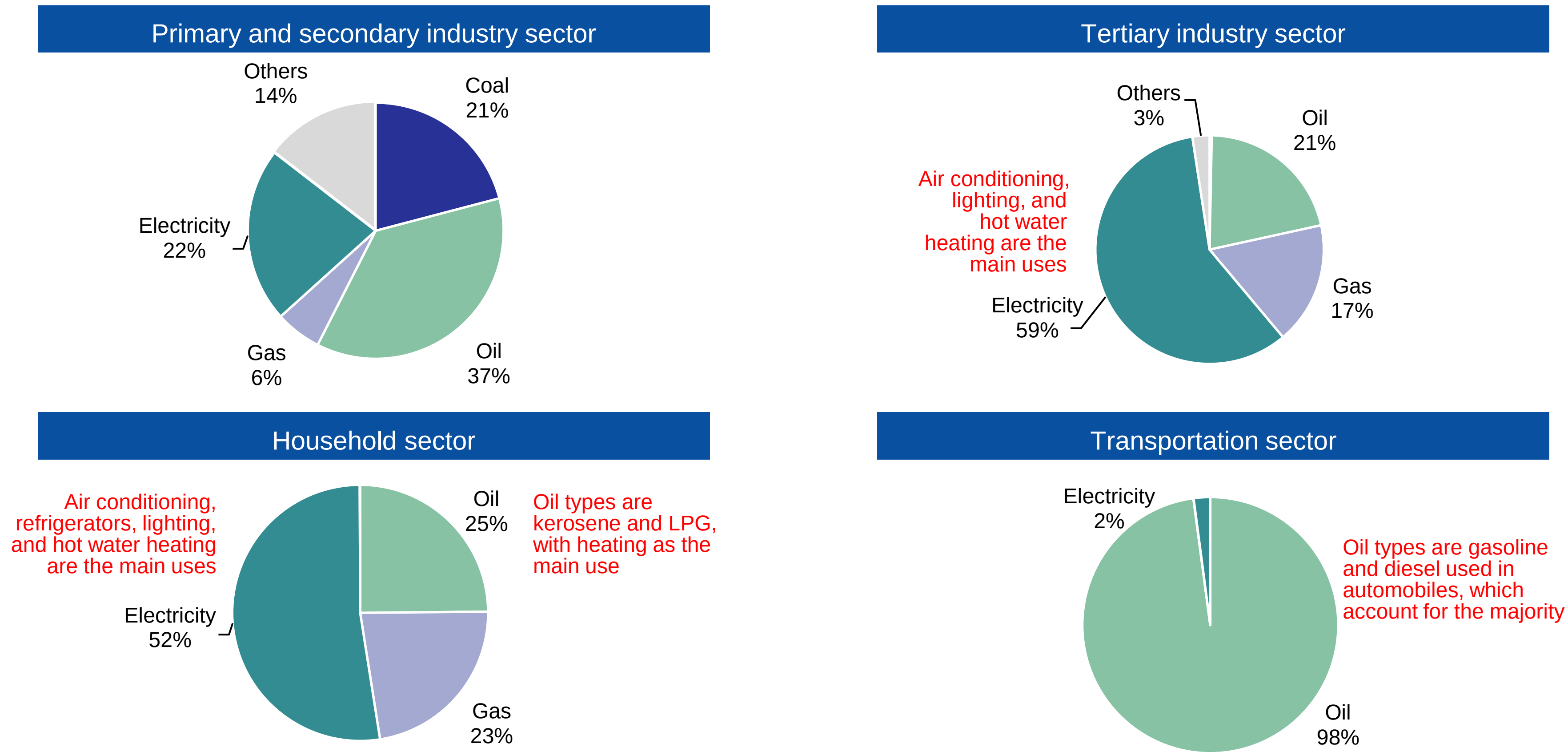
In Japan, the primary types of energy consumed differ by sector

- Because the types of energy that are mainly consumed differ among primary and secondary industry sectors, tertiary industry sector, household sector, and transportation sector, different approaches are required for each sector.
  - Tertiary industry and household sectors have high electrification rates, with air conditioning, lighting, and hot water heating as main uses.
  - The transportation sector consumes a lot of oil, with gasoline and diesel fuel for automobiles accounting for the majority.

Energy consumption percentage by sector (2022)

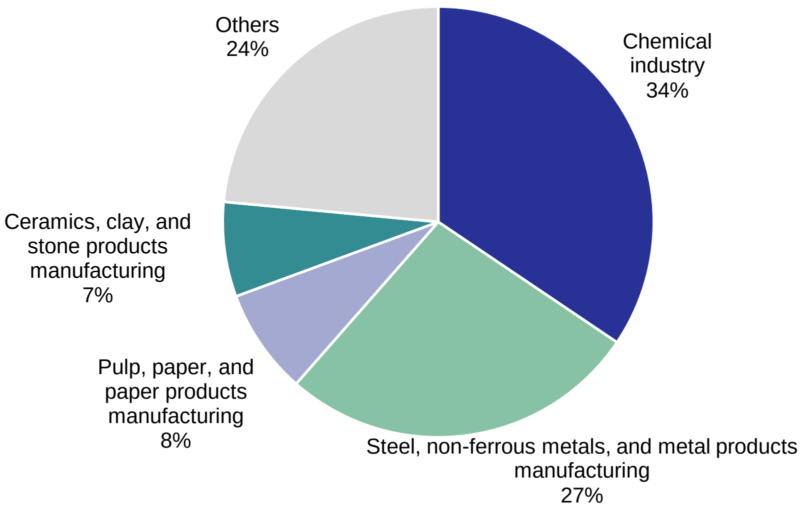


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics"

Energy consumption structure and energy saving potential in primary and secondary industry sectors

- More than half of the energy consumption in primary and secondary industry sectors is accounted for by chemical industry and by steel, non-ferrous metals, and metal products manufacturing.
- Suppressing energy demand by introducing energy-saving equipment through facility upgrades and implementing innovative manufacturing processes is expected to hold significant energy-saving potential toward 2050.

Energy consumption percentage by industry type in primary and secondary sectors (2022)



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics"

Potential for energy saving measures in manufacturing (examples)

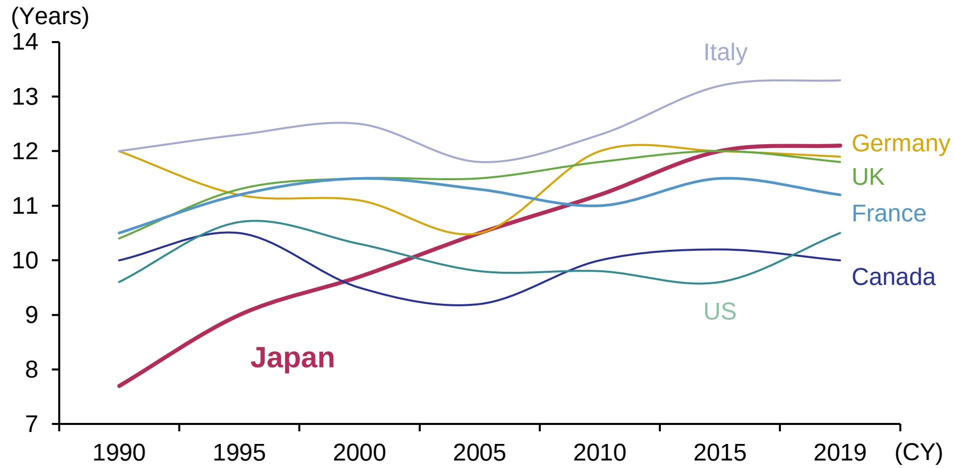
Industry type	Energy saving measures	Overview
Chemical industry	Energy saving process technology introduced through facility upgrades	Facility upgrades in naphtha cracking furnaces, caustic soda manufacturing equipment, and heat/steam generation facilities
	Recovery of waste energy	Use of discharged hot/cold heat, fuel conversion of waste liquids, waste oils, waste gases, etc.
Steel industry	Enhancement of energy-saving equipment	Introduction of energy-saving equipment such as waste heat utilization including blast furnace top pressure recovery power generation and sensible heat recovery in coke ovens
	Introduction of innovative pig iron processes (ferrocoke)	Using innovative coke substitute reducing agents (ferrocoke) made from low-grade coal and low-grade iron ore as raw materials, accelerating and lowering the temperature of reduction reactions in blast furnaces
Ceramics, clay, and stone products manufacturing	Introduction of innovative cement manufacturing processes	Development and introduction of innovative manufacturing technology that enables reduction of firing temperature in the clinker firing process
	Introduction of innovative glass melting processes	Efficient product manufacturing by instantly converting raw materials into glass using high temperatures from plasma, etc.
Pulp, paper, and paper products manufacturing	Introduction of high-efficiency waste paper pulp manufacturing technology	Introduction of pulpers that more efficiently mix and break down waste paper and water than conventional models, reducing operating energy consumption

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on 31st Energy Efficiency and Conservation Subcommittee, 48th Strategic Policy Subcommittee of the Advisory Committee for Natural Resources and Energy

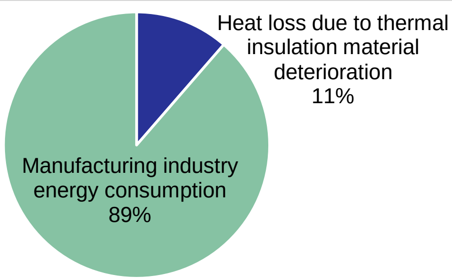
Promoting renewal investment for aging equipment is important from an energy conservation perspective

- According to Cabinet Office, Japan currently has the second-longest equipment service life among G7 countries.
  - This is presumed to be due to large companies prioritizing overseas investment in recent years, while mid-sized and small and medium-sized enterprises have limited capacity for capital investment.
  - As equipment aging progresses, energy efficiency deteriorates (e.g., heat loss), making the promotion of renewal investment important for pursuing energy conservation.
- According to the Energy Conservation Center, Japan, which conducts energy conservation optimization assessments mainly for small and medium-sized enterprises, analysis shows that factories, particularly those of SMEs, generally have energy conservation potential of around 10%.

Equipment service life (vintage)

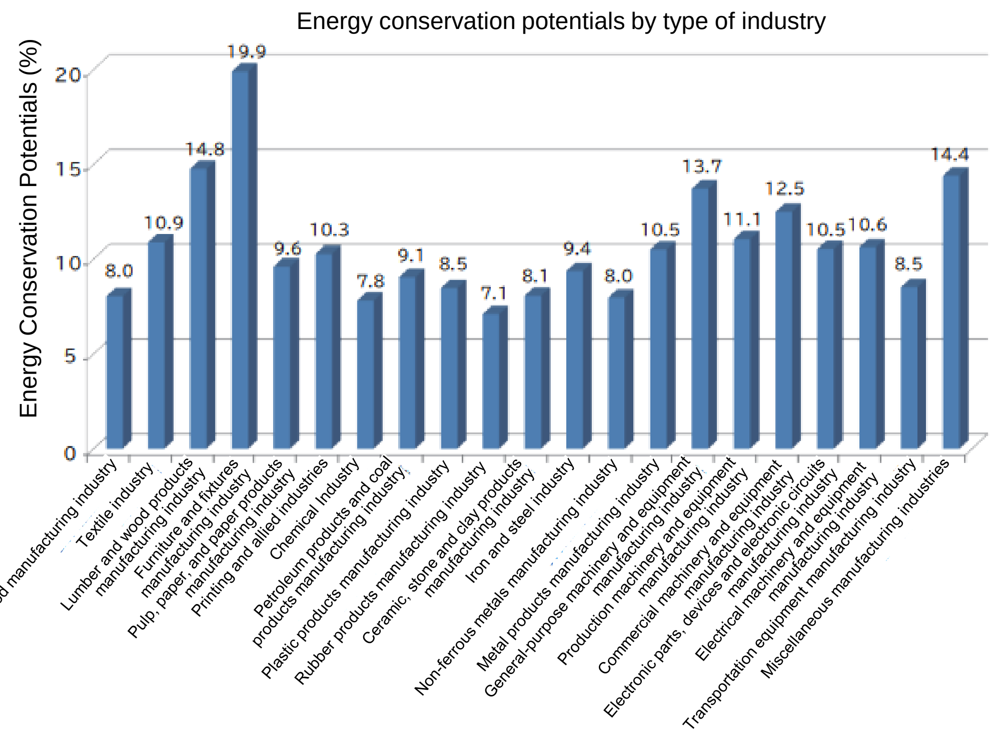


Scale of heat loss in manufacturing energy consumption (as of 2014)



Source: Upper chart from Cabinet Office 'FY2023 Annual Report on the Japanese Economy and Public Finance,' lower chart from 3rd Energy Efficiency and Conservation Subcommittee materials, prepared by Mizuho Bank Industry Research Department

Energy conservation potentials at factories, mainly SMEs



Note: Energy conservation potential: Ratio of proposed energy conservation amount to energy consumption of target business establishments

Source: The Energy Conservation Center, Japan 'Energy Conservation Guidebook for Factories 2024' P13

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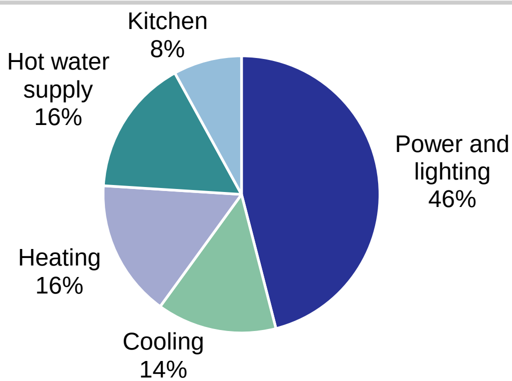
Energy Consumption Composition and Energy Conservation Potential in the Tertiary Industry Sector

- Energy usage in the tertiary industry sector is mainly for electronic equipment including lighting and air conditioning.
  - The use of high-efficiency electronic equipment and construction of buildings with high thermal insulation properties that require as little energy as possible for heating and cooling are required.
- According to the Energy Conservation Center, Japan, which conducts energy conservation optimization assessments focusing on small and medium enterprises, there is also analysis showing that approximately 15% energy conservation potential exists in buildings centered on small and medium enterprises.

Energy usage breakdown in tertiary industry sector (FY2020)

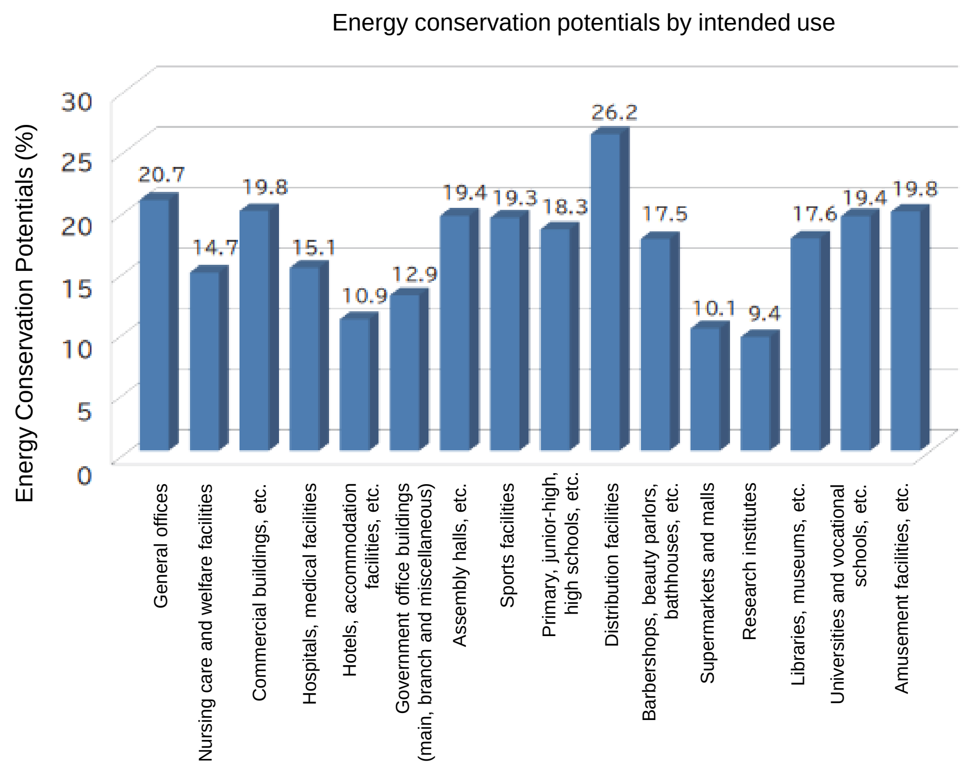


Energy conservation potential in offices and other facilities in the tertiary industry sector

Improvements to energy conservation performance of power and lighting equipment	Improvements to air conditioning energy conservation performance
● Copying machine ● Printer ● High efficiency router ● Server ● Storage ● Electric refrigerator ● Vending machine ● LED lighting, etc.	● Thermal insulation performance of buildings ● Promotion of Cool Biz and Warm Biz, etc. **Improvements to hot water supply equipment energy conservation performance** ● Latent heat recovery type hot water heater ● Commercial heat pump hot water heater ● High efficiency boiler, etc.

Source: Upper chart from Ministry of Economy, Trade and Industry "Energy White Paper" (2022), lower chart from Post-2020 Global Warming Countermeasures Study Subcommittee and Global Environment Subcommittee Pledge Draft Study Working Group Joint Meeting (5th session), prepared by Mizuho Bank Industry Research Department

Energy conservation potentials in buildings, mainly SMEs



Note: Energy conservation potential: Ratio of proposed energy conservation amount to energy consumption of target business establishments
Source: The Energy Conservation Center, Japan "Energy Conservation Guidebook for Buildings 2024" P12

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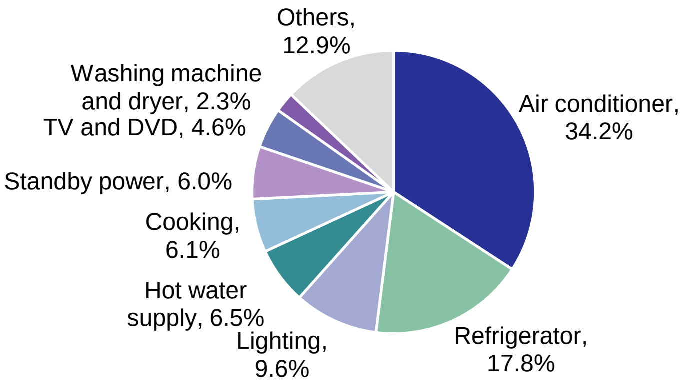
Electricity Consumption Composition and Energy Conservation Potential in the Household Sector

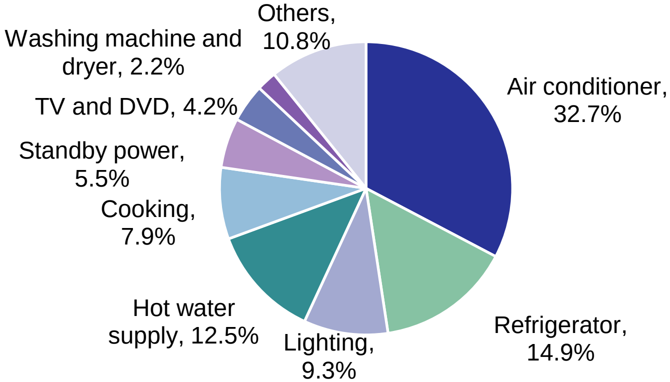
- In the household sector, air conditioners have the highest power consumption, followed by other applications such as refrigerators, lighting, hot water supply, and cooking
- We respectfully observe that home appliance energy conservation performance improvement, building thermal insulation performance improvement, and consumer electricity-saving behavior are key factors for advancing energy conservation

Electricity consumption ratio by home appliance

Summer season (13.1kWh/household･day)



Winter season (14.2kWh/household･day)



Source: Compiled by Mizuho Bank Industry Research Department based on Agency for Natural Resources and Energy "Energy Conservation Portal Site" and Ministry of Economy, Trade and Industry "FY2018 Electric Power Supply and Demand Countermeasures Public Relations Survey Project"

Energy conservation potential in the household sector

Energy conservation potential of home appliances

Improvements to energy conservation performance of power and lighting equipment
- Television
- Refrigerator
- DVD recorder
- Computer
- Microwave oven
- Rice cooker
- LED lighting, etc.

Improvements to air conditioning energy conservation performance
- Air conditioner
- Building thermal insulation performance, etc.

Improvements to hot water supply equipment energy conservation performance
- Latent heat recovery type hot water heater
- CO_2 refrigerant heat pump hot water heater
- Solar water heater, etc.

Impact of consumer behavioral change

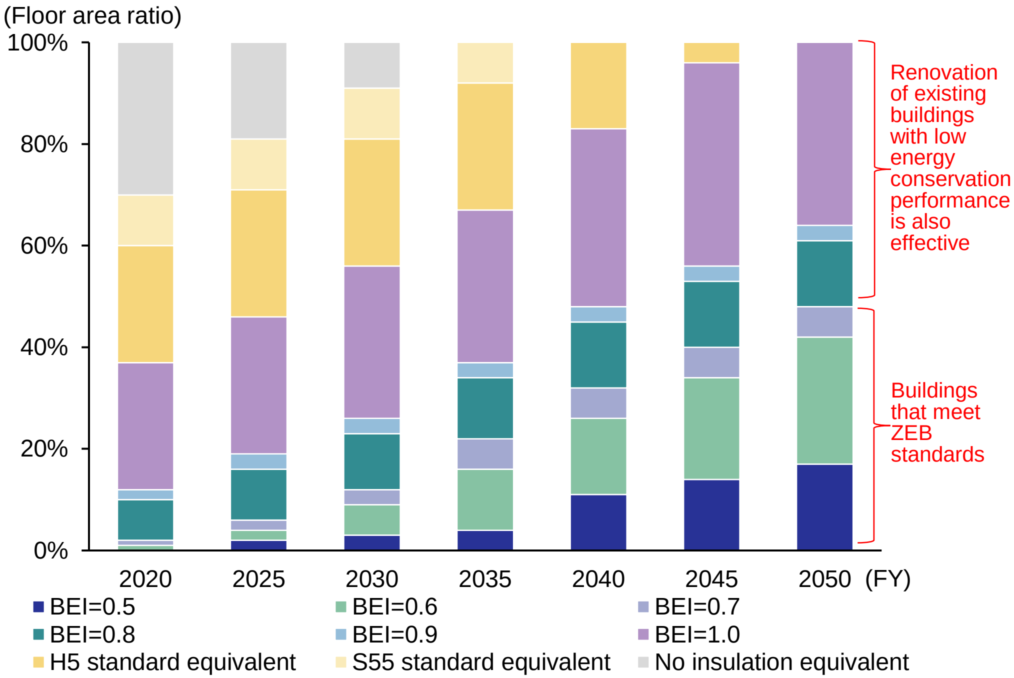
When lowering the heating set temperature by 1° C every day	In one winter… 53.08kWh savings
In the case of reducing heating operation by 1 hour per day	In one winter… 40.73kWh savings
In the case of choosing to live in an apartment building instead of a detached house	In one year… 40% savings in annual energy consumption

Note: Assumption of cooling period: 112 days, heating period: 169 days
Source: Compiled by Mizuho Bank Industry Research Department based on Post-2020 Global Warming Global Environment Subcommittee Pledge Draft Study Working Group Joint Meeting (5th session), Survey on the Actual Conditions of Carbon Dioxide Emissions from Residential Sector in FY2020 and Agency for Natural Resources and Energy "Energy Conservation Portal Site"

Improving the energy conservation performance of buildings is an urgent priority for energy conservation in the tertiary industry and household sectors

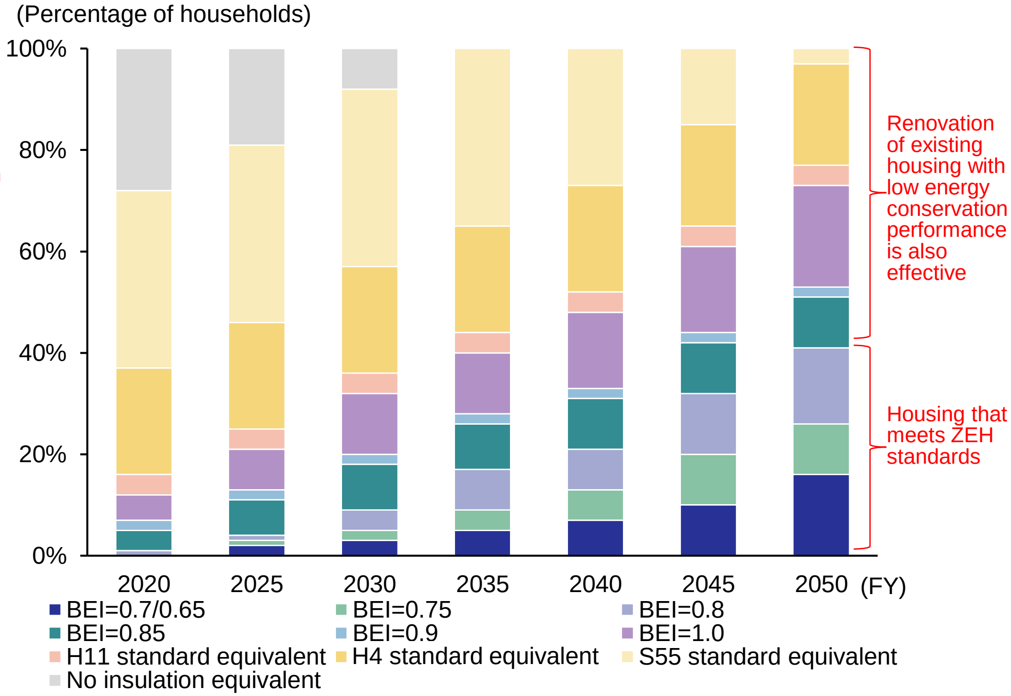
- To suppress energy consumption for air conditioning in the tertiary industry and household sectors, improving the energy conservation performance of buildings is necessary.
- The government is setting a target to make approximately 40% to 50% of the building and housing stock high energy conservation performance by 2050.
  - Considering the long service life of buildings, the construction of buildings with high energy conservation performance must be encouraged as early as possible.
  - Also, improving energy conservation performance through renovation of existing buildings and housing is an effective measure.

Share of building stock by performance level



Note 1: BEI: Building Energy Index, refers to the ratio of primary energy consumption of the design building compared to the reference building. For hotels, hospitals, etc., BEI≦0.7, for factories, offices, etc., BEI≦0.6 is evaluated as ZEB Oriented, BEI≦0.5 as ZEB Ready, etc.
Note 2: ZEB: net Zero Energy Building, a building that aims to achieve zero annual primary energy consumption balance
Note 3: S55 standard, H5 standard: Energy conservation standards established in Showa 55 and Heisei 5, respectively
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials from the Study Group on Energy Conservation Measures for Housing and Buildings toward a Decarbonized Society (5th session)

Share of housing stock by performance level

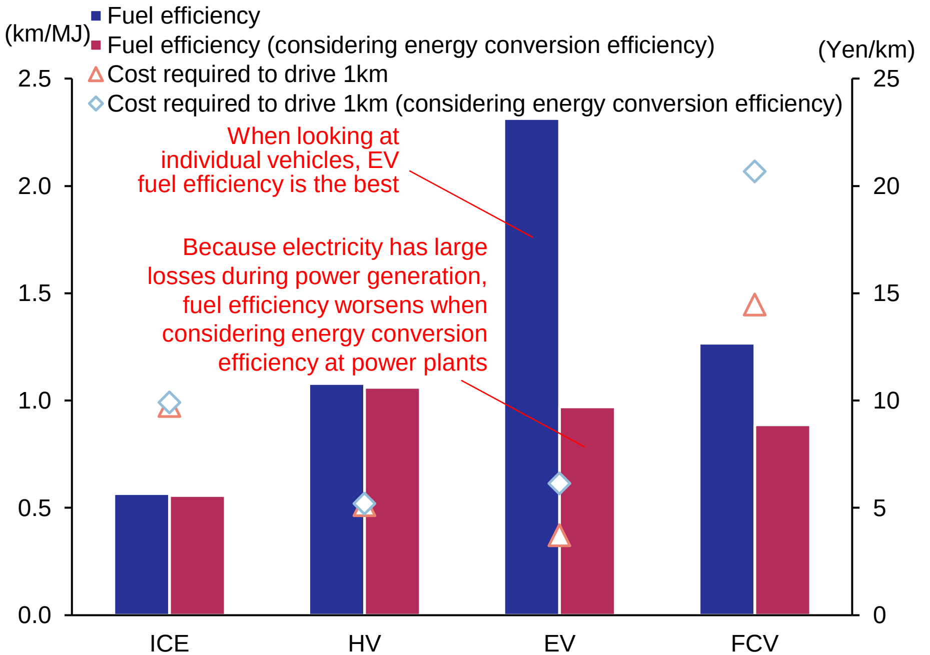


Note 1: BEI≦0.8 is one of the ZEH standards
Note 2: ZEH: net Zero Energy House, a house that aims to achieve zero annual primary energy consumption balance
Note 3: H4 standard: Energy conservation standard established in Heisei 4
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials from the Study Group on Energy Conservation Measures for Housing and Buildings toward a Decarbonized Society (5th session)

In the transportation sector, promotion of HV or EV adoption and modal shift are important

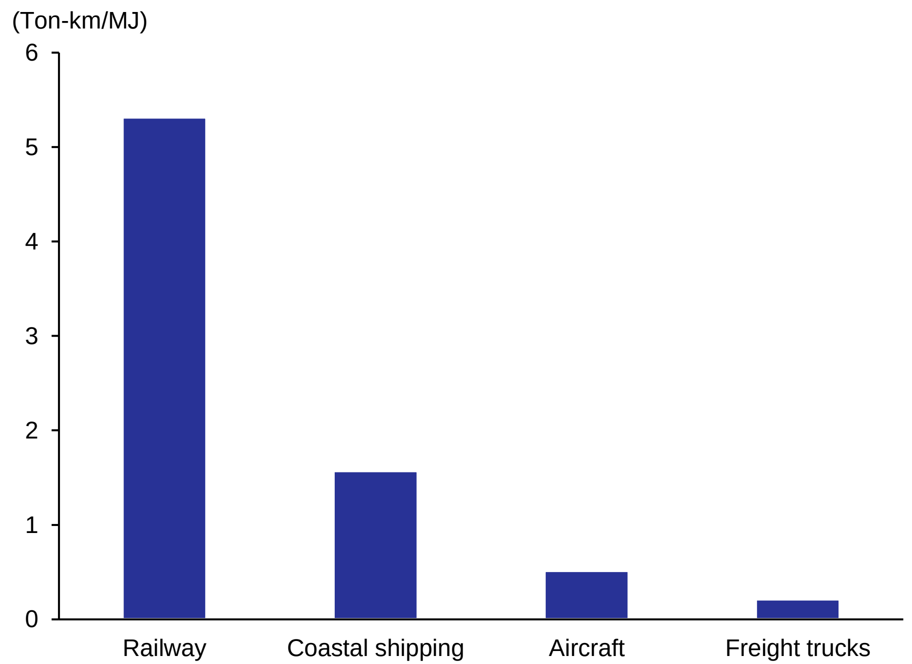
- When comparing passenger car fuel efficiency in energy content, EV fuel efficiency (distance that can be traveled with 1MJ) is the best, but because electricity has large energy losses during power generation, when considering energy conversion efficiency in the energy conversion sector, calculation results show that HV fuel efficiency is the best.
  - To achieve both decarbonization and energy conservation in society as a whole, liquid fuel decarbonization and HV adoption must be promoted together as a set, or promote power generation efficiency improvement, decarbonized power source expansion, and EV adoption as a set.
- Regarding freight transportation, because railways, coastal shipping, and aircraft have higher energy consumption efficiency than freight trucks, modal shift is important.

Fuel efficiency comparison by powertrain



Note 1: ICE: Internal combustion engine vehicle
Note 2: For fuel efficiency, ICE uses average values published by the Ministry of Land, Infrastructure, Transport and Tourism, HV uses Toyota Yaris catalog values, HV uses Toyota Lexus RZ300e catalog values, FCV uses Toyota MIRAI catalog values
Note 3: Assumes gasoline at 184 yen/L, electricity rate at 3 yen/1kWh, hydrogen at 2,200 yen/kg
Note 4: Energy conversion efficiency is calculated as output÷input from current energy balance and flow
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Ministry of Land, Infrastructure, Transport and Tourism website, Toyota Motor Corporation website, and Agency for Natural Resources and Energy "Energy White Paper"

Freight transportation ton-kilometers per energy consumption by transportation mode

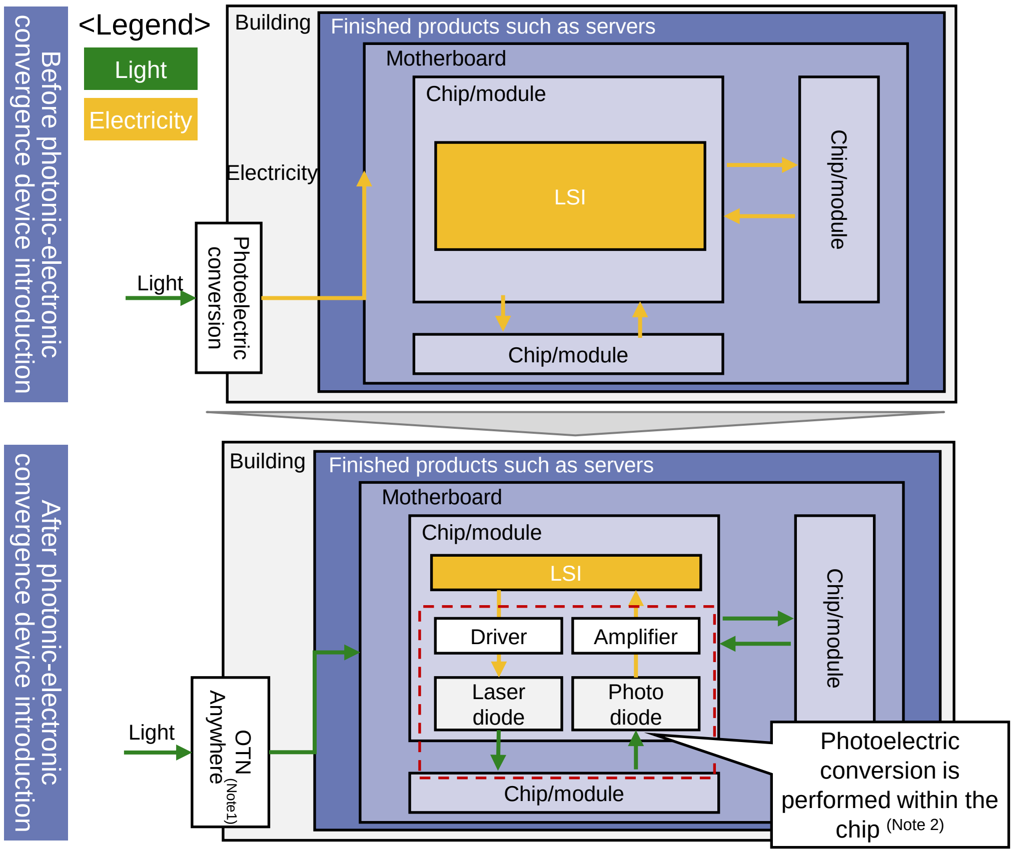


Note: Calculated as freight transportation ton-kilometers by transportation mode ÷ energy consumption
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics," Ministry of Land, Infrastructure, Transport and Tourism "Railway Transport Statistics Survey," "Coastal Shipping Transport Statistics Survey," "Air Transport Statistics Survey," and "Motor Vehicle Transport Statistics Survey"

Energy consumption is also expected to be reduced through new technological advancements - photonic-electronic convergence devices

- In photonic-electronic convergence devices, the location where photoelectric conversion is performed transitions to the deep interior of finished products (servers, etc.)
  - By suppressing transmission losses during data transmission and reducing standby power consumption in GPU accelerators, it becomes possible to reduce energy consumption.
- Japanese companies have advantages in various materials and processing/manufacturing process technologies, creating business opportunities.

Changes in photoelectric conversion location accompanying evolution of photonic-electronic convergence devices



Note 1: Terminal device equipped with delay visualization and delay adjustment functions
Note 2: Depending on the stage, there are also cases where photoelectric conversion is performed on the motherboard
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Layers where Japan can leverage strengths in the photonic-electronic convergence device value chain

Layer	Example directions for strengths/initiatives that can be utilized by Japanese companies
(1) Various materials	■ Initiatives by domestic material companies toward polymer optical waveguides and optical fiber adhesives for CPO
(2) LD and laser	■ Manufacturing of optical engine chipsets through technical collaboration between laser diodes and laser modules
(3) PD and other optical components	■ Visible light control technology utilizing lithium niobate ■ Knowledge of various MLCC manufacturing companies regarding barium titanate
(4) Substrate and package	■ Materials and processing/manufacturing process technologies related to high heat-resistant ceramic packages
(5) Various electronic components	■ Especially having advantages in materials and processing/process technologies for passive components (capacitors, etc.), maintaining and continuing that advantage by keeping those technologies confidential
Others	■ Rapidus's policy for utilizing IOWN technology in semiconductor manufacturing ■ NTT's research and development in the field of silicon photonics

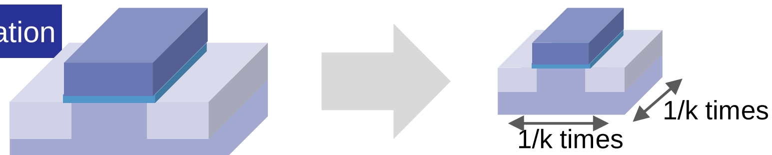
Note 1: LD: Laser diode
Note 2: PD: Photo diode
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Energy consumption is also expected to be reduced through new technological advancements - semiconductor and DC cooling technologies

- Besides photonic-electronic convergence, power consumption efficiency improvement is expected through information processing efficiency improvement from high semiconductor integration and advancements in data center cooling technology.
  - Japanese companies have strengths in semiconductor manufacturing equipment and materials, and are highly regarded by the global market as indispensable technologies in areas such as miniaturization and high density.
  - Japanese companies are also implementing cutting-edge auxiliary equipment introduction in data centers, and overseas expansion is expected.

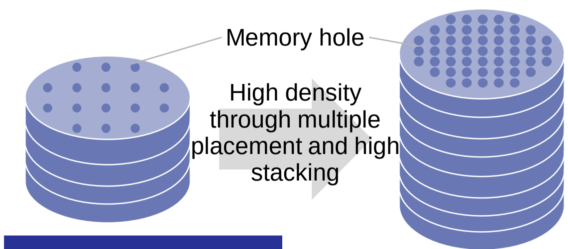
High integration of semiconductors

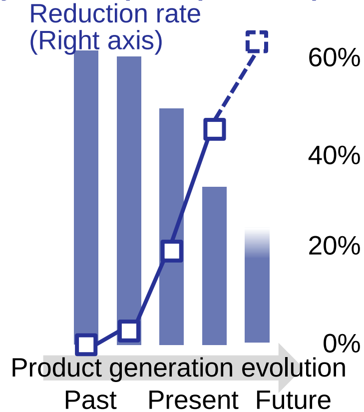
Miniaturization



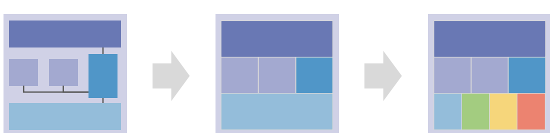
Semiconductor gate width and length are each 1/k
⇒Power consumption $1/k^2$

High density (Example) NAND memory





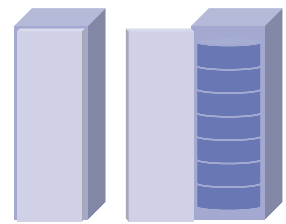
Advanced mounting



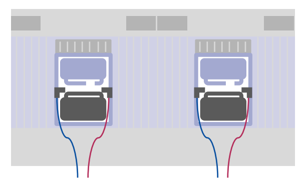
Through high integration, wiring and other components are shortened, and while improving information transmission and processing speed, energy efficiency is also improved

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on GX Implementation Council materials

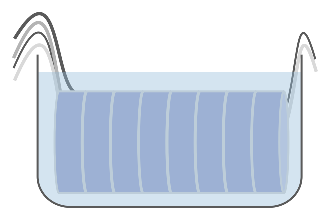
Latest DC cooling technology



Water-cooled rear door type air conditioning unit
Cooling is performed by installing a cross-flow heat exchanger that sends cold water and a fan at the rear of the rack, which is the exhaust section for high-temperature exhaust from servers.
- By configuring it to immediately recover server exhaust heat, heat exchange efficiency is increased, realizing high cooling performance and energy efficiency.
- Performance of approximately PUE 1.2 is expected.



Cold plate cooling
- A metal plate for cooling is attached to the chip, which directly dissipates heat generated from the chip
- Because direct heat exchange is performed between the coolant and chip through the metal plate, high cooling capacity and energy efficiency are realized
- Performance of approximately PUE 1.2 to 1.1 is expected.



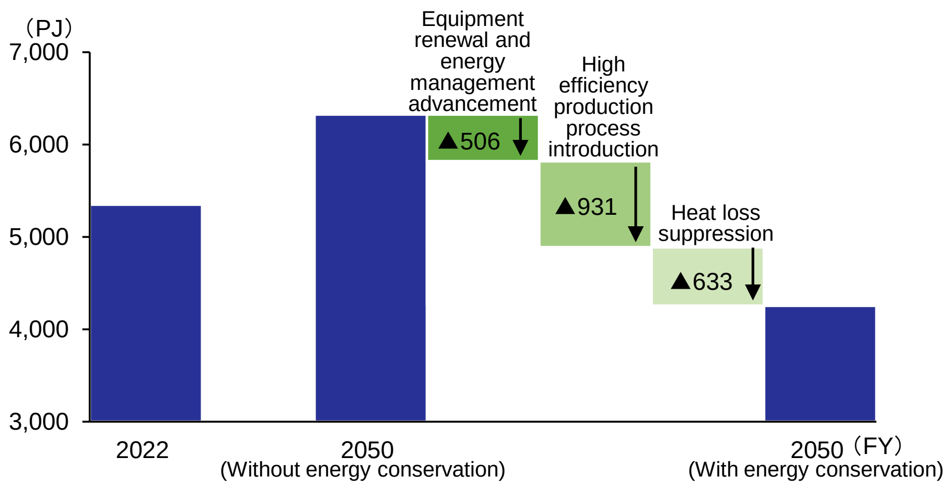
Liquid immersion cooling
- Servers are entirely immersed in a liquid tank filled with coolant for cooling.
- "Because the entire server is in direct contact with the coolant, cooling power is high, and cooling fans etc. are unnecessary, realizing high cooling performance and energy efficiency.
- Performance of approximately PUE 1.1 to 1.0 is expected.

Note: PUE: Power Usage Effectiveness, an indicator showing the power usage efficiency of data centers. The value obtained by dividing the total power consumption of the data center by the power consumption of ICT equipment such as servers
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Expert Group on the Development of Digital Infrastructures (DCs, etc.) (7th session)

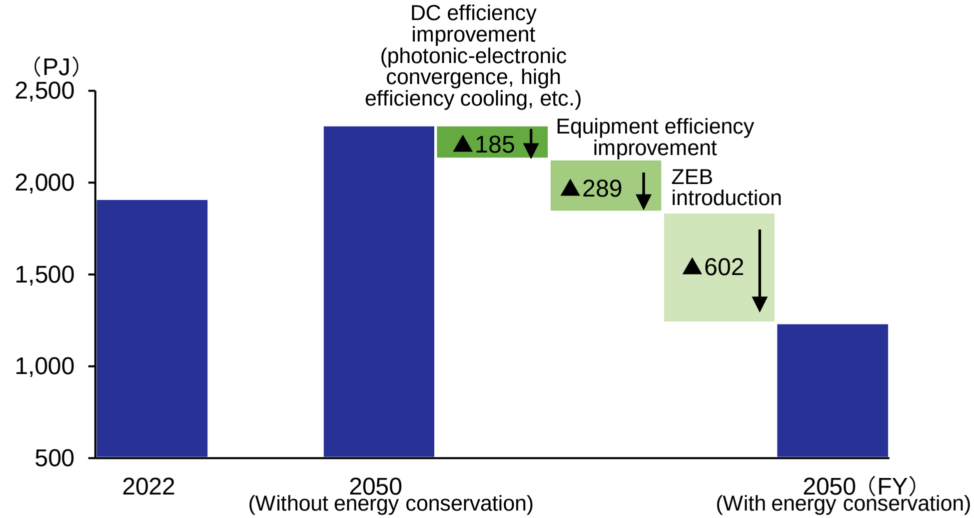
[Mizuho's Estimate] Final energy consumption outlook incorporating energy conservation effects

- The final energy consumption outlook incorporating energy conservation effects is as follows.

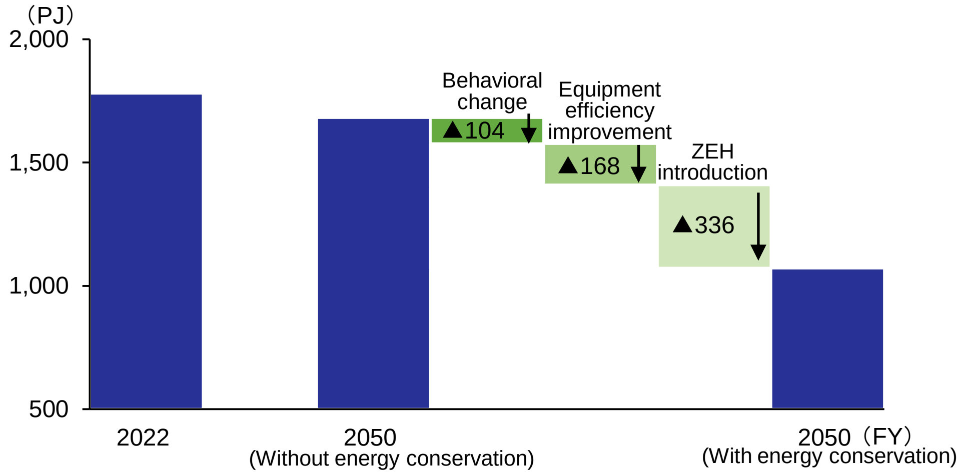
Primary and secondary industry sectors



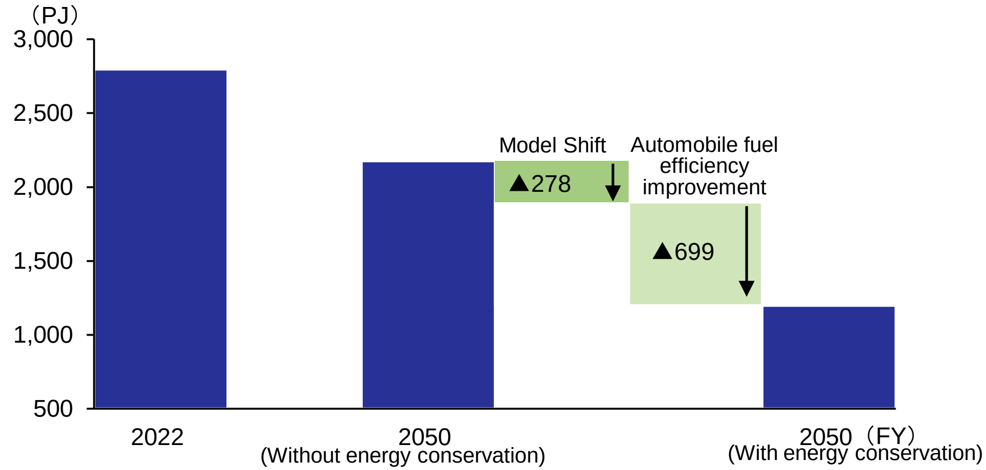
Tertiary industry sector



Household sector



Transportation sector

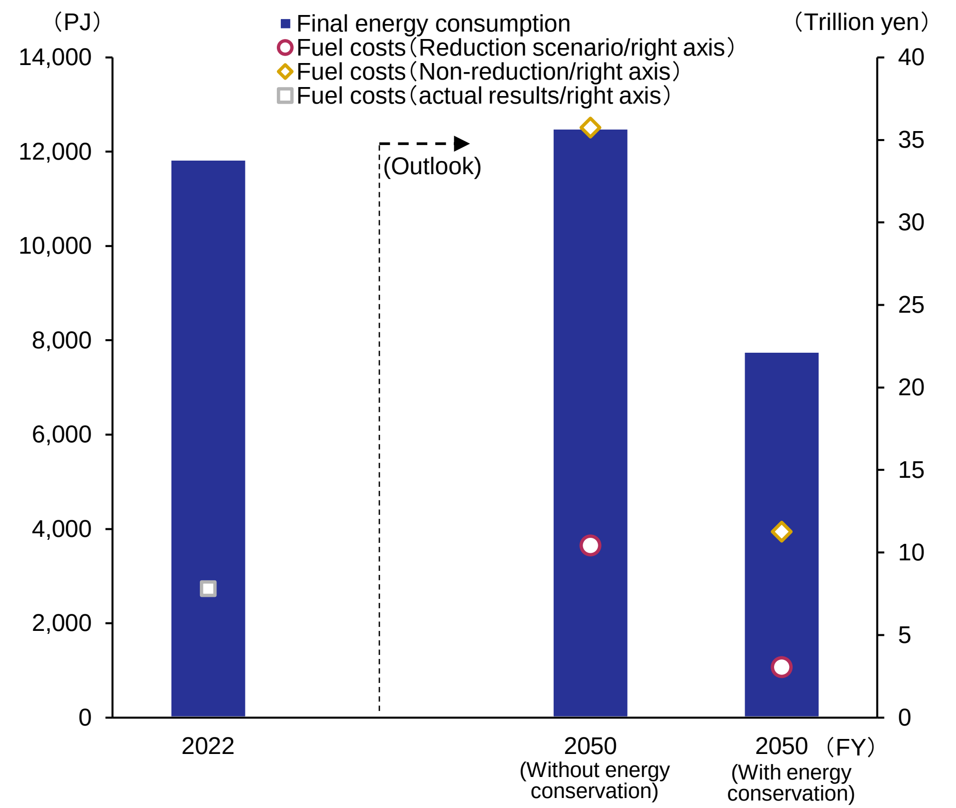


Note: FY2050 estimates by Mizuho Bank Industry Research Department
Source: All figures are compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics"

Energy conservation reduces overall energy consumption and fuel costs for thermal power generation, bringing positive impacts to all of Japan

- If energy conservation is realized to the maximum extent, final energy consumption is expected to decrease by approximately 35% compared to FY2022.
  - Fuel costs for thermal power generation are influenced by future energy prices and CCS costs, but there is also a possibility that they will decrease from current levels.
- Reducing fuel costs will generate positive effects, including enhanced industrial competitiveness, reduced burdens on households, and improved energy security.

Final energy consumption and fuel cost estimates after considering energy conservation



Note: FY2050 estimates by Mizuho Bank Industry Research Department
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics", IEA, World Energy Outlook 2024, and various reports.

Effects of fuel cost suppression

1 Strengthening industrial competitiveness

- By creating an industrial structure that can generate high added value with lower energy intensity, industrial competitiveness is improved compared to other countries
- By keeping outflow of national wealth to a minimum, capital accumulation within Japan is promoted

2 Reducing general household burden

- Through widespread adoption of energy-efficient equipment use and lifestyle habits, utility costs and fuel costs, which are said to account for several percent of general household expenditure are reduced
- Money flowing to other consumption and investment is increased, activating economic activity

3 Strengthening energy security

- In Japan, which is not blessed with energy resources, if energy procurement from overseas is interrupted, it has an adverse impact on economic activity
- By suppressing energy import volume, risks in terms of energy security are reduced

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

[Mizuho's Hypothesis] Approaches to areas with large energy conservation potential are efficient

- To efficiently promote energy conservation, we infer it is important to provide carrots and sticks targeted at energy conservation measure implementing entities and energy conservation technology providers, with priority given to areas with large energy conservation potential.
- If Japan itself is viewed as an energy consumer with energy conservation potential, a macro approach toward society as a whole is also effective.

Areas with large energy conservation potential and approaches

Large energy conservation potential ↑

Sectors	Energy conservation methods	Main energy consumers	Energy conservation measure implementing entities	Energy conservation technology providers
Primary and secondary industries	High efficiency production process introduction	High energy-consuming companies	Same as left	Industrial equipment manufacturers
Transportation	Automobile fuel efficiency improvement	Automobile users	Same as left	Automobile manufacturers
Primary and secondary industries	Heat loss suppression	High energy-consuming companies	Same as left	Industrial equipment manufacturers
Tertiary industry	ZEB introduction	Building tenant companies	Building owners	Building materials, construction companies
Primary and secondary industries	Equipment renewal and energy management advancement	High energy-consuming companies (especially small and medium enterprises)	Same as left	Industrial equipment manufacturers

Approach	
Approach 1	Efficiently promote energy conservation by providing carrots and sticks targeted at energy conservation measure implementing entities and energy conservation technology providers, with priority given to areas with large energy conservation potential (micro approach)
Approach 2	Promote energy conservation by attempting to change the status quo, targeting society as a whole such as economic structure and citizen awareness (macro approach)

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

[Mizuho's Hypothesis] Measures to aim for energy consumption suppression (micro approach)

- To further build upon the advances in energy conservation that have been achieved thus far, government support and regulation become important.
  - First of all, as mentioned above, an approach toward consumers with large energy conservation potential centered on the industrial sector can be considered.
  - Also, regardless of energy conservation potential within Japan, technologies that contribute to energy conservation and where Japan has strengths (automobiles, insulation materials, semiconductor manufacturing equipment and materials, photonic-electronic convergence, DC cooling technology, etc.) should also aim for foreign currency acquisition by striving to maximize added value with energy conservation performance as a differentiation factor.

Strengthening supportive and regulatory measures for energy consumers and energy conservation measure implementing entities

Energy consumers in energy-intensive industries

- Introduction of energy conservation equipment and energy conservation processes is difficult due to financial constraints, etc.
- Unable to grasp latest technologies that contribute to energy conservation

<Carrot>
- Expand subsidies and interest subsidies for energy conservation equipment and energy conservation process support

<Stick>
- Expand the scope of coverage of the Energy Conservation Law
- Raising carbon pricing

Government

- It becomes easier to proactively introduce energy conservation equipment and energy conservation processes
- Contribute to Japanese industry competitiveness strengthening through energy cost suppression

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Expansion of support for energy-saving equipment and technology suppliers

- Identify technologies that contribute to energy conservation and where Japan has strengths
  - Hybrid vehicles (contribute to fuel consumption suppression)
  - High thermal insulation building materials for ZEB (contribute to building and housing energy consumption suppression)
  - Manufacturing equipment and materials that contribute to semiconductor high integration (contribute to power consumption suppression)
  - Photonic-electronic convergence and DC cooling technology (contribute to power consumption suppression)

- Government backs up manufacturers
  - Provide focused support for manufacturers' technology development related to energy conservation products
  - Prioritize introduction of equipment with high energy conservation performance in government procurement
  - Support overseas expansion through energy conservation equipment sales in AZEC and Japanese energy conservation technology transfer utilizing ODA

- By maximizing added value with energy conservation performance as a differentiation factor and expanding to global markets, contribute not only to own country's energy conservation but also to world energy conservation, and also acquire foreign currency

Contribute to transformation toward Japan's industry tomorrow

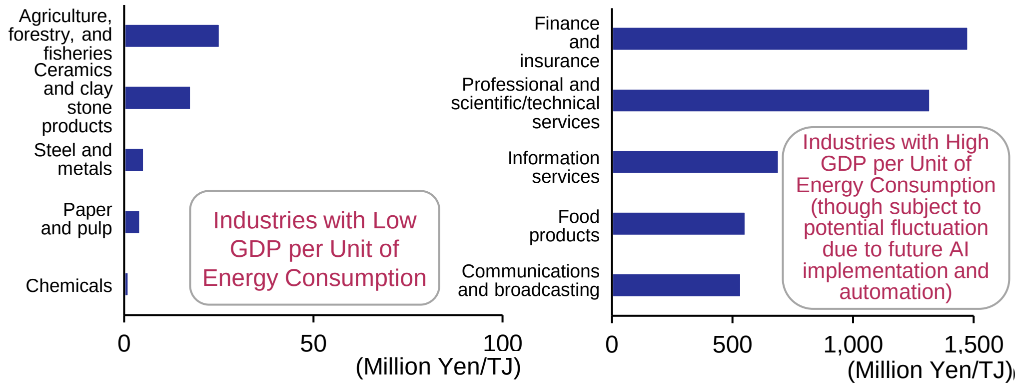
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

[Mizuho's Hypothesis] Measures to aim for energy consumption suppression (macro approach)

- To achieve GDP growth while controlling energy consumption, it is necessary to transition from an industrial structure centered on energy-intensive industries to one where industries with high GDP per unit of energy consumption expand.
- Additionally, since the household and transportation sectors are predominantly characterized by energy use by general consumers, it is also important to appeal to general consumers about the significance of energy conservation and promote behavioral change.

Shift to industrial structure with high GDP per unit of energy consumption

GDP per Unit of Energy Consumption (as of 2022/reposted)



By transitioning from energy-intensive heavy and chemical industries to an industrial structure centered on finance, communications, and information services with high GDP per unit of energy consumption, both energy conservation and economic growth can be achieved simultaneously.

To become an international financial center...
- Expansion of English speakers
- Fostering growth expectations for the domestic ('mother') market
- Flexible institutional responses by financial regulatory authorities, etc. are considered necessary

To strengthen communications and information services…
- IT talent development
- Fostering and attracting AI companies within Japan
- Support for data center infrastructure development, etc. are considered necessary

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Cabinet Office Economic and Social Research Institute "Annual Report on National Accounts" and Agency for Natural Resources and Energy "Comprehensive Energy Statistics"

Promoting behavioral change among general consumers

Government Awareness and Information Dissemination

Information dissemination through education and awareness activities for general consumers
Notification that fuel costs may rise and electricity bill burdens may become heavier as decarbonized power sources are introduced

Raising Public Awareness Among General Consumers

Fostering correct public understanding regarding the importance of decarbonization and energy conservation

Behavioral Change Among General Consumers

Temperature adjustment and reduction of operating hours for air conditioning
Active introduction of ZEH (Zero Energy Houses)
Living in collective housing rather than detached houses
Active switching to fuel-efficient vehicles

Advancement of Energy Conservation Nationwide Centered on Household and Transportation Sectors

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

3. Measures for Stable Power Supply, Emission Reduction, and Energy Cost Reduction

On the supply side, a comprehensive approach with balanced prioritization is required, taking into account the characteristics of power sources and technology timelines

- For electricity, since each power source type has different characteristics, complementarity between power source types is necessary to maintain stable supply. While there are technologies expected to achieve breakthroughs, their realization timelines differ, and it is currently unclear which technology will stand out.
- The supply side is expected to take a comprehensive approach, but at the same time, gentle prioritization is also necessary.
  - Hereafter in this section, individual issues will be identified and priorities will be examined.

Characteristics of power source types

Power Source Type	Advantages	Disadvantages
Renewable Energy (Solar, Wind)	• Zero marginal cost • No CO2 emissions during generation	• Power output depends on solar irradiance and wind conditions
Fossil Fuel Thermal Power	• Relatively easy to control power output	• Dependence on overseas fuel procurement • Fluctuating fuel costs • CO2 emissions during generation
Nuclear Power	• No CO2 emissions during generation • Stable power generation possible	• Restart of idle plants requires time • High-level radioactive waste disposal required
Hydrogen/ Ammonia Dedicated or CCS-equipped Thermal Power	• No CO2 emissions during generation or considered virtually carbon-free	• Large-scale supply chains for hydrogen/ammonia and CO2 not yet established • Higher fuel costs or CCS costs compared to fossil fuel thermal power

- ✓ Since each power source type has different characteristics, complementarity between power source types is necessary to maintain stable supply, and Japan should not depend on any specific generation method
- ✓ For renewable energy, expand primarily solar and wind power, which have room for growth
- ✓ For thermal power, maintain certain generation capacity and fuel procurement while pursuing low-carbon and decarbonization
- ✓ For nuclear power, pursue maximum utilization with safety assurance as the fundamental prerequisite

Technologies expected to achieve breakthroughs

Technology	Overview	Timeline
Perovskite Solar Cells	• Solar cells manufactured using mixed organic and inorganic materials with the same crystal structure as perovskite • Contributes to expansion of installation sites	• ~2030: Mass production system establishment • 2030~: Mass production and cost reduction
Floating Offshore Wind Power	• Power generation method installed on offshore floating structures • Can be installed in deep-water areas	• Operating track record in Europe • Japan plans to establish introduction targets through 2040 at government review meetings in FY2025
Marine Resources	• Resources sleeping on the seabed • If developed, energy security would improve	• 2030~: Aim to start commercial projects (methane hydrate)
Next-generation Geothermal Power	• Not affected by natural terrain, eliminating steam volume uncertainty • High site selectivity	• ~2030: Demonstration and technology establishment • 2030~: Accelerated social implementation
Fusion Power Generation	• Power generation through nuclear fusion	• 2030~: Power generation demonstration • Around 2050: Practical application prospects

- ✓ It is currently unclear which technology will stand out
- ✓ Technologies with the potential to be game-changers tend to have longer timelines for realization

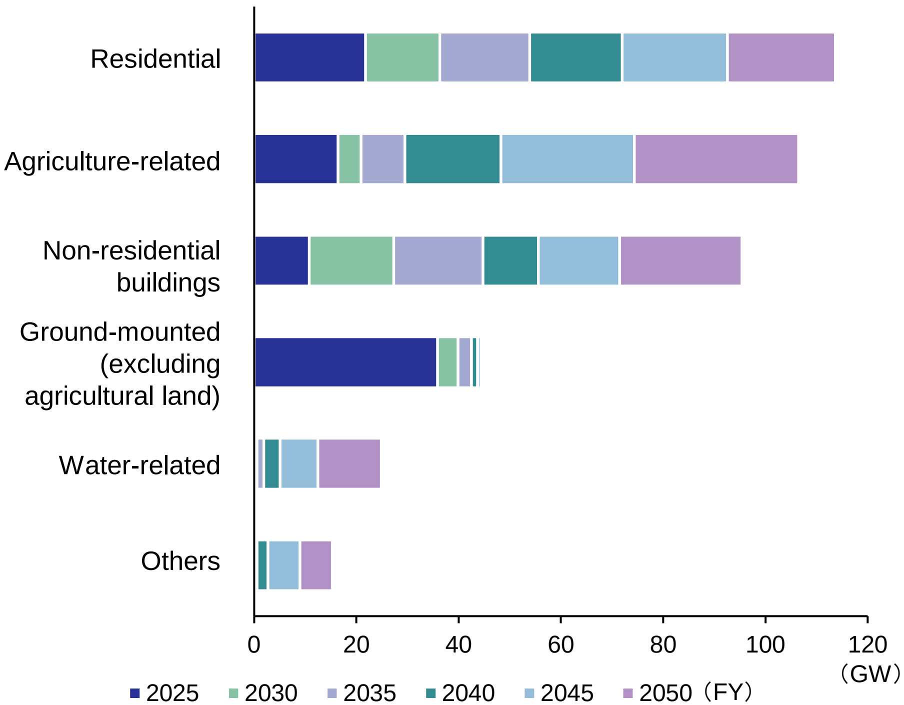
While the supply side is basically expected to take a comprehensive approach, government budgets and corporate capital are finite, requiring gentle prioritization as well.

Source: Both figures compiled by Industry Research Department, Mizuho Bank, Ltd.

[Power Source Type (1) Renewable Energy] Sites with high introduction potential have been identified, and steady development promotion is expected

- Among renewable energy sources, solar power generation is expected to be introduced not only through ground-mounted installations but also in residential, agriculture-related, and non-residential building applications.
- For onshore wind power, accelerating introduction through resolution of site constraints and lead time reduction is important for maximum deployment, with introduction potential existing in forest conservation areas and natural parks. For offshore wind power, abundant potential exists in Hokkaido, Tohoku, and Kyushu regions, with expansion into EEZ (Exclusive Economic Zone) also anticipated.

Solar power generation introduction outlook by category (prepared by Japan Photovoltaic Energy Association)

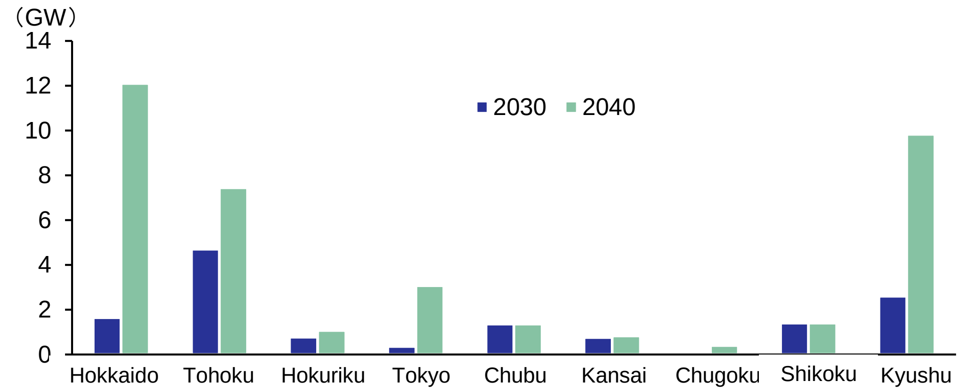


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Subcommittee on Mass Introduction of Renewable Energy and Next-Generation Power Networks (64th session), Japan Photovoltaic Energy Association "Challenges and Initiatives for Expanding Solar Power Generation"

Measures to resolve site constraints for onshore wind power generation and potential (prepared by Japan Wind Power Association)

Measures	Introduction Potential
Promoting site development within forest conservation areas (relaxation of designation removal requirements, etc.)	136 GW
Resolution of site constraints within natural parks (relaxation of permit standards for activity regulations in Special Areas Type 2 and Type 3)	24 GW
Promoting site development in green corridors	17 GW
Promoting site development in abandoned farmland and degraded agricultural land (relaxation of agricultural promotion area removal requirements)	5 GW

Regional Offshore Wind Power Generation Introduction Image

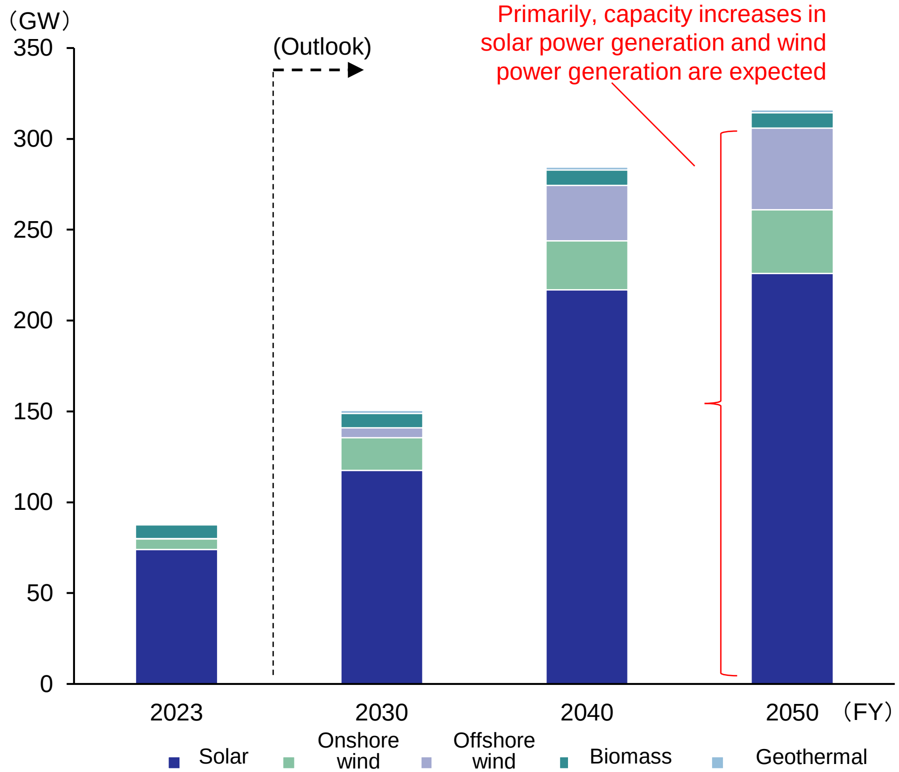


Note 1: Green corridors: Networks centered on protected forests that protect and manage habitats for rare wildlife, etc.
Note 2: Where ranges exist in the figures below, median values are adopted
Note 3: Regional divisions are based on general transmission and distribution operator supply areas
Source: Upper figure from Japan Wind Power Association "JWPA Wind Vision 2023," lower figure from Vision for Offshore Wind Power Industry (1st), Compiled by Industry Research Department, Mizuho Bank, Ltd.

[Power Source Type (1) Renewable Energy] Solar and wind power are expected to be drivers for capacity enhancement, but challenges are also identified

- Toward 2050, strengthening renewable energy generation capacity is essential to achieve both responding to increased electricity demand and achieving carbon neutrality.
  - Primarily, capacity enhancement of solar power generation and wind power generation is expected.
- However, challenges have also been identified for expanding renewable energy capacity, requiring coordinated public-private responses to individual issues.
  - There are areas where technological development progress is strongly expected to overcome challenges, and initiatives toward social implementation of innovative technologies are also necessary.

Renewable energy generation capacity outlook



Note: FY2030 figures are government targets; FY2040 and FY2050 are Mizuho Bank Industry Research Department estimates

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics" and Agency for Natural Resources and Energy published materials, etc.

Challenges identified for energy basic plan formulation

<u>Challenges for Making Renewable Energy a Main Power Source</u>

1. <u>Challenges for Expanding Renewable Energy Introduction</u>
   1) Coexistence with local communities
   2) Suppression of public burden
   3) Response to output fluctuation
   4) Acceleration of innovation and supply chain construction
   5) Response to end-of-life solar panels
2. <u>Challenges by Power Source Type</u>
   1) Solar Power Generation
      — Expansion of installation sites (with agricultural land installation and perovskite solar cell development in mind)
   2) Wind Power Generation
      — Expansion of suitable sites
      — Steady project formation for offshore wind power
      — Development of transmission networks

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Subcommittee on Mass Introduction of Renewable Energy and Next-Generation Power Networks (71st session) "Summary of Discussions Toward Formulation of the Next Energy Basic Plan"

MIZUHO

[Power Source Type (1)-1 Solar Power] Energy supply increases through cutting-edge generation methods are also expected ~ Perovskite Solar Cells ~

- There are two types of perovskite solar cells (single junction), depending on the substrate: film type and glass type. The film type is expected to be introduced in locations where silicon solar cell installation has been difficult, leveraging its lightweight and flexible characteristics.
- Tandem solar cells, which are made by stacking two different solar cells and improve conversion efficiency by absorbing the wavelengths that are each cell's specialty, are one of the important approaches for increasing solar power generation as they enable improvement in power generation per unit area.

Approaches to increase power generation in perovskite solar cells

Limited Suitable Sites / Decrease in New Solar Panel Installation Potential

Development of new installation locations that were previously difficult to use

Improvement in power generation per unit area, including replacement of existing installations

Single Junction

Film type

(From SEKISUI CHEMICAL)

(From Toshiba Energy Systems & Solutions Corporation)

- Uses PET films as substrates to achieve **lightweight and flexible** modules
- Can be installed on low load-bearing roofs and walls where silicon solar cells were difficult to install
- Scaling up and improving durability are challenges

Glass type

(Both from Panasonic Holdings)

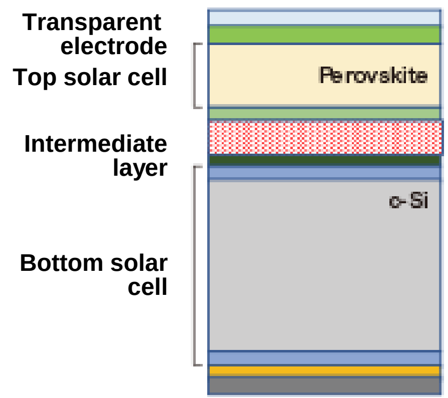
- Uses glass substrates to achieve modules with a certain transparency
- Can be installed as building materials on windows of high-rise buildings and residences
- Easier to ensure durability compared to films

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on published materials from SEKISUI CHEMICAL, Toshiba Energy Systems & Solutions Corporation, and Panasonic Holdings

Tandem type
(Stacking two different solar cells to achieve high efficiency)

〈Example: Perovskite/heterojunction crystalline silicon solar cells in tandem configuration〉

(From Kaneka)



- Apply a perovskite power generation layer on top of silicon solar cells to improve conversion efficiency by leveraging differences in absorption wavelengths
- Can increase power generation per unit area by replacing existing silicon solar cell installations
- Currently in R&D stage, aiming to improve conversion efficiency

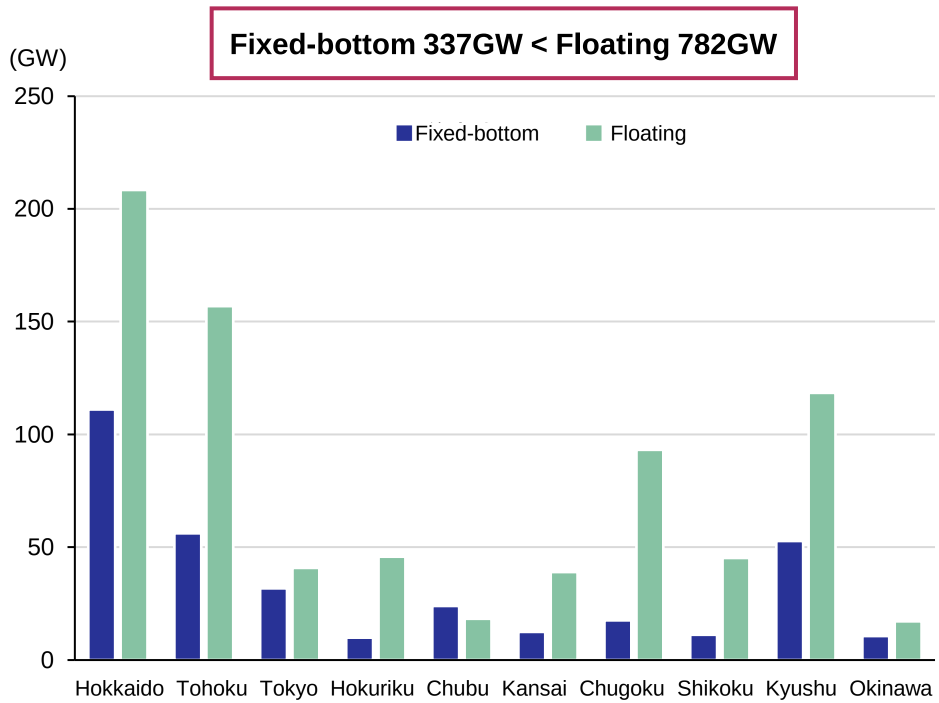
Note: The tandem type connects two different types of solar cells in series, and combinations with solar cells other than silicon solar cells also exist.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Kaneka website

[Power Source Type (1)-2 Wind Power] Energy supply increases through cutting-edge generation methods are also expected ~ Floating Offshore Wind Power ~

- Floating offshore wind power generation has high potential for introduction in deep sea areas and possesses higher potential compared to fixed-bottom installations in Japan, which has a vast exclusive economic zone relative to its land area.
- By promoting domestic establishment of floating offshore wind power generation supply chains, new industry creation and cost reduction through mass production can be expected, making it a key to achieving carbon neutrality.

Offshore wind power generation capacity potential estimates



Note 1: Regional divisions are based on general transmission and distribution operator supply areas

Note 2: Generation capacity is calculated by installable area (km²) × equipment capacity per unit area (kW/km²). Installable area is the total sea area where wind speed at 140m above sea level is 6.5m/s and distance from land is less than 30km. Equipment capacity per unit area is 8,000kW/km²

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Ministry of the Environment Renewable Energy Information Provision System [REPOS]

Advantages of floating offshore wind power

Advantages of Floating Offshore Wind Power	
Installation Environment	✓ Can be installed in windy offshore areas, enabling increased power generation and expected reduction in generation costs ✓ Less susceptible to earthquake impacts ✓ Can be installed in deep-water areas
Technology and Infrastructure	✓ Floating structures can be applied to various sea areas with the same design, enabling mass production ✓ Installation may be possible without using self-elevating platforms (SEP vessels) in some cases (though other types of vessels may be required)

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Japan's Floating Offshore Wind Group "Expectation and Foresight of FOW in Japan"

MIZUHO

[Power Source Type (2) Thermal Power] Thermal power generation is undergoing low-carbon and decarbonization studies in various locations, but challenges also exist

- Electric power companies are working on decommissioning inefficient coal-fired power plants and building new or replacing gas-fired power generation, while also participating in hydrogen and ammonia supply hub formation and advanced CCS project frameworks. Studies for low-carbon and decarbonization of thermal power generation are advancing in various locations.
- However, multiple challenges also exist, and for steady low-carbon and decarbonization of thermal power generation, investment predictability improvement and stable long-term fuel procurement must also be considered.

Major plans for CCS and hydrogen/ammonia co-firing at power plant sites

Decarbonization Method	Project Name/ Location	Participating Companies & Overview
Addition of CCS Equipment to Existing Thermal Power Plants	Tomakomai Area	• Japan Petroleum Exploration, Idemitsu Kosan, Hokkaido Electric Power • Separate, capture, and inject/store CO2 emitted from power plants and refineries
	East Niigata Area	• Japan Petroleum Exploration, Tohoku Electric Power, Mitsubishi Gas Chemical, Hokuetsu Corporation • Separate and capture CO2 emitted from thermal power plants and factories, inject and store in existing oil and gas fields
	Kyushu West Offshore CCS Project, etc.	• West Japan Carbon Storage Survey, ENEOS, ENEOS Xplora, Electric Power Development • Separate, capture, transport, and store CO2 emitted from thermal power plants and refineries in the Setouchi and Kyushu regions
Hydrogen Co-firing at Gas-fired Power Plants	Kansai Region (Himeji No.2 Power Station)	• Kansai Electric Power implementing demonstration with NEDO subsidies • Plans hydrogen co-firing during Osaka-Kansai Expo period using existing generation equipment
Ammonia Co-firing at Coal-fired Power Plants	Tomakomai Area (Tomato-Atsuma Power Station)	• Hokkaido Electric Power, Hokkaido Mitsui Chemicals, IHI, Marubeni, Mitsui & Co., Tomakomai Port • Studying overseas ammonia receiving, storage, and supply hub development, with ammonia co-firing in coal-fired power as one application
	Chubu Region (Hekinan Thermal Power Station)	• JERA and Chubu Region Hydrogen/Ammonia Social Implementation Promotion Conference member companies studying hydrogen/ammonia supply chain construction in Chubu region • Co-firing studies at coal-fired power plants are advancing

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on company press releases, etc.

Challenges for thermal power generation decarbonization

Challenge 1

Capital investment for CN conversion is required, but with declining capacity utilization rates for thermal power generation, investment predictability is low.
Even when investment decisions are made, there are concerns about insufficient capacity among manufacturers and contractors.

Challenge 2

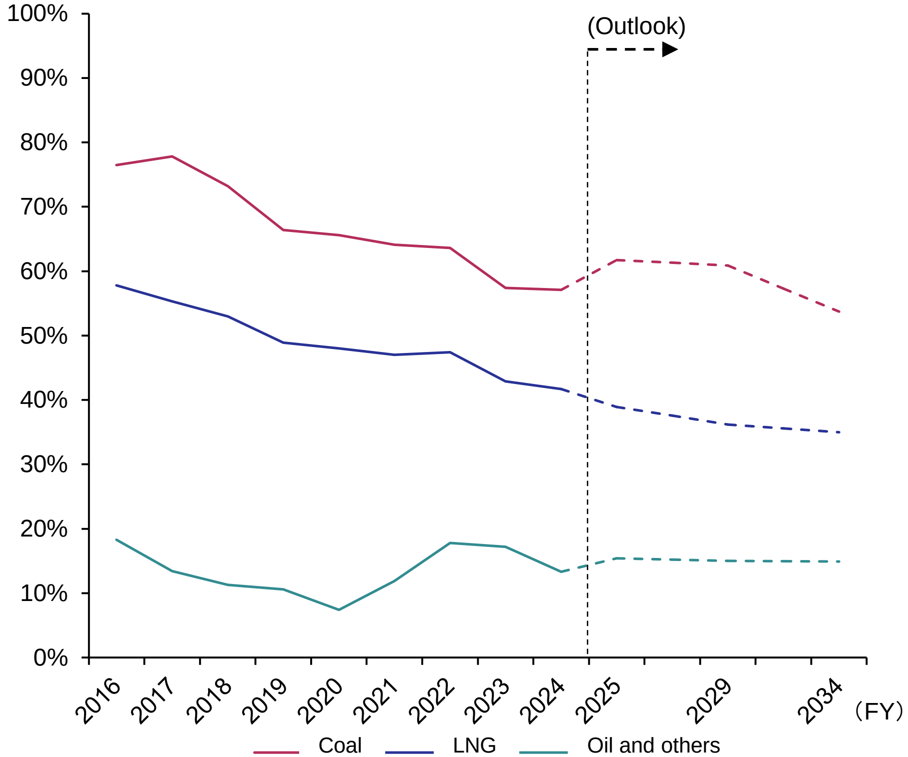
Long-term contracts are decreasing due to CN trends, etc., and there is a risk of being outbid for fuel needed to operate thermal power plant in the future.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

[Power Source Type (2) Thermal Power] Mechanisms contributing to low-carbon and decarbonization of thermal power generation are being introduced, but there is room for further deepening

- With the expansion of renewable energy introduction, the capacity utilization rate of thermal power generation is declining. Under these circumstances, equipment upgrades and new construction for low-carbon and decarbonization of thermal power generation face reduced investment predictability.
  - — Additionally, securing capacity from manufacturers and contractors is also important for equipment upgrades and new construction.
- While mechanisms such as Long-Term Decarbonization Power Source Auction that ensure investment predictability are being introduced, we respectfully observe that there is room for further deepening.

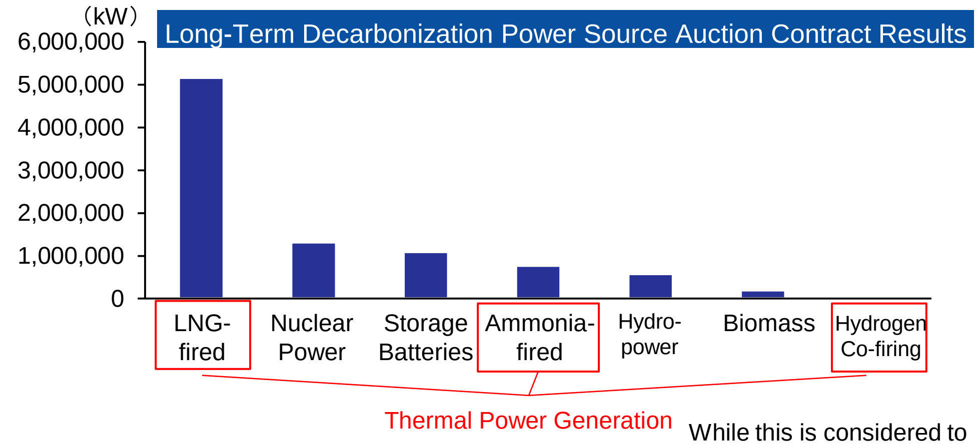
Thermal power generation capacity utilization rate trends



Note: FY2025 and onwards are Organization for Cross-regional Coordination of Transmission Operators, Japan outlook

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Organization for Cross-regional Coordination of Transmission Operators, Japan "Aggregation of Electricity Supply Plans for FY 2025"

Existing measures and room for further deepening



While this is considered to contribute to securing future decarbonized power sources to some extent...

Room for Deepening:
- Long-Term Decarbonization Power Source Auction could enhance investment predictability for businesses by showing multi-year procurement plans rather than single-year plans
- Construction of thermal power plants and equipment upgrades for CN conversion require cooperation from manufacturers and contractors. It is necessary to build a system where not only power plant owner companies but the entire supply chain collaborates to increase CN power source capacity

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Organization for Cross-regional Coordination of Transmission Operators, Japan "Capacity Market Long-Term Decarbonized Power Auction Contract Results (Bidding Year: FY2023)"

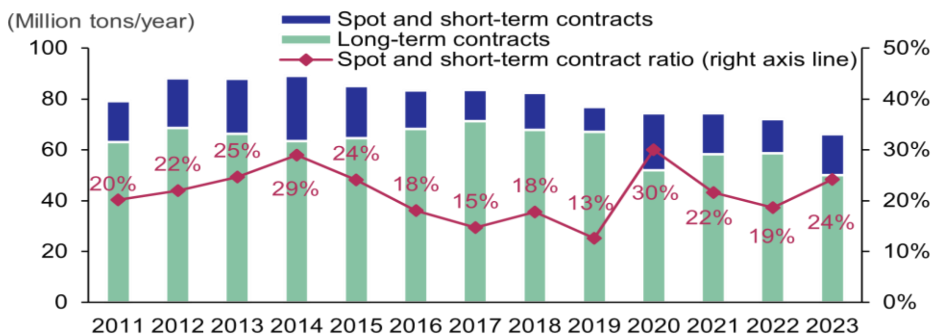
[Power Source Type (2)-1 Gas-fired Thermal Power] Measures that contribute to concluding long-term contracts are required for stable fuel procurement

- Taking LNG, which plays an important role in the low-carbon transformation of thermal power generation, as an example, Japan has a high ratio of long-term contracts, which also suppressed the impact of price surges stemming from Russia's invasion of Ukraine. However, with uncertain future operating conditions for thermal power generation, consumers are cautious about long-term contracts.
  - This is a challenge common to the procurement of decarbonized fuels such as hydrogen and ammonia, and CCS-equipped thermal power.

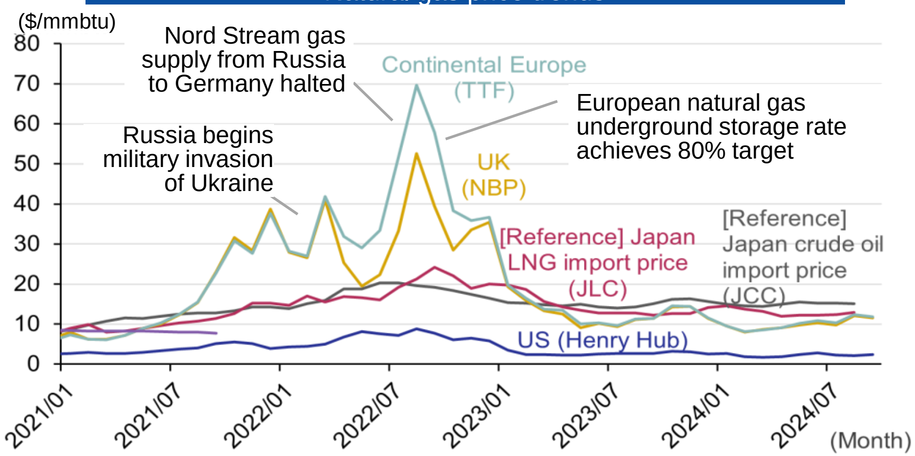
- The government is required to implement measures that make it easier to forecast fuel demand, thereby contributing to private companies' conclusion of long-term contracts.

Japan's LNG procurement status and price trends

Japan's LNG Spot and Short-term Contract Ratio



Natural gas price trends



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on GIIGNL "Annual Report 2024," S&P Global Commodity Insights, etc.

Measures to make fuel demand forecasting easier

Factors Making Long-term Contract Conclusion Difficult:
- Difficult to forecast long-term operating rates of thermal power plants and fuel consumption, making it hard to conclude long-term fuel offtake contracts
- With strict scrutiny on fossil fuel use amid carbon neutrality declarations by various countries, cannot exclude risks of further strengthening of global decarbonization policies that could make LNG use difficult or cause trading market contraction, making it difficult to commit to long-term contracts

Room for Deepening:
- Make it easier for power generation companies to forecast fuel demand by requiring retail electricity providers to obligate long-term electricity contracts
- Create a scheme where the government conducts long-term offtake of certain fuel quantities from overseas for ten to several decades, then sells to consumers such as electric power companies through several-year short-term contracts, allowing the government to take supply-demand mismatch risks and ensure energy security

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

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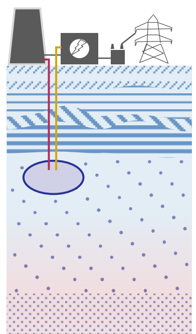
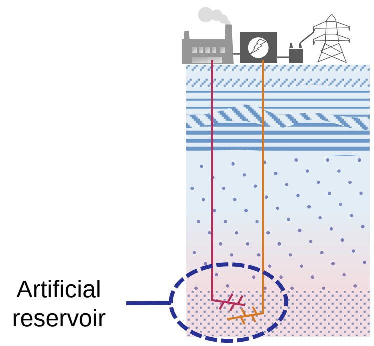
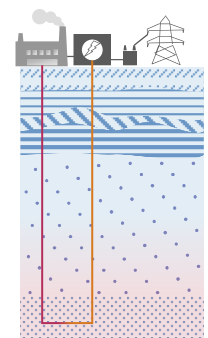
[Breakthrough Technology (1)] Energy supply increases are expected in the future, though the timeline is distant ~ Next-Generation Geothermal ~

- Japan possesses the world's third-largest abundant geothermal resource reserves, but due to technical challenges and other factors, power generation capacity relative to resource reserves is limited. Currently prevalent geothermal power generation technology worldwide involves drilling to find underground reservoirs where hot water and steam heated by magma accumulate, extracting hot water and steam through production wells to utilize heat, and repeating the cycle of returning water underground through reinjection wells for power generation.
  - Therefore, geothermal power plant sites require (1) existence of reservoirs, (2) water-permeable geology, and (3) heat sources.
- Next-generation technologies (EGS, AGS) are not affected by the location of naturally formed reservoirs and also eliminate steam volume uncertainty.
  - With high site selectivity, geothermal power generation could potentially expand to areas that were difficult to develop with conventional technologies.

Comparison of conventional and next-generation geothermal power generation technologies (organized by DOE)

Classification	Conventional Type	EGS (Next-Generation Type)	AGS (Next-Generation Type)
Power Generation Method (Drilling)	Extract high-temperature, high-pressure steam and hot water from natural geothermal reservoirs for power generation	Replenish water to geothermal reservoirs with reduced steam and hot water production OR expand/create reservoirs for utilization	Run pipes through underground high-temperature rock bodies, circulate water through them, and recover heat
Schematic Diagram	Hydrothermal 	Enhanced Geothermal Systems (EGS) 	Closed Loop Geothermal Systems (AGS) 
Heat	Required	Required	Required
Permeability	Required	Required	Not Required
Reservoir	Required	Not Required (create artificial reservoir)	Not Required

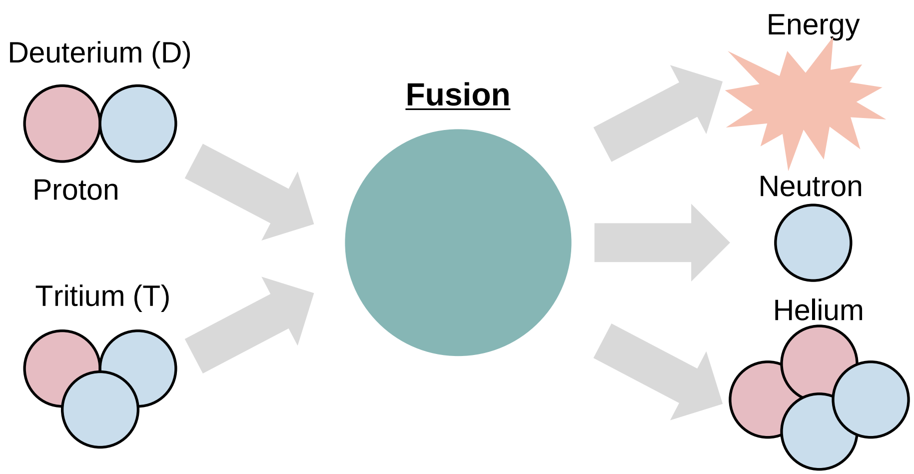
Note 1: EGS: Enhanced Geothermal Systems, AGS: Advanced Geothermal Systems
Note 2: According to DOE, Closed Loop technology and AGS technology are identical
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on U.S. Department of Energy "Pathways to Commercial Liftoff: Next-Generation Geothermal Power"

MIZUHO

[Breakthrough Technology (2)] Energy supply increases are expected in the future, though the timeline is distant ~ Fusion Energy Power Generation ~

- Fusion energy power generation is a power generation method that utilizes the enormous energy generated when light atomic nuclei such as deuterium and tritium fuse together to form heavier nuclei, with the total mass difference before and after fusion being converted into massive energy.
  - To achieve fusion, also called the sun on earth, the D-T reaction(Note) is considered to have the highest feasibility as it requires relatively low temperature and pressure for the reaction, has high reaction probability, and generates large amounts of energy.
- Meanwhile, nuclear fission used in nuclear power generation utilizes energy generated when heavy nuclei split into lighter nuclei as neutrons collide with uranium-235, which is a different process from fusion energy power generation.

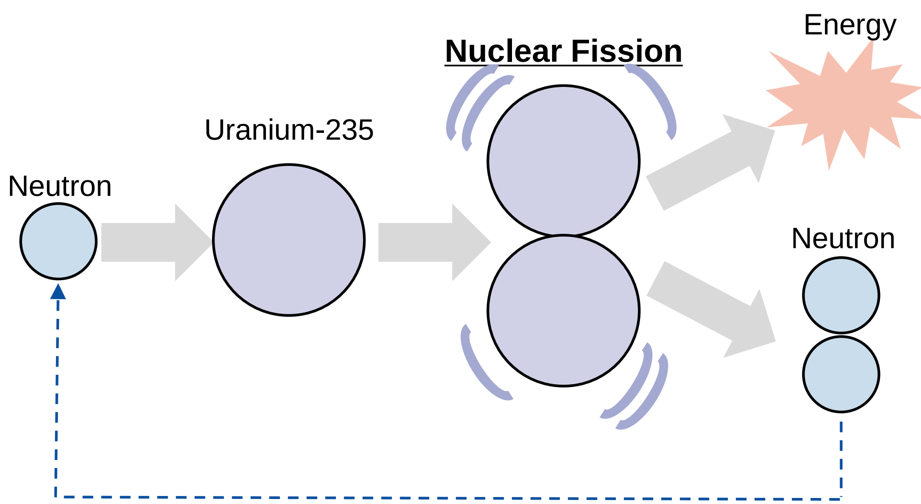
Mechanism of fusion energy power generation (D-T reaction)



Note: Fusion reaction using deuterium and tritium. Other fusion reactions using different fuels also exist

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on various published materials

Mechanism of nuclear fission in nuclear power generation



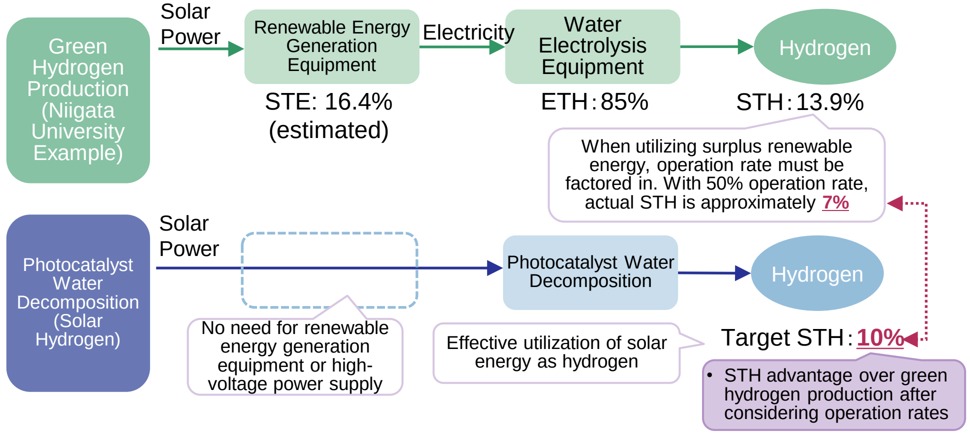
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on various published materials

MIZUHO

[Breakthrough Technology (3)] Energy supply increases are expected in the future, though the timeline is distant ~ Solar Hydrogen ~

- Hydrogen is attracting attention as an important energy source for achieving decarbonization, but manufacturing and transportation costs are bottlenecks.
- Domestic hydrogen production is expected to be dominated by green hydrogen for the time being, but solar hydrogen that decomposes water using photocatalysts has advantages in energy utilization efficiency, space savings, and cost reduction.
- Additionally, the use of solid hydrogen storage alloys is attracting attention for suppressing hydrogen transportation costs.

Characteristics of solar hydrogen (comparison with green hydrogen)



Item	Pros	Cons
Green Hydrogen	• Role as adjustment capacity for surplus renewable energy; role expands with renewable energy proliferation • Technically mature and can be introduced early	• Low operation rates when premised on surplus renewable energy utilization
Solar Hydrogen	• STH advantage over green hydrogen production after considering operation rates • Advantages in terms of site area • Strong advantage for off-grid utilization • Potential for manufacturing cost reduction due to no need for power supply equipment	• STH improvement still in progress • Currently, technical maturity is lower compared to other hydrogen production technologies, so other technologies may dominate the market

Note: STE: Solar cell solar-to-electricity conversion efficiency, ETH: Water electrolysis cell electricity-to-hydrogen conversion efficiency, STH: Solar-to-hydrogen conversion efficiency

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Niigata University press releases, NEDO Artificial Photosynthesis Project Results Report materials, etc.

Characteristics and application examples of general solid hydrogen storage materials

Characteristics of Solid Hydrogen Storage Materials

Solid hydrogen storage materials are attracting attention from the perspectives of compactness and safety because they store hydrogen as atoms or molecules.

Item	Overview
Pros	• High safety with limited regulations • Affinity for consumer applications and urban use
Cons	• In the case of alloys, heavy and inconvenient for portability; concerns about ground subsidence even for stationary installations

Examples of Initiatives Using Solid Hydrogen Storage Materials

Business Entity	Initiative Overview
Hitachi, Marubeni, Miyagi COOP, Tomiya City, Miyagi Prefecture	• Green hydrogen produced at Miyagi COOP's logistics center is filled into hydrogen storage alloy cassettes and delivered to households and children's clubs through the COOP's existing logistics network. Cassettes are attached to fuel cells for energy use
Coca-Cola Bottlers Japan, Fuji Electric	• Developed vending machines powered by hydrogen. Composed of the vending machine body and generator, with hydrogen cartridges loaded into the generator. To be installed at the Osaka-Kansai Expo
ABILITY	• Developed atmospheric pressure hydrogen cartridges that can be used for daily life, mobility, beauty, and health applications. Started rental service after demonstration of hydrogen-assisted bicycles in Kofu City

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on various materials

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[Mizuho's Hypothesis] It is desirable to prioritize stable energy supply as the top priority and then work on decarbonization and cost reduction

- Since stable energy supply is the foundation of economic activity, the top priority amid expected future increases in electricity demand should be to increase power generation capacity across various power source types.
  - With stable supply as the fundamental prerequisite, Japan should continue to effectively utilize fossil fuels while steadily working on low-carbon/decarbonization and innovative technology development.
- Looking at global trends, there is growing momentum to prioritize securing energy at low cost and with stability.

Supply-side approach image for addressing energy constraints

High Priority ↑

Efforts to Enhance Generation Capacity to Meet Increasing Electricity Demand	■ **Since stable energy supply is the foundation of economic activity, this should be addressed with the highest priority** ■ **Based on the characteristics of renewable energy, nuclear power, and thermal power, it is important to increase power generation in a balanced manner without being biased toward specific power sources** ➢ Therefore, fossil fuels should be oriented toward maintaining utilization within the scope necessary for stable supply rather than rapid phase-out
Low-Carbon and Decarbonization of Power Sources	■ **Toward achieving the 2050 carbon neutrality goal, aim for low-carbon and decarbonization of thermal power while monitoring the technological maturity of hydrogen, ammonia, and CCS**
Expansion of Domestic Energy Supply and Energy Cost Reduction Through Innovative Technology Development	■ **Advance development of promising but time-consuming technologies such as next-generation geothermal power, fusion power generation, and solar hydrogen to lead other countries in improving energy self-sufficiency and cost reduction** ➢ However, since energy cost levels are determined by relative comparison with other countries, if innovative technologies spread globally, global energy costs overall may decrease, potentially not contributing to strengthening Japanese industrial competitiveness in terms of costs

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Recent attitudes of various countries regarding energy situations

USA	✓ After President Trump's inauguration, energy policy underwent major transformation ✓ The administration advocates energy dominance, promotes fossil fuel development, and aims to lower energy prices ✓ Regarding increased electricity demand accompanying AI development progress, presents the stance that coal and gas thermal power, which are large-scale stable power sources, and nuclear power are effective
Europe	✓ Germany faces difficulties due to energy price and electricity bill surges stemming from Russia's invasion of Ukraine ✓ The importance of stable supply has been re-recognized following large-scale blackouts on the Iberian Peninsula
Japan	✓ In the 7th Strategic Energy Plan, showed the possibility of long-term LNG demand increases while announcing a policy to maximize nuclear power utilization ✓ Introduced multiple policies aimed at new investment in power generation facilities and maintaining facility capacity, such as long-term decarbonized power auctions and reserve power systems

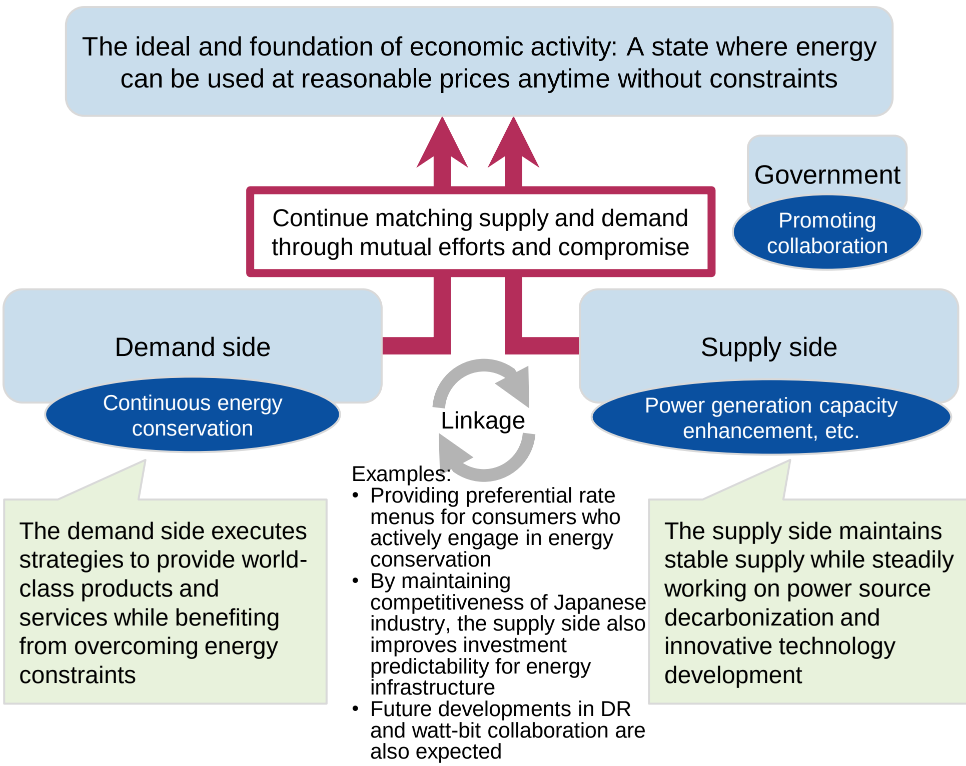
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

4. Conclusion

[Mizuho's Hypothesis] Initiatives by both demand and supply sides are key to overcoming energy constraints

- To overcome energy constraints in Japan, which lacks abundant energy resources, energy consumers and suppliers should deepen their cooperative relationships.
  - Energy constraints should be viewed as an all-Japan challenge, requiring proactive action not only from the supply side but also from the demand side.
  - It is important for the public and private sectors to advance the creation of mechanisms that bring mutual benefits between demand and supply sides (e.g., DR and watt-bit collaboration).
- From a broader perspective, we expect the government to play a leading role in designing various regulations that link the fundamentally incompatible framework of capitalism with decarbonization efforts, and in creating a level playing field with overseas.

Linkage between demand and supply sides



Note: DR: Demand Response, where consumers control electricity demand according to power supply conditions

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

The path Japan should take as a unified nation

Private sector

To overcome energy constraints in Japan, which lacks abundant energy resources, energy consumers and suppliers should deepen their cooperative relationships further

- DR, Collaboration in technology development, etc.

Private sector / Public sector

While the energy business has strong national policy aspects and responsibilities/burdens for stable supply and decarbonization tend to be biased toward the energy supply side, it is important for the public and private sectors to advance the creation of mechanisms where demand and supply sides collaborate and bring mutual benefits

- Watt-bit collaboration, etc.

Public sector

From a broader perspective, the traditional capitalist framework based on mass production and mass consumption is fundamentally incompatible with decarbonization efforts. We expect the government to play a leading role in designing various regulations such as carbon pricing that link these together and in establishing a level playing field with overseas markets

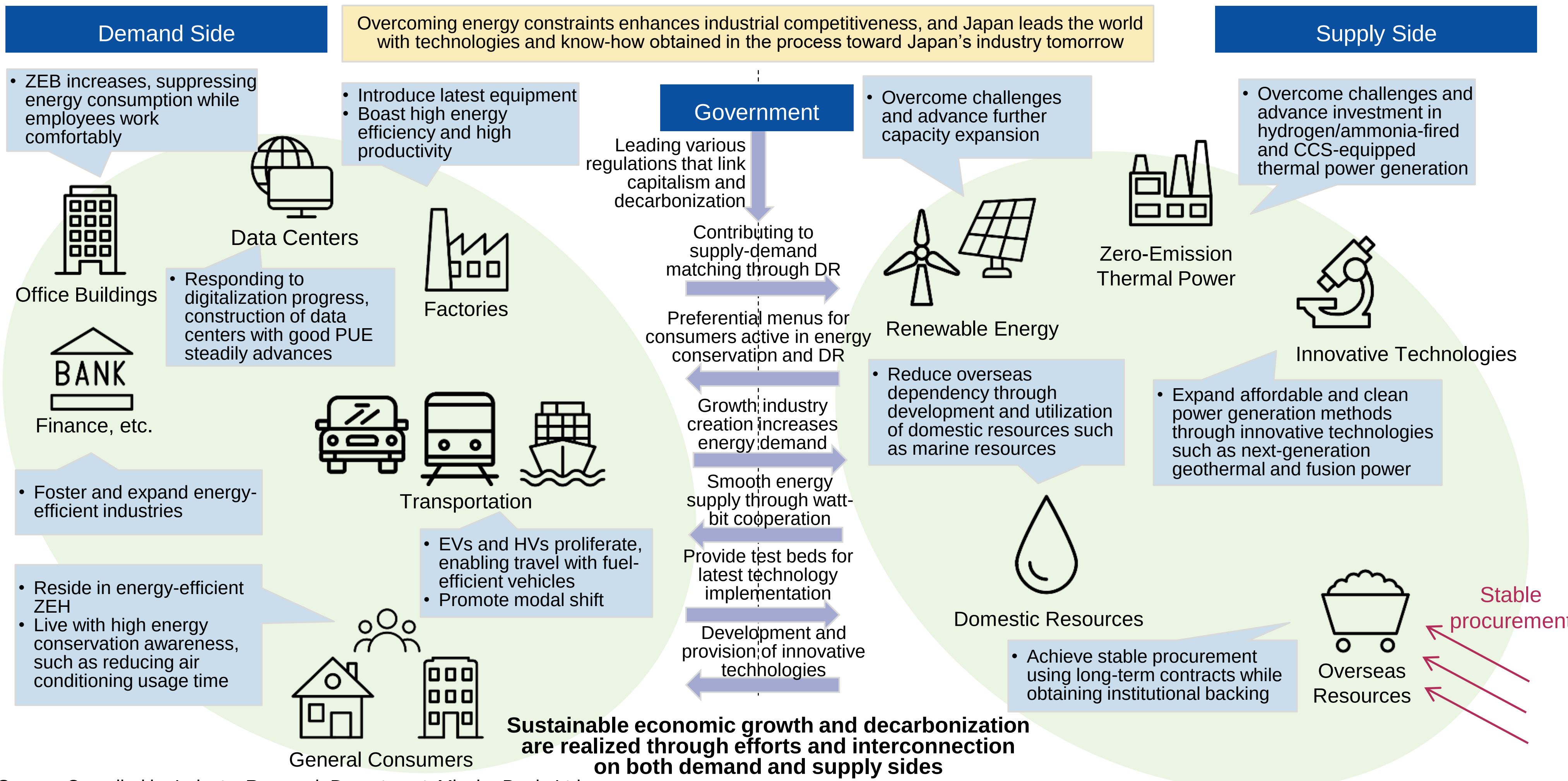
- Refining the institutional design of GX-ETS, leading international rule development, etc.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

Achieving both economic growth and decarbonization through deepening energy conservation and clean, affordable energy supply

- To overcome energy constraints, efforts on both the demand and supply sides are required. On the demand side, it is necessary to advance energy conservation, while on the supply side, it is presumed necessary to aim for decarbonization of power sources and cost reduction through innovative technology development, with stable procurement as a prerequisite.
- By realizing these initiatives, it becomes possible to create a structure where economic growth and decarbonization are achieved simultaneously.

Vision when deepening energy conservation and clean, affordable energy supply are realized



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd

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