Electric Power

Rebuilding profitability and proving value in a low-carbon society

Mizuho Bank Industry Research Department
Research & Consulting Unit
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Link to survey

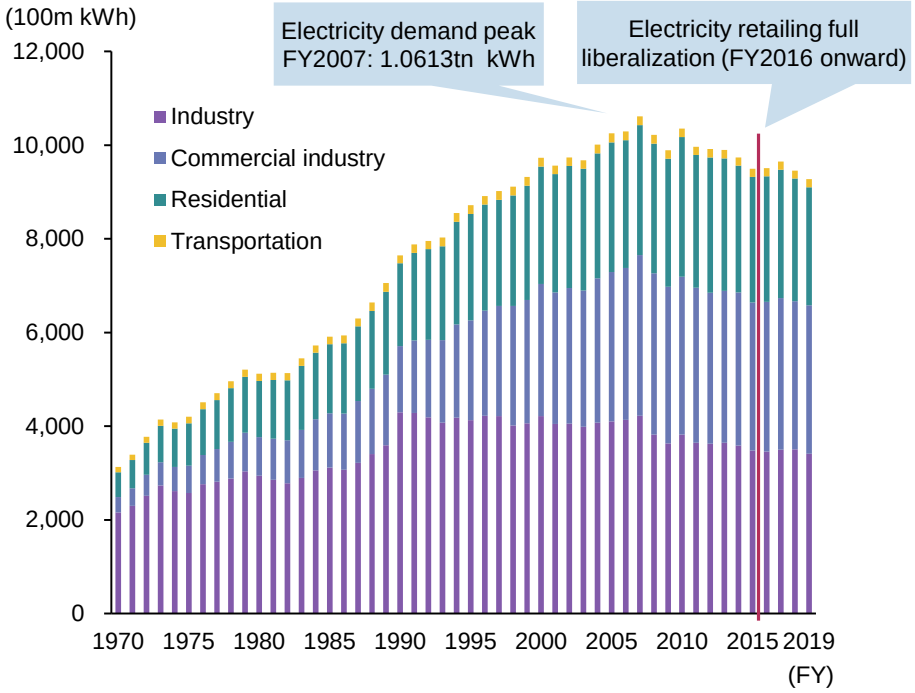
Summary

- Electricity companies are expected to see an underlying decline in demand over the short to medium term, with fiercer competition among market participants under Electricity System Reform. Coupled with the adoption of solar power and other distributed generation, it means that there will like be less predictability of returns on investment in power generation.
  - In order to decarbonize while pursuing stable supply and economic efficiency, new investment in renewable energy and effective harnessing of existing thermal and nuclear assets are essential.
- In a carbon neutral 2050, while overall energy consumption will be lower due to better efficiency and other factors, domestic electricity demand is forecast to increase as non-electricity sectors electrify.
- The electric power industry will decarbonize by striking a good balance of renewables, nuclear and zero-emissions thermal. It will also aim to ensure a stable supply of electricity through appropriate control of supply and demand fluctuations.
  - It is hoped that the value of the industry will be demonstrated by stable supply of low-carbon energy to large electricity consumers, hydrogen production powered by surplus power and stable operation of the energy system characterized by the rise of prosumers in a distributed economy.
- To achieve this, the electric power industry as a whole must aim for carbon neutrality in Japan, taking steady steps toward 2050 in each category be it thermal, nuclear or renewable generation, or supply and demand management.
- Electricity companies will not be able to avoid downgraded profits from their existing business focused on large power generation assets. In addition to branching out into new businesses like domestic renewables, distributed energy and supply/demand management, they will also need a strategic plan to capture profit from overseas operations.
  - ASEAN, where many Japanese companies have invested due to its geographical proximity to Japan, is a promising market where demand for electricity is expected to increase.
- While competition will deepen in the electric power industry, including with players from outside the sector, collaboration will also be needed in some areas to deal with public welfare issues.
- In future competitive fields such as low-cost renewables adoption and upgraded supply and demand management, it will be vital to team up with other players, including from outside the sector.
  - On the other hand, collaboration will be needed in the areas such as the balancing the progressive reduction of fossil fuel generation with stable supply and the continued utilization of nuclear power.
  - Both competition and collaboration can be assumed as necessary toward the establishment and commercialization of thermal power decarbonizing technologies, depending on the alliance strategies of each player.

Electricity demand has declined in the last decade. Energy self-sufficiency has not recovered to pre-disaster levels

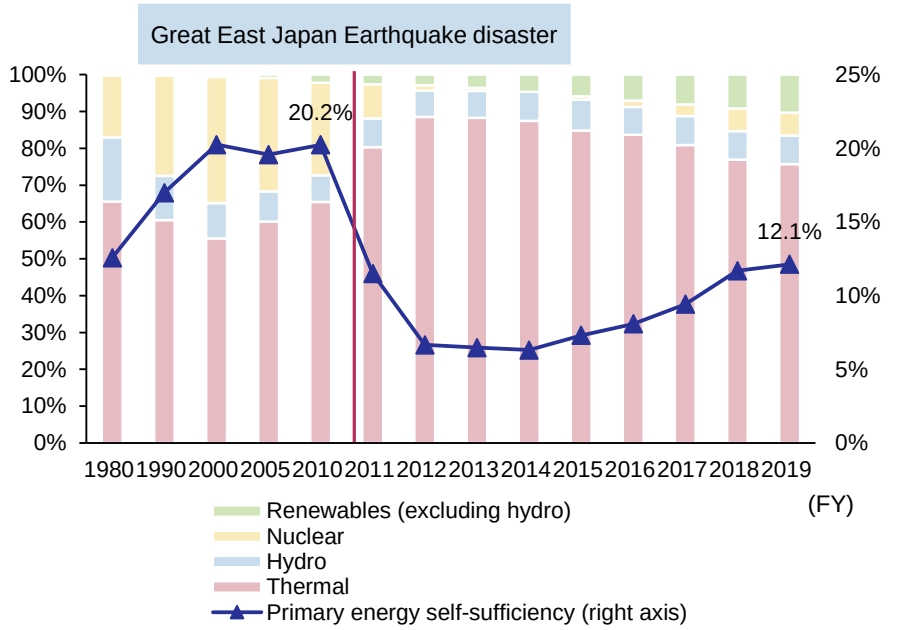
- The electric power industry underpinned Japan's high-speed economic growth and developed to meet burgeoning demand. However, demand peaked in 2007 and the for last decade or so, the trend is down, mostly because of energy efficiency.
- Following the introduction of new standards in the aftermath of the 2011 earthquake and tsunami and the disaster at the Fukushima Daiichi Nuclear Power Station, the nuclear restart has progressed slowly and dependence on thermal generation remains high.
  - Whereas primary energy self-sufficiency reached 20% prior to Fukushima, in 2019 it was stalled at 12%.

Electricity consumption



Source: Compiled by Mizuho Bank Industry Research Department based on *Comprehensive Energy Statistics*

Electricity generation mix and primary energy self-sufficiency

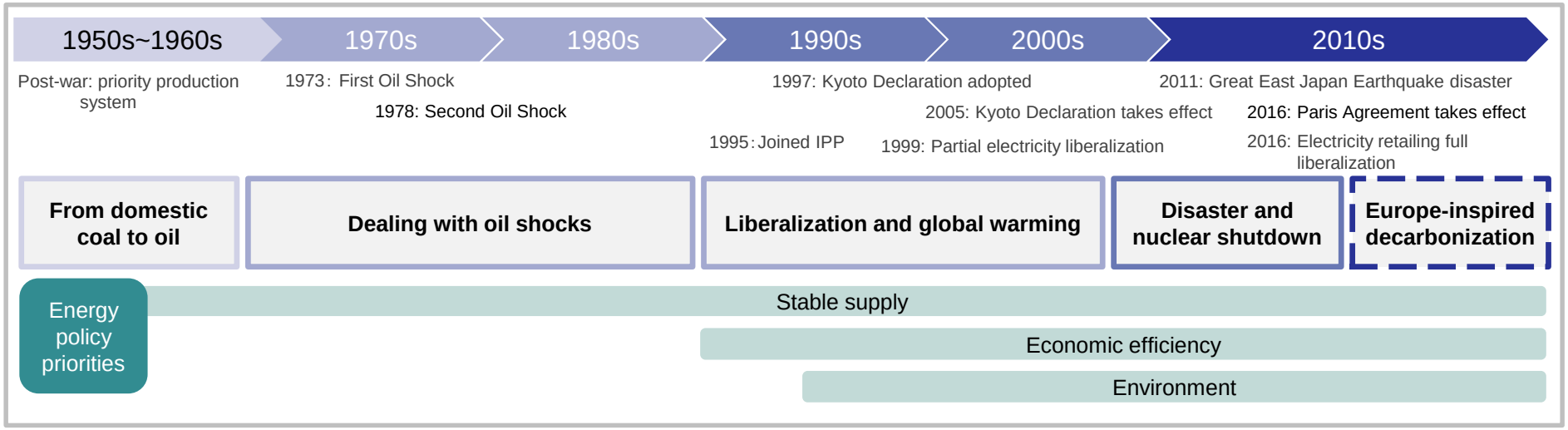


Source: Compiled by Mizuho Bank Industry Research Department based on *Comprehensive Energy Statistics*

(Reference) Energy policy and the role of the electric power industry over time

- Japan, a country not blessed with the energy resources vital to economic and social activity, has developed a sophisticated energy policy to address the changing domestic and international economic and energy environment.
- The electric power industry has fulfilled its public responsibility in the regulatory environment to maintain a stable supply of electricity to consumers while carrying the burden of building electricity infrastructure.

Changing energy policy and the role of the electric power industry



Role of electric power industry

<u>To resolve public welfare issues on the basis of electricity sector regulation, with focus on developing generation</u>

Power companies to maintain a stable supply of electricity to consumers, while bearing the investment risk for power infrastructure investment with a long-term payback period based on fully distributed cost

Source: Compiled by Mizuho Bank Industry Research Department based on public documents

Electricity system reforms since the 2011 disaster have promoted competition among companies

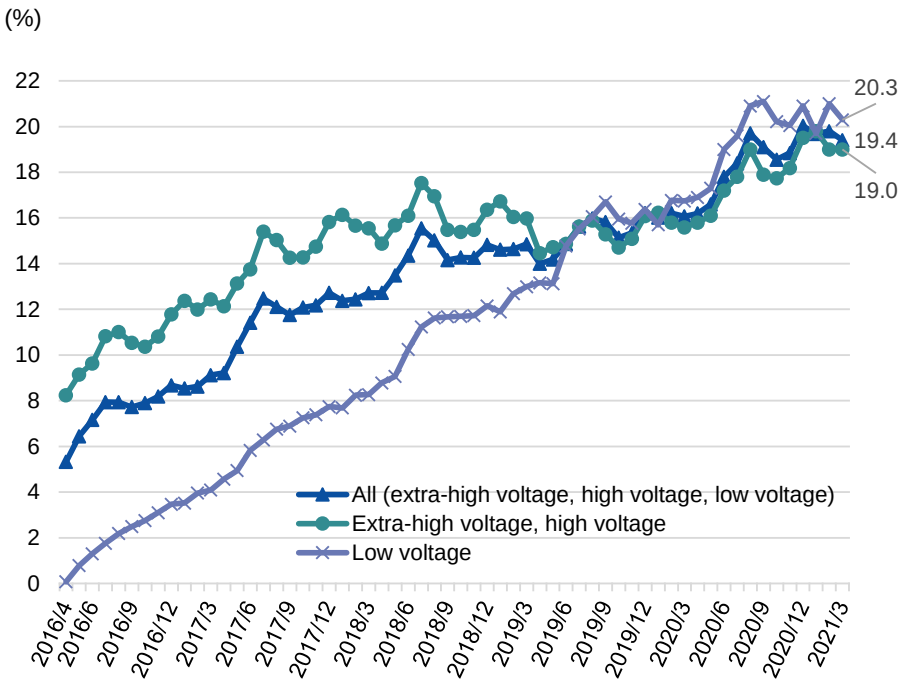
- The Japanese government was prompted by the Great East Japan Earthquake disaster and the nuclear accident to address the various issues that dogged the existing electricity system. Cabinet adopted the Policy on Electricity System Reform in April 2013.
- Based on liberalization under the reforms, the market share of new electricity has increased to around 20%.

Goals and key measures of the Electricity System Reform

Key measures	Contents	Date
Cross-regional organization	• Established as a single entity to create a nationwide supply and demand plan and manage demand peaks	April 2015
Full retailing liberalization	• Deregulated market entry＝Regional monopolies abolished (both regulated and unregulated rates in place)	April 2016
	• Full liberalization (removal of regulated rates)	April 2020 (timing of regulated rates removal decided by area)
Legal separation	• Compulsory unbundling of transmission business	

Source: Compiled by Mizuho Bank Industry Research Department based on *Comprehensive Energy Statistics*

Monthly share of new energy by voltage (since full liberalization)



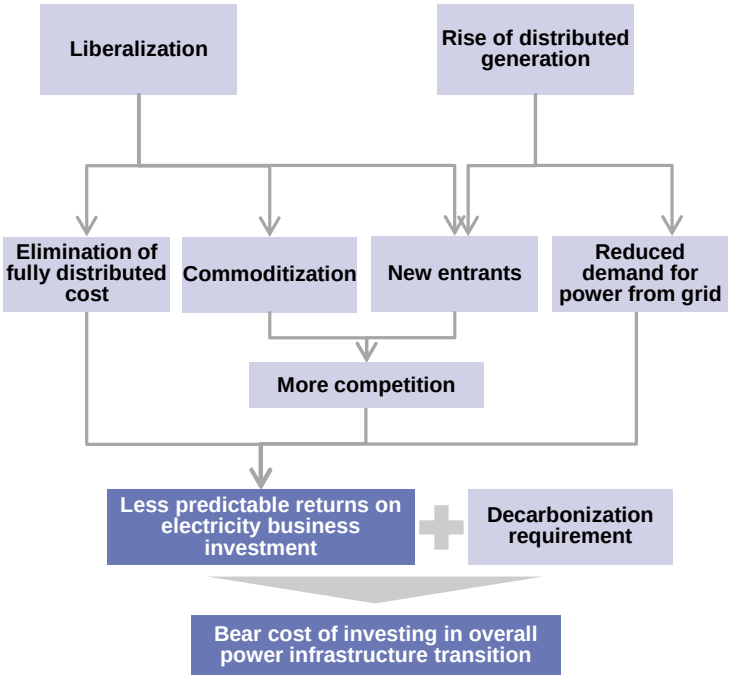
Source: Compiled by Mizuho Bank Industry Research Department based on *Comprehensive Energy Statistics*

The need to address decarbonization amid reduced business predictability

- The elimination of fully distributed cost method and the rise of competition under liberalization, as well as the change in the value structures of electric utilities with the expansion of distributed generation, have made their investment returns less predictable.
- Electric utilities are being pressed to accept the burden of investing in decarbonization of the whole power infrastructure.

Changing trends faced by power companies

Electricity System Reform	• Elimination of fully distributed cost and secured bonds • Full retail liberalization (abolition of regional monopolies)
Climate change measures	• Action launched to meet global decarbonization trend and national goal of carbon neutrality by 2050 • Accelerated moves by some customers toward zero CO2 emissions across supply chain • Higher awareness of resilience as disasters get more frequent and severe
Energy resource decentralization	• Higher level electricity management to handle increased variability of renewable generation • The lower cost of solar power and the rise of post-FIT generation means increased number of prosumers • Diversification of consumer needs, rise of new business models with technological advances
Increased competition from new entrants	



Source: Compiled by Mizuho Bank Industry Research Department

Need for new investment toward decarbonization and effective harnessing of existing assets

- The changes afflicting the electric power industry will have impacts on all aspects of the business.
- In order to decarbonize without neglecting the public welfare issues of stable supply and economic efficiency, there needs to be new investment in renewables. Existing assets, particularly large-scale thermal and nuclear generation, also must be harnessed effectively.

How changing trends affect business environment of each electricity category

Electricity System Reform | **Climate change measures** | **Energy resource decentralization** | **Increased competition from new entrants**

Thermal	• Concerns about low utilization rate due to rise in renewables (deteriorating profitability) and security of supply • Hope that it will serve as a supply/demand regulator as renewables grow • Global pressure on coal-fired thermal power
Nuclear	• Growing burden of investment in safety • Signs of re-evaluation as the only decarbonized large-scale baseload and contributor to self-sufficiency rate • Strategic Energy Plan simply states, “Continuously utilize at the necessary scale, on the condition that safety is assured”
Renewables	• Renewed growth drive of solar and wind in particular under policy to make it a major power source • Pressure to reduce costs in order to reduce financial burden on citizens
Transmission / supply and demand management	• Development of network linking renewable energy regions with power demand • Ageing of infrastructure developed during era of high growth • Higher level supply and demand management in line with continued growth in variable and distributed generation
Retail	• Reduced rates, commoditization and new market entrants mainly due to liberalization • Increased demand for renewable energy procurement from industrial consumers • Reduced demand for power from grid as distributed generation grows

Source: Compiled by Mizuho Bank Industry Research Department

(Reference) Overview of the 6th Strategic Energy Plan

■ The 6th Strategic Energy Plan lays out energy policy towards new goals continuing to strive for carbon neutral by 2050 and a 46-50% cut in GHG by 2030 (compared to 2013 levels) .

Overview of the 6th Strategic Energy Plan

Tackling climate change	• Carbon neutral by 2050 • GHG emission reduction goal for 2030 (46% less than FY2013)
Overcoming Japan's structural energy issues	• Pursue S+3E* principle *Safety + Energy Security (self-sufficiency) + Economic Efficiency (power prices) + Environment

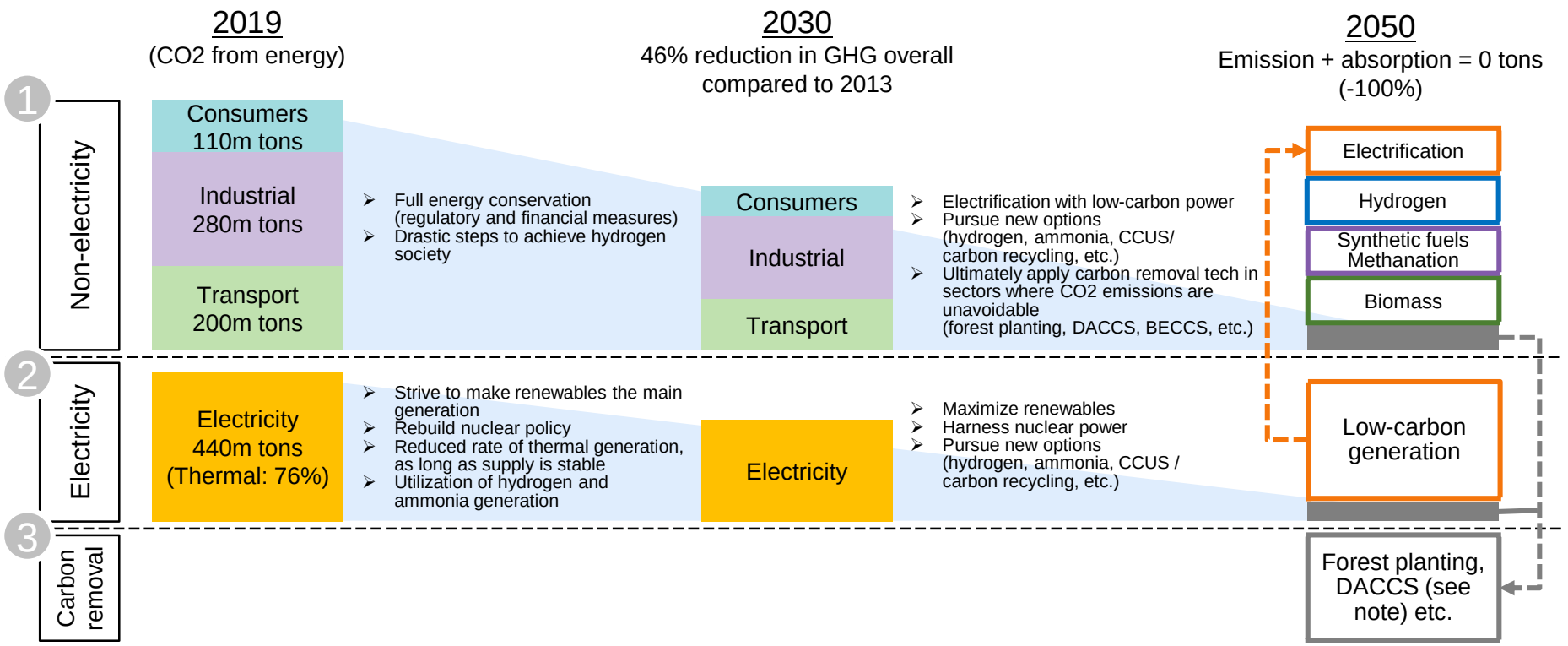
Road to 2050	
Electricity sector	• Steady decarbonization harnessing **ready-to-go renewables, nuclear and other low-carbon sources** • **Pursuit of innovation** in thermal generation, based on carbon storage and reuse through **hydrogen and ammonia power generation and CCUS/carbon recycling**
Other sectors	• **Electrification based on low-carbon electricity** • Ultimately apply **DACCS, BECCS and forest sequestration in sectors where CO2 emissions are unavoidable**

Note: DACCS is the acronym for Direct Air Capture with Carbon Storage, BECCS for Bio-Energy with Carbon Capture and Storage (biomass CCS)
Source: Compiled by Mizuho Bank Industry Research Department based on *6th Strategic Energy Plan*

All hands on deck needed to achieve carbon neutral by 2050

- To go carbon neutral, all of the following will be needed: (1) reduced CO2 emissions from non-electricity sectors, (2) reduced CO2 emissions from the electricity sector and (3) absorption/exploitation of CO2 emitted by sectors unable to decarbonize.
  - In non-electricity sectors, electrification using low carbon power, hydrogen, methane and synthetic fuel will be needed.
  - In the electricity sector, based on the goal of decarbonization, in addition to maximum adoption of renewables and utilization of nuclear power, CO2 emissions from thermal power generation must be cut using hydrogen and ammonia, as well as collection, reuse and storage of CO2 via CCUS / carbon recycling.

Conversion to carbon neutral, illustrated

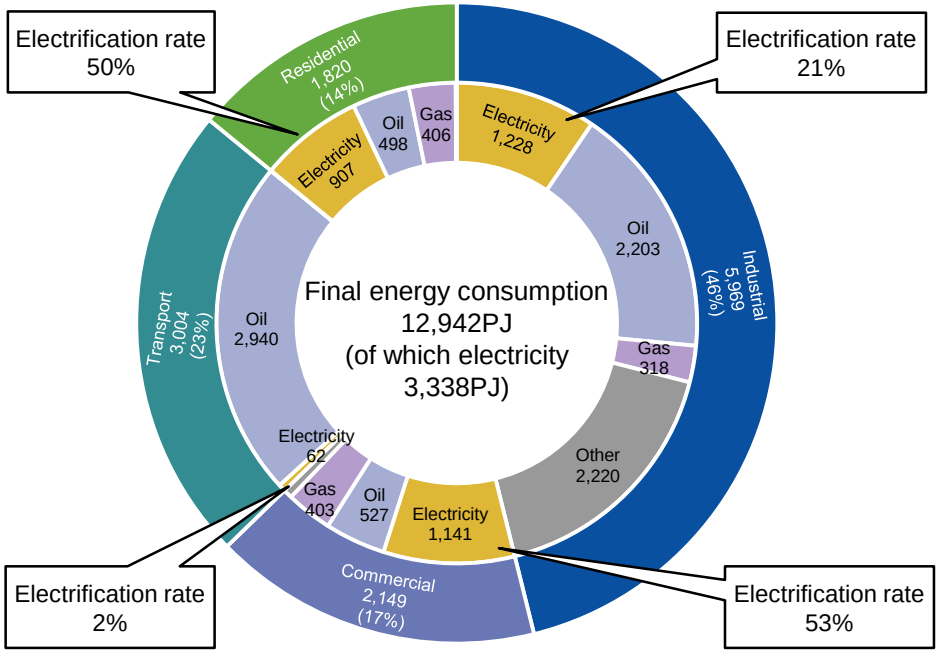


Source: Compiled by Mizuho Bank Industry Research Department based on Agency for Natural Resources and Energy documents

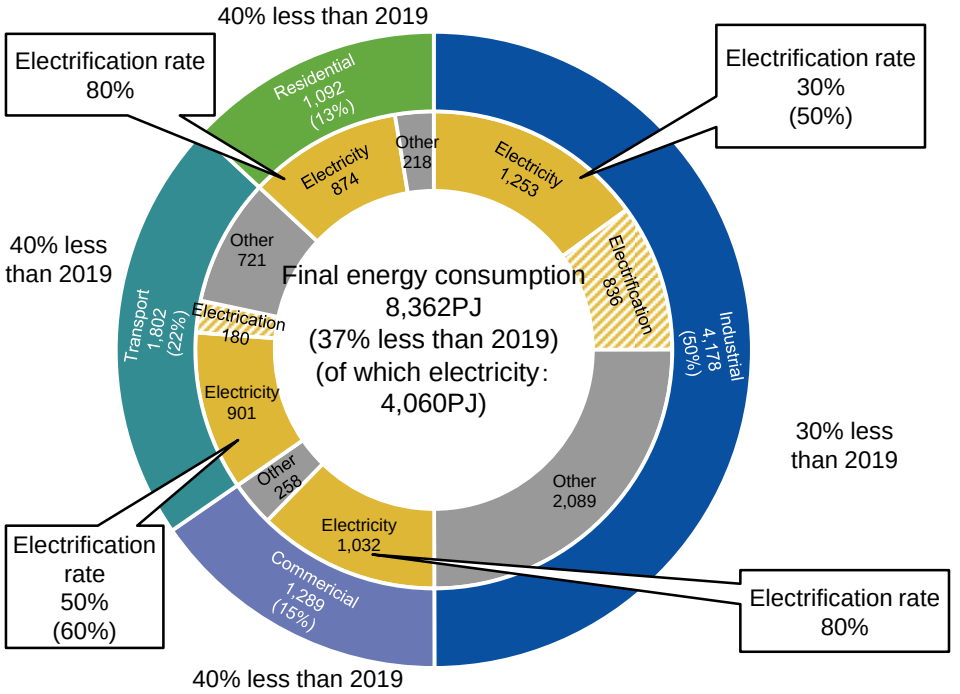
Mizuho Bank: Projected final energy consumption and electrification in each sector

- Projected final energy consumption structure from 2050 final energy consumption by sector (looking at electrification rate) .
  - Reduced energy demand (less production and services) and improved output per unit leads to 40% less final energy consumption than 2019.
  - Electricity demand calculated from percentage of electricity in final energy consumption, based on projected electrification in each sector.
- Assuming that the electricity sector decarbonizes (net zero CO_2 emissions), other sectors will minimize emissions through fuel conversion, CCUS, etc.
  - For sectors that cannot be electrified, supplies of biomass, synthetic fuel and hydrogen are needed to replace oil and gas.

Final energy consumption by sector (FY2019)



Final energy consumption by sector (FY2050 projection)



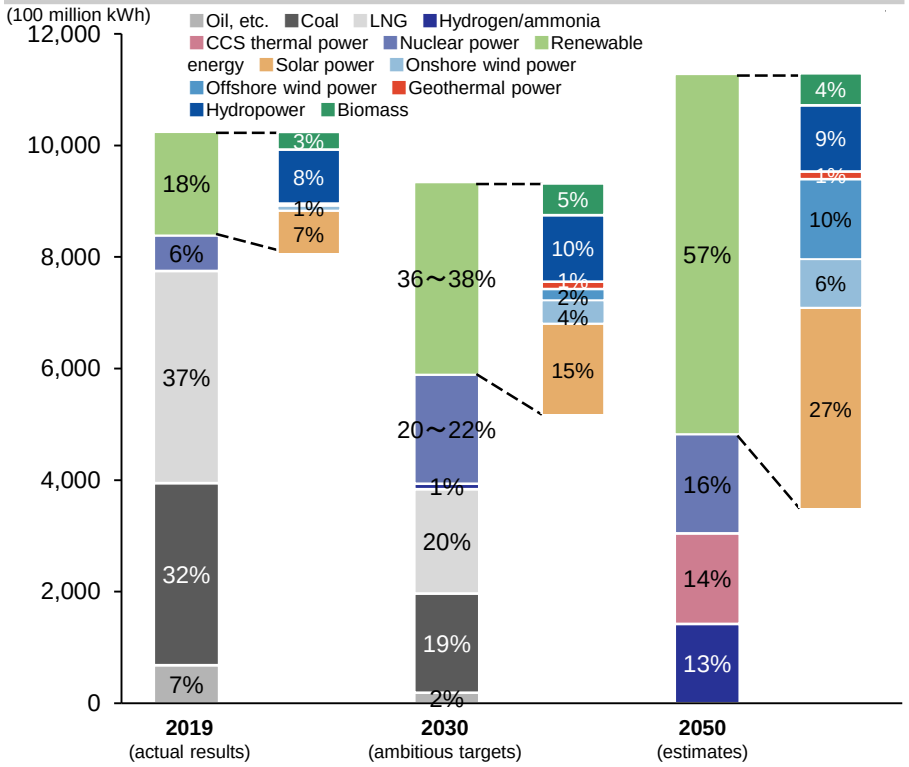
Note: 2050 electrification rates in the Industry and Transport sectors are forecast at 50% and 60% respectively depending on extent of electrification

Source: Compiled by Mizuho Bank Industry Research Department based on documents from Agency for Natural Resources and Energy, National Institute for Environmental Studies

Electric power industry may need to invest trillions of JPY in renewable energy by 2050

- On the assumption of decarbonization of the power sector, this slide details a simulation of a power source composition that will meet electricity demands in 2050.
  - While renewable energy centered around solar and wind power is expected to expand significantly, power source composition that includes nuclear power and zero-emission thermal power is assumed.
- The investment scale necessary to realize the below power source composition was calculated from current costs for each power source and target costs.
  - Even if only the capital costs for renewable energy are considered, it is estimated that trillions of JPY in investment will be required.

Outlook for power source composition (2030 target and 2050 estimate)



Note: Power source composition (power generation amount) and installed capacity are calculated assuming annual power supply and demand

Source: Compiled by Mizuho Bank Industry Research Department based onvarious materials

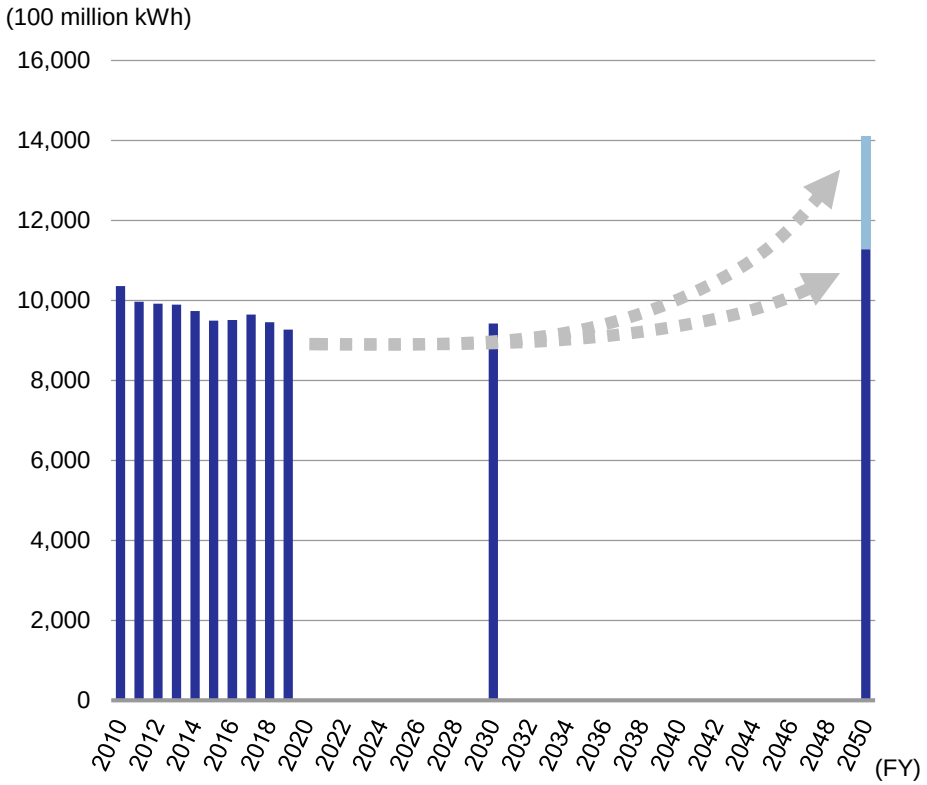
Image of installed capacity outlook and scale of investment amount for each renewable energy power source

Power source type, etc.	Assumed 2050 scenario		
	Introduction amount, etc.	Introduction scenario	Investment scale (capital costs)
Solar power	260GW	Demand areas (homes, large facilities): 107 GW, Non-demand areas (rundown agricultural land, farms): 153 GW	30-51 trillion JPY
Onshore wind power	41GW	Introductions in grasslands, rundown agricultural lands, and mountains/forests where constant wind speeds (5m/s) can be secured	9-13 trillion JPY
Offshore wind power	45GW	Target value from vision for offshore wind power industry	11-23 trillion JPY
Geothermal power	2GW	2030 energy mix level	3 trillion JPY
Hydropower	51GW		
Biomass	7GW		
Strengthening power grid	—	Required investment amount in master plan	2-5 trillion JPY

Forecast 2050 domestic electricity demand - dependence on electricity is expected to increase

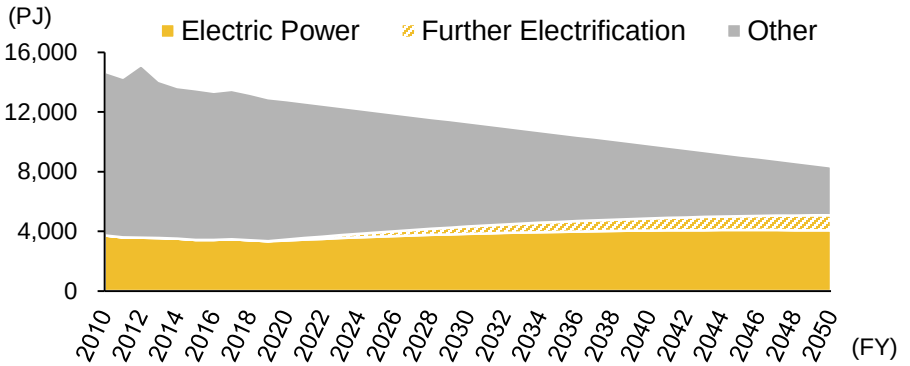
- In aiming to realize carbon neutrality by 2050, final energy consumption is expected to be significantly reduced, while electricity demand will increase due to progress in electrification, and in 2050 it is expected to be approx. 1.1 - 1.4 trillion kWh.
  - If electrification progresses even further in the industrial, commercial, transportation, and household sectors, and if the hydrogen demand in each sector is met by domestic electricity, then electricity demand may greatly increase.

Outlook for domestic electricity demand

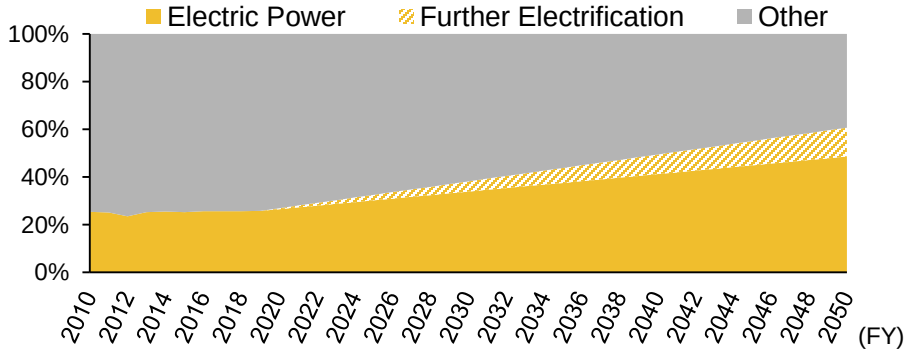


Note: Simply estimated as power demand = power generation amount
Source: Compiled by Mizuho Bank Industry Research Department

[Reference] Outlook for final energy consumption



[Reference] Outlook for electrification rate in final energy consumption

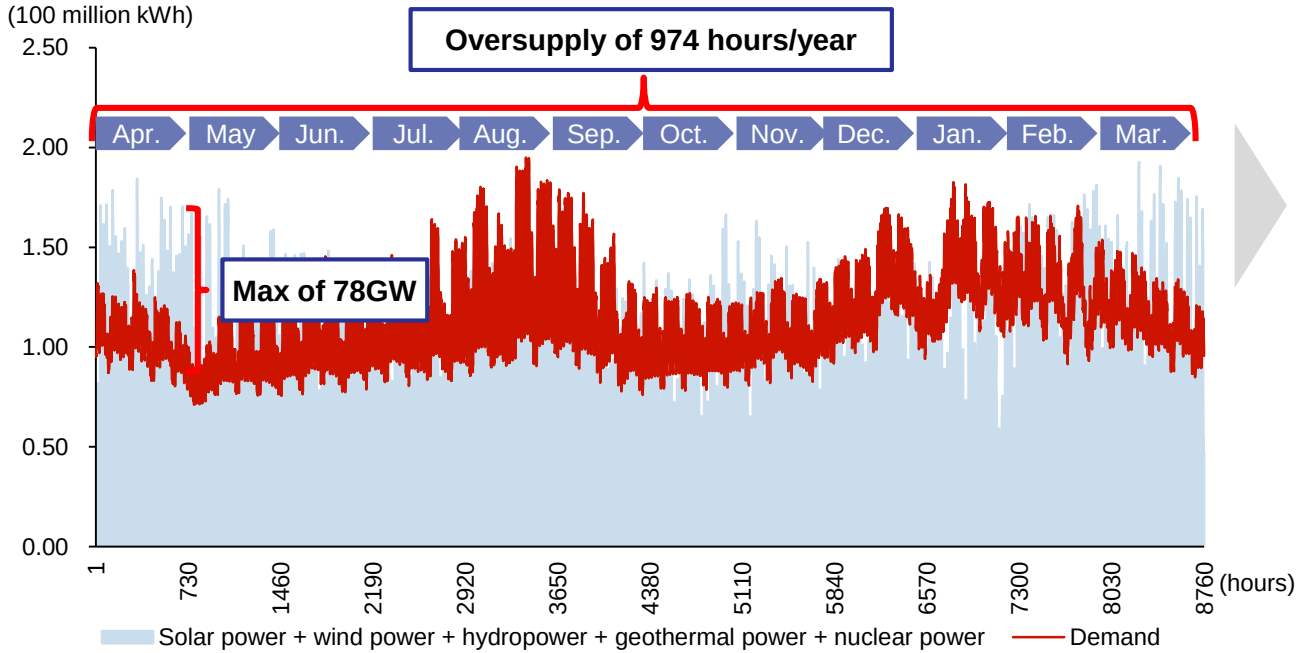


Note: The final energy consumption in 2050 set in this estimation and a transition image of the portion of the final energy consumption to realize the electric power ratios assuming that they change linearly from the present

Amidst an expansion in renewable energy that is not suitable for output adjustments, appropriate control of supply and demand is important

- In 2050, balancing of grid electricity will be realized by appropriately controlling both fluctuating supply and demand.
- Based on current electricity supply and demand, when estimating hourly power demand in the 2050 cross section and the power supply from solar power, wind power, hydropower (excl. pumped storage), geothermal power, and nuclear power, which are not suitable for output adjustments, there will be oversupply for 974 hours per year, with surplus power generation of up to 78 GW.
  - It will be necessary to utilize the power adjustments by pumping water for water storage, storage batteries, and demand response, etc., as well as biomass, advanced operation of CCS thermal power, etc., and utilizing surplus power via hydrogen production.

Simple analysis of hourly supply and demand for FY2050



Oversupply time zones

- Pumping water up for water storage
- Charging storage batteries
- Demand generation via demand response
- Hydrogen production via water electrolysis
- Curtail biomass output, etc.

Insufficient supply time zones

- CCS thermal power generation
- Hydrogen/ammonia power generation
- Power generation via pumped water storage
- Discharging storage batteries, etc.

Note: Electricity demand is calculated as grid demand, is the value obtained by subtracting the power generation amount by solar power in demand areas from total demand (estimated by Mizuho Bank Industry Research Department).
For solar power, wind power, and hydropower (excl. pumped storage), the amount of power generated per hour is calculated based on power generation patterns in FY2020 and estimated power generation amounts in FY2050.
For nuclear power and geothermal power, the estimated power generation amount for FY2050 was evenly distributed across each hour.

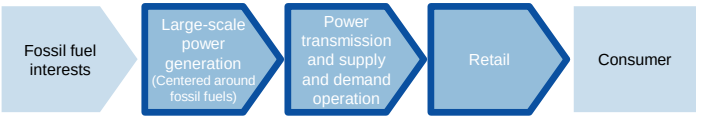
Source: Compiled by Mizuho Bank Industry Research Department.

Businesses will be required to demonstrate the value of their existence according to the form of energy consumers

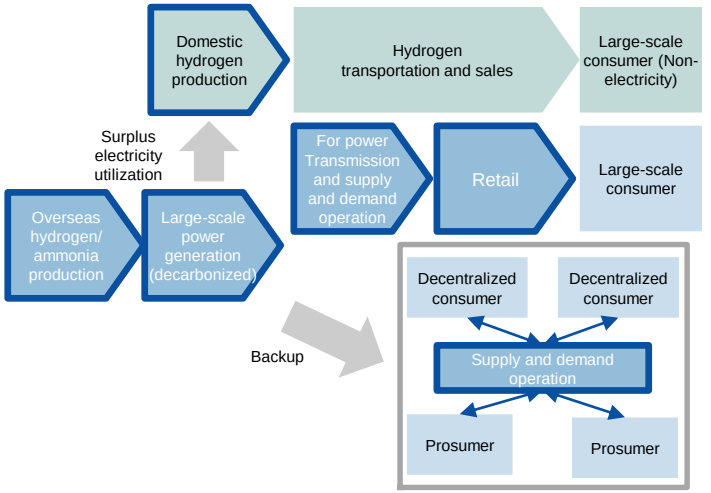
- Although the expansion of distributed power sources is irreversible, it is assumed that the world will continue to have a need for large-scale power sources, primarily for energy-intensive industries, and it is speculated that electricity companies can demonstrate the value of their existence in each area through the following.
  - Large-Scale Consumer Area: Stable supply to large-scale consumers through decarbonized power sources and improving energy self-sufficiency rate via hydrogen production that utilizes surplus electricity.
  - Prosumer Area: Stable operation of energy systems in a decentralized society where power generation and storage functions are partially shifted to the consumer side.

Electricity companies' core competencies in the future image of the electric power industry

Significance of the electric power industry's existence (so far)	Stable supply of electricity to industries and households	Contribution to ensuring energy security, including improving self-sufficiency rate



Consumer classification	Role to play in the future	Revenue sources
Large-scale consumer area	• Stable supply to large consumers through decarbonized power sources • Improve energy self-sufficiency rate via hydrogen production that utilizes surplus electricity	• Construct value chains for zero-emissions thermal power • Supply carbon-free hydrogen to non-electricity sector consumers
Decentralized consumers (Prosumers)	• Stable operation of energy systems in a decentralized society	• Provide supply and demand balance adjustment and backup functions • Transformation and diversification of services due to shift to platforms

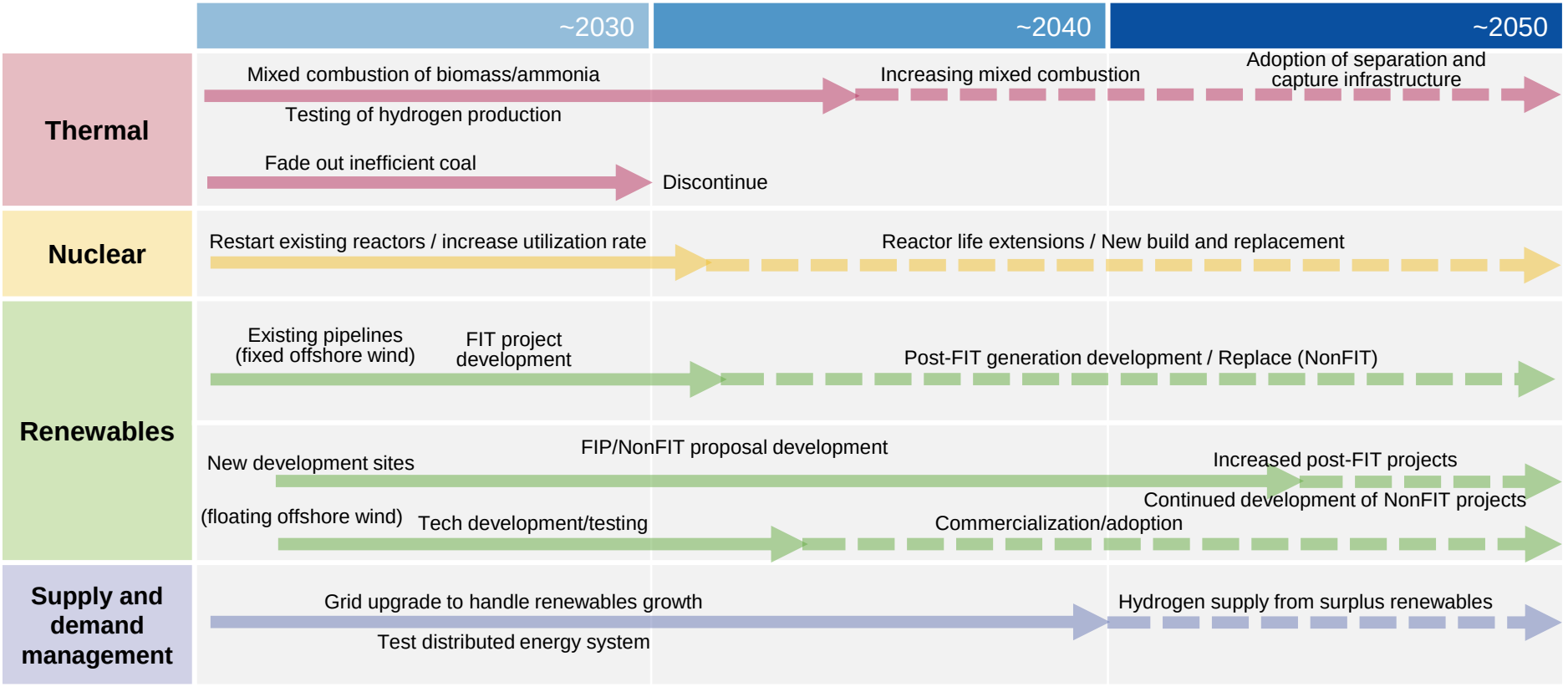


Source: Compiled by Mizuho Bank Industry Research Department.

Timeframe for electricity sector decarbonization

- The timeframe for decarbonizing the electricity sector is as below.
  - Based on the special characteristic of electric utilities – that return on investment takes a very long time – the lead-in to 2050 will require the following.

Timeframe for electricity sector decarbonization

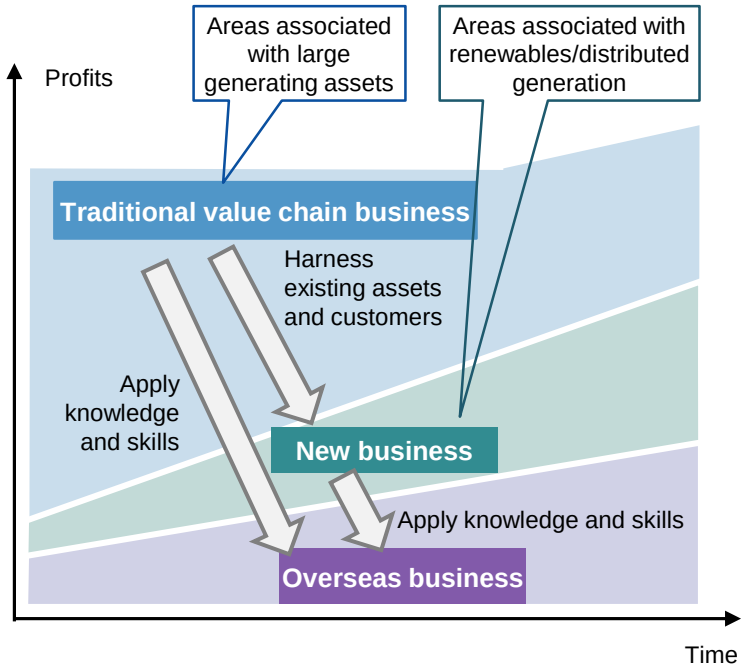


Source: Compiled by Mizuho Bank Industry Research Department

Strategy needed amid unavoidable profit decline in traditional business

- While hopes are high for increasing electricity demand in a carbon neutral economy, the emergence of prosumers as a result of increased renewables and distributed energy resources mean that reduced profits for the traditional value chain businesses are inevitable.
- As such, together with tight operation of large generating assets, a strategy is needed to make up for lower profits from the existing business such as making renewables, distributed energy and supply/demand management more profitable, and through overseas opportunities.

Establishing a profitable future electricity business, illustrated



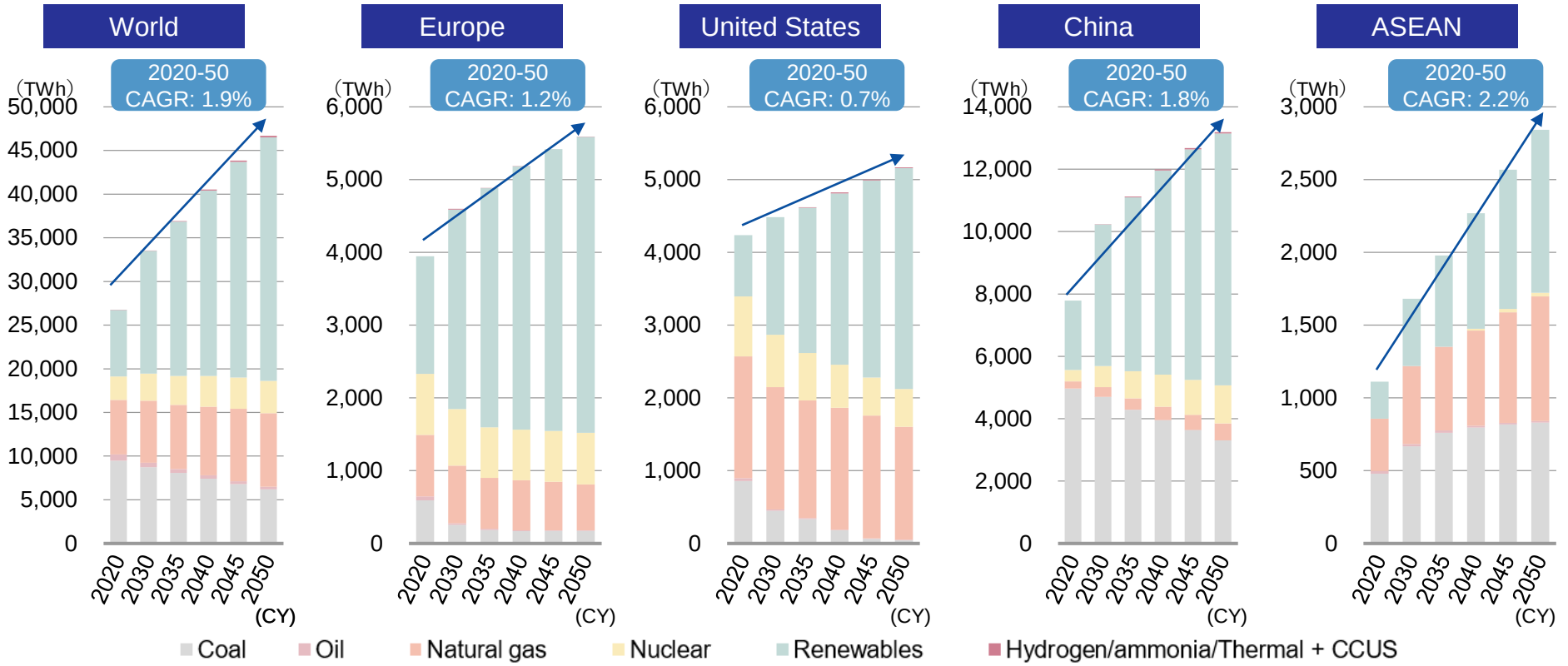
Category	Specific business activities
①Traditional value chain business	• Business based on the traditional value chain starting from large electricity generator (thermal, nuclear, hydro) - transmission and retail
②New business	• Renewable generation • Integration/management of distributed energy • Harness the flexibility of thermal generation to manage supply and demand • Supply hydrogen harnessing surplus low-carbon sources such as renewables and nuclear
③Overseas business	• Address overseas demand by applying know-how gained from (1) and (2) above

Source: Compiled by Mizuho Bank Industry Research Department

(Reference) Global forecast for power generation

- Overall world electricity demand is forecast to grow at an average rate of 1.9% to 2050.
- Focusing on ASEAN, high economic growth and population growth are expected to drive an average growth rate of 2.2%.
- ASEAN is a promising market for Japanese power companies, given its geographical proximity and the presence of Japanese firms.

Global power generation forecasts (IEA World Energy Outlook 2021 / Stated Policies Scenario)



Source: Compiled by Mizuho Bank Industry Research Department based on *World Energy Outlook 2021*, IEA

In the electric power industry, the key will be a different alliance strategy for each area

- While competition will get fiercer among players in the electric power industry, including non-sector players, there will be a need for collaboration in some sectors to address public welfare issues.
  - The adoption of low-cost renewables and the upgrading of supply and demand management are expected to become areas of competition. Tie-ups with players from other industries will be important for companies to establish their presence.
  - On the other hand, as areas of collaboration, balancing the progressive elimination of fossil fuel generation with the need for stable supply, as well as the continued utilization of nuclear power, will require action among industry leaders, based on the roles of the public and private sector.
  - Both competition and collaboration are expected in the establishment and commercialization of thermal power decarbonization technologies, depending on each company's alliance strategy.

Mapping and strategic direction for each business area

	Areas of competition → Areas that should see competition on enhanced services	**Areas of collaboration** → Areas for action by leaders to address public welfare issues
Areas associated with large generating assets	**Thermal** • Build supply chains for next-gen fuels with other industries, link across industry to drive down fuel procurement costs **Transmission / supply-demand management** • Manage supply and demand using batteries (including EVs) • Gain knowledge by working together to supply hydrogen to heavy energy-consuming industries **Retail** • Bundling of other goods and services through partnerships with other industries • Development of platformer businesses	**Thermal** • Optimization of existing assets for security and stability of supply **Nuclear** • Consider working on maximizing utilization of existing reactors and next-generation nuclear power **Transmission** • Optimal network infrastructure and reduced operating costs
Areas associated with renewables/distributed generation	**Renewables** • Joint development with renewables developers, customers, etc. • Link with foreign players to establish floating offshore wind	

Source: Compiled by Mizuho Bank Industry Research Department

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Link to a survey

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