

# Environment & Energy

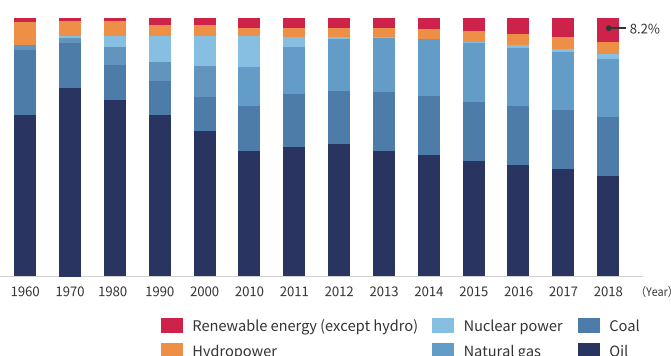
## 1. Overview

### Promoting renewable energy for a carbon-free society

In December 2020, the Ministry of Economy, Trade and Industry (METI) formulated a “Green Growth Strategy towards 2050 Carbon Neutrality.” The strategy identifies 14 key sectors, including four energy-related industries: offshore wind, fuel ammonia, hydrogen, and nuclear. The Japanese government is engaged in creating attractive domestic markets in these industries in particular, to attract domestic and foreign investment and build a competitive and robust supply chain.

Japan has been through several major energy transitions over the past few decades. These include the coal to oil transition for decarbonization in the 1960s, transition from oil following the two oil crises in the 1970s (1973 and 1979), and finally the nuclear power phase-out in the aftermath of the Fukushima Daiichi nuclear disaster triggered by the 2011 Great East Japan Earthquake and Tsunami. After this, with the restart of nuclear power plant operations, the share of fossil fuel consumption decreased slightly. The energy self-sufficiency rate in 2018 was 11.8%, about twice as high as in 2014, which was the lowest on record. In particular, renewable energy is the fastest-growing source of self-sufficient power generation, with renewable energy (excluding hydropower) in Japan’s power mix growing to 8.2% in 2018 (See Figure 1).

Figure 1 Changes in the domestic supply composition of primary energy and the self-sufficiency rate



| Year                             | 1960 | 1970 | 1973 | 1980 | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|----------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Energy self-sufficiency rate (%) | 58.1 | 15.3 | 9.2  | 12.6 | 17.0 | 20.2 | 19.6 | 20.3 | 11.6 | 6.7  | 6.6  | 6.4  | 7.4  | 8.2  | 9.5  | 11.8 |

(Source) Created based on data from the Agency for Natural Resources and Energy

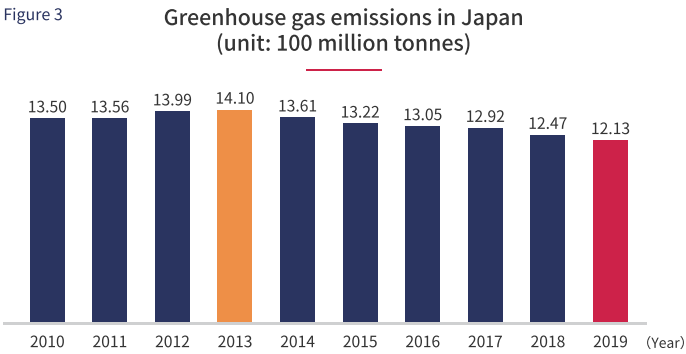
This increase in the supply of renewable energy is in line with current global energy trends and Japan’s energy policy. With the Paris Agreement, an international framework to combat global warming, being implemented in earnest in 2020, nations across the world started to actively take measures to reduce Greenhouse Gas (GHG) emissions. In line with the new trends of “decarbonization” and “carbon-neutral,” Japan has set a medium-term goal of reducing GHG emissions by 26% by FY 2030-31, and a long-term goal of becoming a “carbon neutral society,” i.e., reducing GHG emissions to zero, by 2050. In the fifth Strategic Energy Plan announced in July 2018, Japan aims to achieve an optimal energy mix by 2030 and utilize renewable energy as the main power source by 2050 (See Figure 2).

Figure 2 Major trends for each type of energy

| Power source                                    | Energy mix to be achieved by 2030         | Goals for “energy transition” and “decarbonization” by 2050   |
|---|---|---|
| Renewable energy                                | ■ Power supply ratio 22-24%               | ■ Becoming an economically independent and “decarbonized” major power source  |
| Nuclear power                                   | ■ Power supply ratio 20-22%               | ■ Developing safer, more economical, and more dynamic reactors, and developing technologies to solve back-end problems  |
| Fossil fuels such as oil, coal, and natural gas | ■ Power supply ratio 56%                  | ■ Shifting to use of cleaner gas and phasing out inefficient coal-based power   |
| Energy saving                                   | ■ 35% reduction in real energy efficiency | ■ Promoting energy saving through technological innovation in various fields.<br>Developing technologies such as hydrogen and storage batteries for decarbonization<br>■ Establishing a “decentralized energy system” and promoting regional development through it |

(Source) Created based on materials from the Agency for Natural Resources and Energy

The government has taken concrete measures to decarbonize the energy supply. Initiatives to improve the energy market include reviewing the Feed-In Tariff (FIT) system to promote the use of renewable energy, electricity & gas system reforms to strengthen and expand the retail market, and so on. Another initiative to promote innovation in the fields of environment and energy is the Environment Innovation Strategy, which aims to establish innovative technologies by 2050. As a result of these, GHG emissions have shrunk for six consecutive years from 2014 onwards, with a record low of 1.21 billion tons in FY 2019-20 (preliminary figures) (See Figure 3).



(Source) Created based on data  
from the Agency for Natural Resources and Energy

## 2. Government Initiatives

### Promoting innovation in energy and strengthening market competitiveness

#### 1 Environment Innovation Strategy

On January 21, 2020, Japan formulated the Environment Innovation Strategy to encourage the development of technologies in environmental and energy fields. The strategy aims to discover innovative technologies to achieve global carbon neutrality and reduce past CO2 emissions (the concept of “Beyond Zero”).

The strategy’s “Acceleration Plan” promotes increasing private sector investment in the development of innovative technologies, including through ESG investment (See Figure 4). Moreover, promoting international collaboration and open innovation for technologies related to environment and energy creates conditions conducive for the easy entry of domestic and foreign start-ups.

Figure 4 Three Initiatives of the Acceleration Plan

| Initiative  | Details  |
|---|--|
| 1) Setting up a command tower and promoting it systematically | <ul style="list-style-type: none"> <li>■ Establishment of the “Green Innovation Strategy Promotion Council” (tentative name) to serve as a cross-ministry command tower</li> <li>■ The Council will advise on the research activities of the International Joint Research Center for Zero-Emission Technologies and other research centers, introduce life cycle assessment (LCA) methods to assess GHG reduction effects and costs, and so on</li> </ul>  |
| 2) Bringing together domestic and foreign expertise           | <ul style="list-style-type: none"> <li>■ Establishment of the International Joint Research Center for Zero-Emission Technologies (which will serve as a platform to connect 120,000 G20 researchers), the Next-Generation Energy Platform Research Center (co-created by industry and academia), and the Carbon Recycling Demonstration Research Center</li> <li>■ Intensive support for promising young researchers (Zero-Emission Creators 500), and the detection and development of technological seeds through pioneering research and the Moonshot R&amp;D programs</li> <li>■ Development of research and demonstration projects in the Innovation Area and the “Regional Circulation Symbiosis Zone” to be built on the Tokyo Bay coast, leveraging the diverse cluster of industry, government, and academia and the needs of the region</li> </ul> |
| 3) Facilitating increased private investment                  | <ul style="list-style-type: none"> <li>■ Promotion of VC investment in R&amp;D ventures and promotion of international development in conjunction with institutional reform</li> <li>■ 30 trillion yen of R&amp;D investment by the public and private sectors over the next 10 years</li> </ul>   |

(Source) Created based on materials from the Prime Minister’s Office

#### 2 FIT/FIP systems

FIT are fixed payments under which the government promises to purchase electricity generated from renewable energy sources at a fixed price for a certain amount of time. Under the same system, a portion of the cost of electricity purchased by an electric utility company is secured from electricity users as a renewable energy promotion surcharge. As for the electric utility companies, it is easier to recover the high cost of constructing power generation facilities. This has led to a push in the spread of renewable energy, whose purchase price is set higher than that of electricity produced from fossil fuels.

The Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities (REA), which

will be renamed the “Act on Special Measures Concerning Promotion of Utilization of Electricity from Renewable Energy Sources” on 1st April 2022, stipulates the revision of the FIT system by the end of FY 2020-21. The most notable amendment is the introduction of a new Feed-in Premium (FIP) system, which will add a certain amount to the market price in addition to the FIT.

The FIP system allows power producers to freely sell their electricity in the market and makes them eligible to receive a premium over and above the market price. As a more market-based system, FIP applies to large-scale solar and wind power generation projects, which are expected to become independent of the system in the future. It is anticipated that many foreign companies that have already established themselves in the Japanese market for both types of power generation will take advantage of this system to further increase their profits.

The details of the above premium are currently under discussion. In addition, it has been decided to establish a nationwide levy to cover a portion of the costs of reinforcing the network necessary to promote the introduction of renewable energy. This system will be designed in line with the current system for renewable energy levy.

#### 3 Electricity System Reform

The Electricity System Reform promoted by METI has three pillars of reforms, i.e., 1) Expanding the operation of wide-area electrical grids, 2) Fully liberalizing the retail market, and 3) Securing the neutrality of the power transmission/distribution sector through legal unbundling, and is implemented in three stages. In particular, it is expected that fully liberalizing the retail market will increase the number of new entrants in the market, thereby strengthening market competitiveness.

After the initiation of full liberalization of the retail market in April 2017, a more diversified power procurement was enabled, leading to an increase in the number of new entrants obtaining retail licenses in the electricity market. Moreover, not only Japanese but foreign companies as well have increasingly started to enter the power generation/retail sector.

In the power generation field, Invenergy Japan G.K. and SB Energy Corp. entered into a partnership in April 2017 to handle everything from the development to operation of large-scale solar power plants. In retail, XOOM Energy Japan G.K. (Now, T-Dash G.K.) has been doing business in Japan since December 2016, leveraging its marketing strengths in collaboration with partner companies.

Furthermore, since the unbundling of the transmission and distribution business from the power generation and retail business will be mandatory after 2020, most of the Japanese electric utilities had to spin off their existing transmission and distribution business into separate entities. Additionally, from a consumer protection perspective, attention is being focused on future efforts to regulate electricity prices to prevent consumers from being forced to pay unreasonably high prices (See Figure 5).

Figure 5

### Deregulation trends in the domestic electricity market

| Date       | Details   |
|------------|---|
| April 2015 | ■ Establishment of the Organization for Cross-regional Coordination of Transmission Operators (OCCTO) |
| April 2016 | ■ Full liberalization of the electricity retail sector  |
| April 2020 | ■ Legal separation of the electricity transmission and distribution sectors                           |

(Source) Created based on materials from METI

#### 4 Gas System Reform

The full liberalization of the approximately 2.2 trillion JPY city gas retail market from April 2017 opened it up from the monopoly of city gas companies. As a result, the total gas market of about 5 trillion JPY (including not only city gas but also previously liberalized LP gas) is expected to see lower costs and greater convenience for consumers as a result of fierce competition.

However, compared to the liberalization of the electricity retail market, the number of new entrants in the city gas market is limited. In order to enter the newly liberalized market of procurement and import, companies must invest heavily in their own LNG storage terminals (the raw material for city gas) or other facilities with equivalent capacity. Moreover, new entrants to the retail gas business usually pay a fee for the use of existing gas pipelines to supply gas. However, if there is no pipeline in their target area, they will have to build their own pipeline, which also requires a huge investment.

On the other hand, services that significantly lower the barriers to entry have also emerged. For example: “Cloud Space Ship,” a cloud-based business and logistics support system for the energy industry, including gas utilities, released by Nichigas in collaboration with TEPCO. With the current lack of competition, an increasing number of companies anticipate that if they can take advantage of these and other services to enter the city gas retail business, it is likely to become a great business opportunity.

#### 5 Local government Initiatives (Zero-carbon city)

The government plans to actively promote zero-carbon cities, which are municipalities that are aiming to reduce their GHG or CO<sub>2</sub> emissions to net-zero by 2050. As of January 2021, more than 200 municipalities with a combined population of over 90 million people have announced their commitment to becoming zero-carbon cities.

These zero-carbon municipalities have implemented pioneering initiatives and formulated regulatory frameworks to reduce GHG emissions throughout the region. For example, the Tokyo Metropolitan region and Nagano prefecture have implemented a solar mapping project to determine the energy potential of solar power generation for buildings to encourage the introduction of renewable energy in the region. In addition, Kanagawa prefecture, Kyoto, and other places are encouraging the installation of cost-effective solar power through the joint purchase of solar power generation equipment.

With renewable energy becoming the major power source,

large-scale power sources and distributed power sources are moving towards coexistence. The government is also encouraging a “distributed energy system” that integrates supply and demand in the region. Their aim is to create employment and make it profitable for the area by implementing a commercial system where renewable energy is produced locally for local consumption. As an initiative to sell locally produced renewable energy, in December 2019, a collaboration was signed between Yokohama City and 12 local governments in the Tohoku region, and small and medium enterprises in Yokohama City have begun to purchase electricity from renewable energy sources in Tohoku. As municipalities in urban areas find it challenging to supply renewable energy to meet local energy demand, efforts to achieve net-zero carbon emissions through collaboration between local governments in rural and urban areas are also effective.



### 3. Attractive Markets

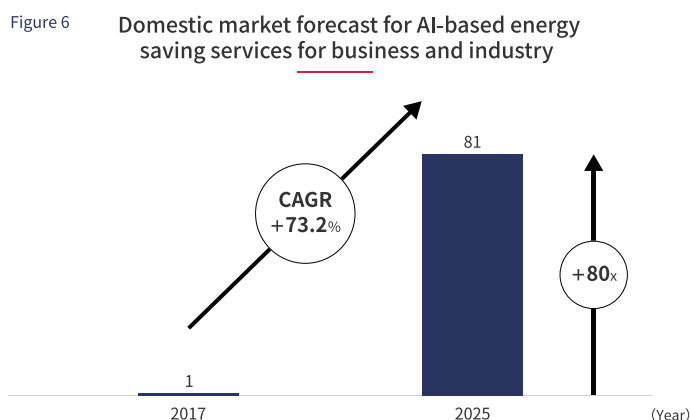
In this report, we focus on the following four attractive markets in the Environment & Energy industry:

- 1 Advanced digital control technologies
- 2 Renewable energy
- 3 Hydrogen energy
- 4 Solid-state batteries

#### 1 Advanced digital control technology

##### ① Energy management

The use of digital technologies in the field of energy is increasing. The market for energy-saving services for business and industry, such as visualization of energy consumption using AI, data analysis, and support for operational improvement, is expected to grow to 8.1 billion JPY in FY 2025-26 (See Figure 6). While some companies are now commercializing AI-based energy management for their factories, it is expected that it will expand into the mid- to long-term in the housing, business, and energy sectors, because of its ability to provide differentiation from competitors and its high added value.



Energy management is also expected to be essential for regional energy initiatives. Behind this trend is the successive entry of local governments into the electricity business as a “new regional electricity.” The “local production for local consumption” of renewable energy created in the region will not only enable regional revitalization in the economic aspect, but also serve as a disaster prevention measure by providing secure power in the event of a disaster. Therefore, by supplementing the unstable system of renewable energy with other electricity, it is necessary to build a stable supply system by controlling the energy of the region through strong energy management.

In this way, local governments are also expected to introduce and upgrade energy management, and the scale of the domestic market for the construction of regional energy management facilities and systems is expected to increase from 20 billion JPY in FY 2018-19 to 25 billion JPY by FY 2020-21 and 35 billion JPY by FY 2030-31.

#### ② VPP (Virtual Power Plant)

Japan’s VPP market has the potential to be the largest in the Asia-Pacific region. VPP is a system that uses IoT technology to control the energy resources of renewable energy such as solar power, storage batteries, and EVs that are located around the country, and operates them like a large power plant. As it can adjust the power system frequency and consumption, it is indispensable for realization of DR (Demand Response) which is effective for stable power supply and quality stabilization. In addition to the growing popularity of energy facilities such as solar power generation and storage batteries, the government’s energy system reforms have progressed and IoT is rapidly evolving. As a result, an environment conducive to VPP is being created in Japan.

In 2016, Japan launched a demonstration project to build VPPs in order to boost the Energy Resource Aggregation Business (ERAB), which uses VPPs and DRs to conduct transactions and negotiations in the electricity market. 72 companies participated in FY 2019-20, and seven groups conducted demonstration projects. It was verified whether the demand could be changed to the required reduction in a given time period in response to a DR control command, and whether it was possible to continue to respond to changing commands for a given time period. The VPP demonstration business is now targeted not only by conventional electric power companies but also by various other industries such as convenience stores and building automation businesses (See Figure 7)

Figure 7 Examples of VPP demonstration projects in 2019

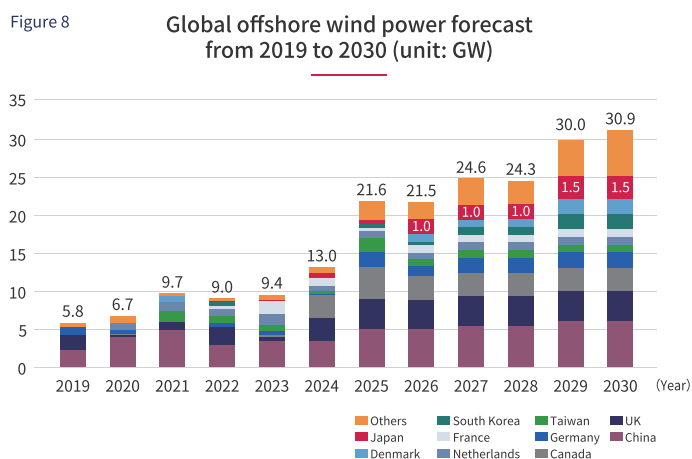
| Business                                | Details   |
|---|---|
| Kansai Electric Power                   | ■ Bringing together a diverse range of resources from household to industrial                       |
| Lawson                                  | ■ Remote management of equipment in about 1000 stores   |
| Azbil                                   | ■ Management of facilities in multiple commercial buildings   |
| TEPCO × Goal connect × NEC              | ■ Multiple aggregators working together on a common platform  |
| SB Energy                               | ■ Avoiding curtailment of renewable energy output through DR that increases electricity consumption |
| ENERES × KDDI                           | ■ Sophisticated control of a variety of household batteries   |
| Chubu Electric Power × Kyoto University | ■ Managing multiple buildings of a university as one  |

(Source) Created based on materials from the Agency for Natural Resources and Energy

## 2 Renewable Energy

### ① Offshore wind power generation

In addition to conventional onshore wind power, the wind power market has recently been focusing on offshore wind power. As per a report published by the International Energy Agency (IEA) in 2019, Japan's offshore wind power potential is the third-largest in the world after the European Union and the United States, and will increase significantly in the future. As a maritime nation, Japan's offshore wind power generation capacity is expected to start growing around 2022 and reach 1.5 GW by 2030, making it the world's seventh-largest wind power producer (See Figure 8).



[Source] Created based on data from GWEC

Starting with the first auction of offshore wind power in general waters in June 2020, Japan's offshore wind power industry is undergoing major transformation. On July 21, 2020, the following four sites were also added as "promising areas" for offshore bidding: Goto City, Nagasaki Prefecture; Noshiro City, Mitane Town, and Oga City, Akita Prefecture; Yurihonjo City, Akita prefecture; and Choshi City, Chiba prefecture. The auction for offshore wind power business operators was conducted under the "Act of Promoting Utilization of Sea Areas in Development of Power Generation Facilities Using Maritime Renewable Energy Resources" enacted in April 2019. The first "Offshore Wind Industry Vision," announced in December 2020, sets specific goals for market expansion, including the formation of offshore wind generation capacity of 10 GW by 2030 and 30-45 GW by 2040, raising the domestic procurement ratio to 60%, and reducing bottom-fixed type power generation costs to 8-9 JPY/kWh by 2030 to 2035.

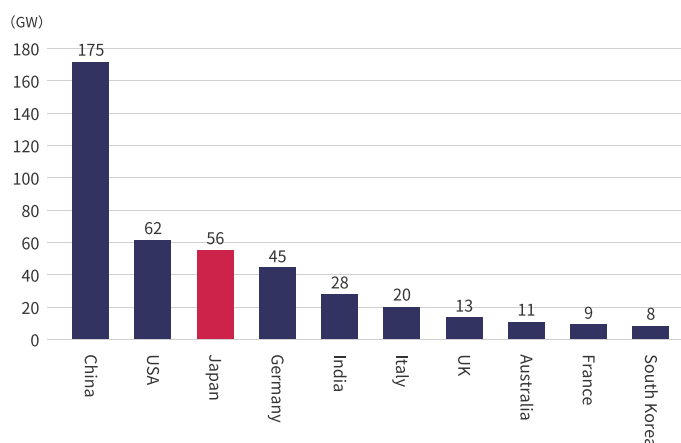
With the enforcement of the "Act of Promoting Utilization of Sea Areas in Development of Power Generation Facilities Using Maritime Renewable Energy," in addition to electric power companies and trading companies, gas and investment companies are also coming forward in the power generation business. Foreign companies with proven records in Europe have also shown interest in collaborating with Japanese companies. In fact, many foreign companies such as GE, Vestas, RWE, ENGIE, etc., have established joint ventures or local subsidiaries with Japanese companies, and both policy and industrial aspects are gaining momentum.

Further, the wind power industry has shown its commitment to the industry as a whole by establishing the "Japan Offshore Wind Task Force" to gain overseas knowledge and to encourage offshore wind growth. Moreover, similar to Europe, a Public-Private Council on Enhancement of Industrial Competitiveness for Offshore Wind Power Generation has been established. The council is working with the public and private sectors to identify issues to be addressed and the policies needed to expand the offshore wind industry.

### ② Photovoltaic power generation

Japan's solar market is one of the fastest-growing markets in the world. As of 2018, with 56 GW of domestic photovoltaic (PV) power generation, it is the third-largest in the world after China and the United States (See Figure 9). Japan is implementing a variety of measures to expand the market. The New Energy and Industrial Technology Development Organization (NEDO) has formulated the NEDO PV Challenges 2020, a new technology development guideline, to facilitate the mass adoption of photovoltaic power generation in society.

Figure 9 Solar installation capacity in different countries (2018 data)



[Source] Created based on data from IEA

This guideline points out the issue of reduction of power generation costs. Foreign companies, which have a particular advantage in cost in the domestic solar power market, are expected to maintain their competitive edge. Canadian Solar, a leading manufacturer of solar panels, is involved in everything from panel manufacturing to power plant construction and maintenance. Suntech Power, a subsidiary of China's Shunfeng International Clean Energy, has introduced remote monitoring systems for solar power plants, LED lighting, and other products. In this way, foreign companies are strengthening their presence in the domestic solar power generation market through a strategy of selling "comprehensive power" including customer support, which until now has been the strength of Japanese manufacturers.

### ③ Other renewable energies

Although Japan has the world's third-largest geothermal resources (23.47 million kW) after the United States and Indonesia, the growth of geothermal power generation in Japan has been sluggish. However, some of the main obstacles in geothermal expansion were the regulations concerning the height of new buildings constructed in national and quasi-national parks, and these were abolished in 2015. Additionally, the scope of excavation for geothermal resources was expanded. It is expected that these deregulations will increase the amount of geothermal power generation in Japan. The government has set a goal of generating 1.5 million kW of power (three times the current level) by 2030. Surveys and construction of power plants have already started at about 100 locations nationwide. As the groundwork to promote geothermal power plants is gradually being laid, Japan's share of the geothermal power generation market is expected to grow in the future.

The biomass power generation market has been expanding rapidly since the introduction of the FIT system in 2012. Although it is a relatively small market, accounting for only 3.5% of the total domestic supply of primary energy, the domestic biomass energy market is expected to grow to 616 billion JPY by 2021, as biomass power plants currently in the planning and construction stage start operations. The need for biomass energy is growing as it contributes to decarbonization of energy sources, effective use of unused resources, and promotion of local industries.

Further, for the domestic supply of primary energy, small- and medium-sized hydroelectric power generation is drawing particular attention as a renewable energy source. This type of hydroelectric power generation does not require the construction of huge dams. Rather, it utilizes the natural rapids of rivers as well as agricultural water and sewage water to generate electricity. The number of certified small- and medium-sized hydropower projects has increased gradually since the introduction of the FIT system, but most of them are still in the development stage due to initial risks and construction costs. However, for Japan, which is blessed with abundant water resources, hydroelectric power has long been popular for power generation. It is considered a valuable source of energy that can be utilized domestically, and further development is expected in the future.

### 3 Hydrogen Energy

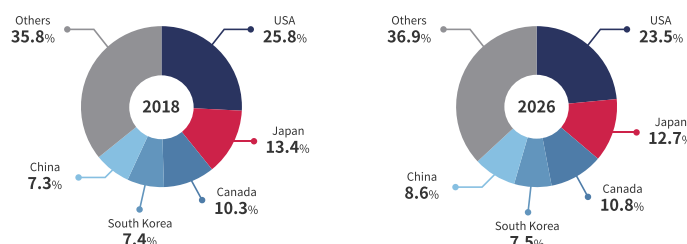
Instead of fossil fuels, hydrogen energy is expected to be the preferred energy source for the future. Hydrogen can be produced from several compounds, including water, and is considered a clean energy source that does not emit any CO<sub>2</sub>. Utilizing surplus electricity from renewable energy sources to produce hydrogen makes it possible to have a "carbon-free" energy source that emits net-zero CO<sub>2</sub> from production to use. Various demonstration experiments have already been conducted, and hydrogen is expected to play a central role in future energy.

In March 2018, the automobile manufacturers Toyota, Nissan, and Honda and 11 major gas and energy companies including the French industrial gas company Air Liquide,

established a new company called Japan H<sub>2</sub> Mobility, to utilize hydrogen as a next-generation energy source. By 2022, 80 new hydrogen stations will be established. On March 12, 2019, the Government of Japan formulated a new Strategic Roadmap for Hydrogen and Fuel Cells in order to realize the goals set forth in the Basic Hydrogen Strategy, and set forth specs and cost targets related to the development of necessary basic technologies.

Japan possesses highly advanced technologies related to hydrogen energy, and the number of patent applications in the field of hydrogen fuel cells is the world's highest. Against this backdrop, Japan's share of the global fuel cell vehicle market was 13.4% in 2018, the second largest market in the world after the United States. Market forecasts through 2026 predict this size to be maintained (See Figure 10).

Figure 10 Global Fuel Cell Vehicle Market Share Forecast from 2018 to 2026 (Top 5 Countries)



(Source) Created based on data from Allied Market Research

### 4 Solid-state batteries

Currently, lithium-ion batteries are widely used in a variety of electronic devices. However, due to the risk of liquid leakage and ignition, there has been a need to develop solid-state batteries as safe and reliable alternatives for IoT devices. One of the reasons why solid-state batteries have been attracting more attention in recent years is the rapid growth of EVs as a means of attaining decarbonization.

By 2030, the Japanese government has set the target of increasing the proportion of HVs, EVs, and other next-generation cars among new passenger cars sold by five to seven times. In addition, it is in the process of setting a target to ban the sale of new gasoline vehicles by the mid-2030s. In this way, demand for solid-state batteries will increase as the demand for EVs increases, and the scale of this market is expected to grow rapidly in the future.

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