Risks and Opportunities for Japanese Oil Industry

Yohei Kato*

Abstract

Japan's domestic oil demand is on a long-term downward trend. In addition, social and economic changes arise from covid-19 have further increased the uncertainty of oil demand, and climate change put stronger management pressure on the oil industry. However, the degree of impact varies from region to region around the world. Although there are many risks, we can find the regions with growing demand and opportunities in new fields such as renewable energy and decarbonization technologies.

This article will identify ways for Japanese oil industry to overcome this difficult situation by analyzing the prospect of different type of energy and the efforts of energy companies around the world.

In the short term, the Japanese oil industry needs to strengthen its domestic revenue base and expand overseas oil business, particularly in Asia, where demand is growing. There are also opportunities in the renewable energy sector, especially in offshore wind power. In the medium to long term, there is great potential for innovative technologies such as carbon recycling, so efforts in this area are also essential. Policy support and business collaboration are important to realize and maximize opportunities.

Key words : Japanese oil industry, renewable, carbon recycling, offshore wind, decarbonization

1. Introduction

The environment surrounding the Japanese oil industry is undergoing substantial changes. These changes include falling domestic demand for oil caused by a declining population, increased fuel efficiency of vehicles, and introduction of EVs, along with the worldwide trends toward combating climate change and decarbonization. Such environmental changes are necessitating major reforms in the Japanese oil industry, which until has been supported by stable, long-term demand.

While uncertainty about the future seems to be rising, this paper will identify the actual risks faced by the industry and analyze where opportunities may be found. Based on this, this paper will review the moves of each fossil fuel company to address these worldwide trends and review sectors where the Japanese oil industry can exploit its strengths. Through the examination of these points, this paper will reveal to which fields and based on what priority the Japanese oil industry should allocate resources and act accordingly.

2. Characteristics of the Oil Company Business and Risks

2.1 Characteristics of Japanese Oil Companies

First, this paper will examine the characteristics of Japanese oil companies. Looking at net sales by the segment of Japan's two major oil companies (Idemitsu Kosan and ENEOS), 79.7% of Idemitsu Kosan's net sales originate from petroleum, while the energy segment of ENEOS, which is different from Idemitsu Kosan in terms of the segment classification but is mainly composed of petroleum, accounts for 84.0% of its net sales (see Figures 1 and 2). As a result, around 80% of the net sales of these oil companies come from petroleum, indicating that petroleum transactions account for an extremely large weighting of their businesses.

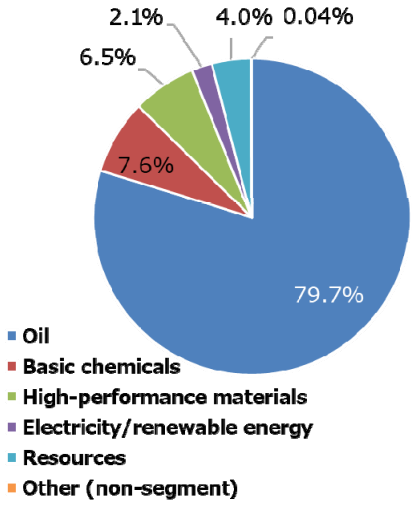

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Fig. 1 Segment Sales (2019) of Idemitsu Kosan

*Global Energy Group 1, Strategy Research Unit
The Institute of Energy Economics, Japan

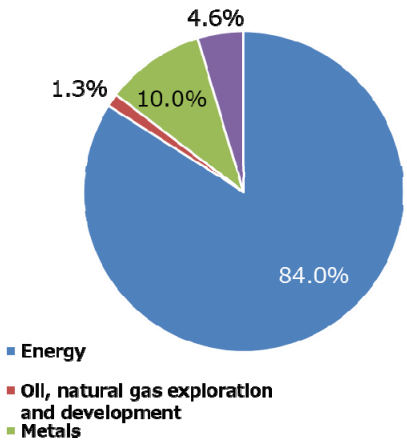

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Fig. 2 Segment Sales (2019) of ENEOS

Next, looking at net sales by region, Japan accounts for 78.4% of Idemitsu Kosan's net sales and 79% for ENEOS. This illustrates that the net sales of both companies lean greatly toward Japan (see Figures 3 and 4). This is not a one-off in nature, but rather a similar trend has persisted looking back several years. As such, Japanese oil companies are highly dependent on petroleum sales in Japan.

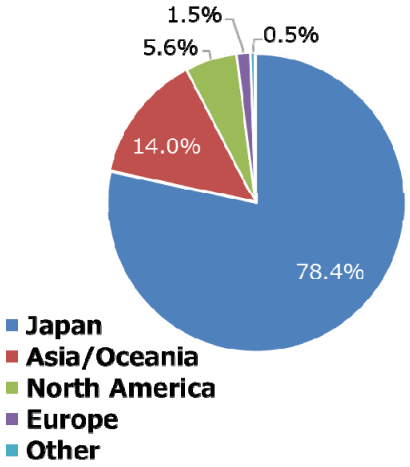

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Fig. 3 Sales by Region (2019) of Idemitsu Kosan

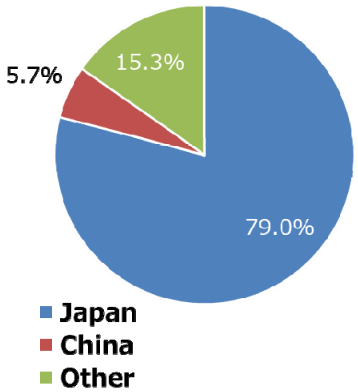

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Fig. 4 Sales by Region (2019) of ENEOS

2.2 Demand Trends for Oil in Japan

This section will look at demand trends in domestic oil products, which account for a large weighting of Japanese oil companies' business portfolios. Demand for petroleum products in Japan continues to decline driven by changes in the social structure including demographics, fuel conversion in response to the environment, and increasing fuel economy of vehicles. Demand has already peaked for all types of oil products. Demand for fuel oil overall peaked in FY1999 at 245.97 million KL, while demand for gasoline peaked in FY2004 at 61.48 million KL (see Table 1).

Table 1 Timing and Volume of Peak Oil Demand in Japan

Type	All fuel oil	Gasoline	Diesel
Year	1999	2004	1996
Quantity	245.97 million KL	61.48 million KL	46.06 million KL
Type	**Kerosene**	**Heavy Oil A**	**Heavy Oil C**
Year	2002	2002	1973
Quantity	30.62 million KL	30.14 million KL	110.00 million KL

Source: Created by the author based on statistics on resources and energy, Ministry of Economy, Trade and Industry

Demand will continue to decline even in short-term forecasts. The forecast for the demand for oil products released by the Ministry of Economy, Trade and Industry (METI)[1)] says that demand for all types of oil products will decline on average by 1.3% per annum until 2023. Diesel will only see a rate of decline of 0.2% until 2023 because of cargo transport volumes, but demand for gasoline is expected to decline by an average of 2.2% per annum until 2023 due to improvements in fuel economy and declining in the number of miles driven by passenger vehicles. The domestic market, which accounts for a majority of Japanese oil companies' net sales, will continue to shrink, and the business environment is expected to become even more severe.

As for the long-term forecast, according to the Institute of Energy Economics, Japan (IEEJ) Outlook 2020[2], the final consumption of oil will gradually decline from 150 Mtoe in 2017 in both the Reference Scenario and the Advanced Technologies Scenario.[i] As of 2050, demand will range between 83Mtoe and 95Mtoe, marking a loss of between 40 and 50% over around 30 years. Therefore, there are limitations posed by a

business portfolio based on the domestic market alone.

2.3 The Trend of Climate Change Countermeasures

The adoption of the Paris Agreement in 2015 created two common long-term goals for the world. The first is to keep a global temperature rise in this century well below 2 degrees Celsius above pre-industrial level and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius. To that end, second is to undertake rapid reductions of emissions in order to achieve a balance between emissions by sources and removals by sinks (e.g. forest) of greenhouse gases in the second half of the 21st century. This has resulted in the major trend of low carbon or decarbonization, causing changes in various aspects of social trends including policy, popular will, and finance. Within this trend, initiatives are being created that will put pressure on fossil fuel companies (see Table 2).

Table 2 Examples of Decarbonization and Low Carbonization Initiatives

Initiative	Detail
RE100	An initiative launched in 2014 with the objective for member corporations to switch to 100% renewable energy in powering their business operations. The trend for businesses to urge their suppliers and clients to switch to renewable energy, in addition to their own companies, is also seen.
Science Based Targets (SBT)	An initiative that involves establishing a carbon dioxide emissions reduction target based on scientific evidence in order to limit the rise in the global average temperature to well below 2°C above pre-industrial levels.
Climate Action100+	A global initiative for institutional investors to conduct constructive dialogue on information disclosure and efforts aimed at reducing greenhouse gas emissions with corporations that possess large influence in addressing global environmental issues.
Carbon Disclosure Project (CDP)	The project strives to disclose the status of environmental initiatives undertaken by businesses using a common measure through the collection of information via the survey on emissions reduction and climate change related initiatives of major global companies, and analysis and evaluation of the survey responses. Its focus is on the collection and disclosure of climate change-related information of concern to institutional investors.
Task Force on Climate-related Financial Disclosures (TCFD)	The TCFD was established by the Financial Stability Board (FSB) at the request of the G20 in order to examine how to disclose climate-related information and the response of financial institutions. It issued recommendations to companies regarding governance, strategy, risk management, and metrics and targets concerning climate-related risks and opportunities.

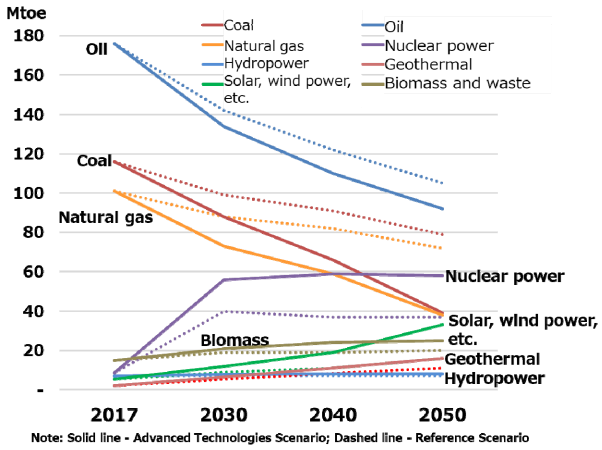
Source: Compiled by the author based on various reference materials

3. Future Growth Markets

3.1 Energy Demand Trends of Japan

The previous section shed light on the risks facing Japanese oil companies. Next, this paper will identify the growth fields in Japan while reviewing the situation for each energy source from IEEJ Outlook 2020. First to focus on is electricity. The ratio of electricity in final energy consumption (electrification rate, hereinafter) is growing by a substantial amount, and it will increase for both the Reference Scenario and Advanced Technologies Scenario up to 2050. This ratio will rise from 28% in 2017 to 32% by 2030, 34% to 35% by 2040 and 38% to 39% by 2050, showing that the importance of electricity will continue growing.

Next, the outlook for primary energy consumption in Japan indicates that it will continue declining following the country's declining population. Also, the usage amount of fossil fuels will fall due to measures to combat climate change. Oil demand will decline from 176 Mtoe in 2017 to 105 Mtoe by 2050 (92 Mtoe in the Advanced Technologies Scenario), representing a 40 to 50% drop. Coal demand will drop from 116 Mtoe in 2017 to 79 Mtoe by 2050 (39 Mtoe in the Advanced Technologies Scenario), or between 30 and 70%. Natural gas demand will fall from 111 Mtoe in 2017 to 72 Mtoe by 2050 (38 Mtoe in the Advanced Technologies Scenario), or between 40% and 60%. Meanwhile, among renewable energies, solar and wind power will increase from 5.5 Mtoe in 2017 to 16 Mtoe (38 Mtoe in the Advanced Technologies Scenario), for an increase of between 3 and 7 times (see Figure 5).



Source: Compiled by the author based on IEEJ Outlook 2020

Fig. 5 Long-term Outlook for Primary Energy Consumption (Japan)

Japan's declining population and depopulation of rural areas will make it difficult to maintain its energy network. However, this trend will further promote the use of electricity and may further grow demand for solar and wind power (offshore wind power in the future) as distributed energy.

Demand for fossil fuels will decline largely, but even in the Advanced Technologies Scenario, oil will remain the largest energy source as of 2050. For this reason, consideration will need to be given to the point that oil will retain its importance.

Based on the above, Table 3 shows the results of an evaluation and summary of the growth potential of each energy source. The importance of oil will remain, but in Japan electrification of demand will rise, and renewable energy, which is expected to grow, will become a growth field.

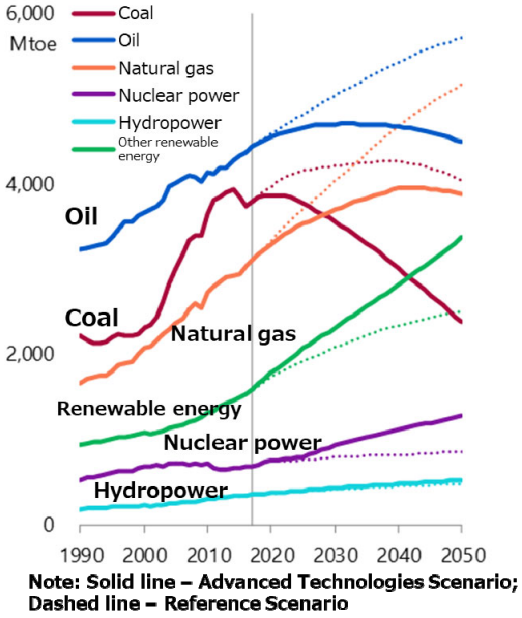
Table 3 Evaluation of Growth Potential by Energy Source (Japan)

	Evaluation (Growth potential)	Outlook for 2050	Challenges
Renewable Energy	Excellent	Growing demand, especially large growth in solar power and wind power	Decrease in suitable land Output volatility, integration cost
Nuclear and Water Power	Poor	Nuclear power: Increase Hydro power: Marginal change	Maintenance and updates New investment Safety and economic efficiency
Natural Gas	Poor	While demand is expected to increase due to the possibility of alternatives to coal-fired power and demand for city gas, it will gradually decrease in the long run.	Alternatives to coal-fired power City gas demand supplement View of gas as a fossil fuel
Oil	Poor	Downward trend due to decreasing population, increasing fuel cost and stronger EV growth. Slight decrease also expected in demand for petrochemicals.	Speed of EV development Competitiveness of refineries
Coal	Bad	Large decrease due to increased replacement of non-efficient coal-fired power	Decreased coal-fired power generation Divestment of steel manufacturing process

Source: Compiled by the author based on various reference materials

3.2 Worldwide Energy Demand Trends

Next, this section will look at worldwide demand. The outlook differs for Japan and international markets, and demand trends for energy also vary by region. In the Reference Scenario, primary energy consumption grows on the back of rising populations around the world. Natural gas demand is expected to increase from 3,107 Mtoe in 2017 to 5,165 Mtoe by 2050, up about 1.7 times, and oil demand is also forecast to increase by a large amount from 4,449 Mtoe in 2017 to 5,707 Mtoe, up about 1.3 times. In the Advanced Technologies Scenario, energy conservation and climate change measures will cause primary energy consumption to decline by 2,842 Mtoe compared to the Reference Scenario for 2050, but still, increase overall. In addition, while demand for renewable energy will increase, coal demand will drop substantially. Demand for oil will peak in 2030 and for gas in the first half of the 2040s. Nevertheless, similar to Japan, oil will remain the largest energy source even as of 2050 (see Figure 6).



Source: IEEJ Outlook 2020

Fig. 6 Long-term Outlook of Primary Energy Consumption (World)

The driver of demand will be Asia with its huge population and high growth potential. In contrast, demand will decline in developed countries including the OECD. The importance of electricity will continue to grow worldwide. The amount of power generation in the world will continue to increase from 25,606 TWh in 2017 to 45,361 TWh by 2050 in the Reference Scenario, representing an increase of about 1.8 times. The electrification rate of demand also will rise from 19% in 2017 to 26% by 2050. This trend remains largely the same as with the Advanced Technologies Scenario. The increase in power generation will see electricity demand covered by natural gas-fired thermal power and renewable energy, with the role of coal remaining in emerging countries.

Let us now look at the cost structure of renewable energy covering this increase in electricity. According to IRENA, power generation cost by renewable energy is declining worldwide[3]. Photovoltaic power has declined around 80% from 0.378 USD/kWh in 2010 to 0.068 USD/kWh. Similarly, onshore wind power has fallen from 0.086 USD/kWh to 0.053 USD/kWh, or down around 40%. Installed capacity from renewable energy will continue to rise due to declining costs and climate change measures.

However, the large-scale introduction of renewable energy faces the challenges of cost for addressing the variable nature of output and difficulty in satisfying demand for high temperature heat required by industry. Renewable energy is an extremely

important energy source for decarbonization, but it is not the only countermeasure. Initiatives other than renewable energy will become necessary.

Table 4 presents the results of an evaluation by energy source based on future growth potential. The overarching trend will be for coal to be replaced by renewable energy. As such, renewable energy will continue to grow going forward. Meanwhile, particularly in Asia, demand for fossil fuels including coal will grow and oil will continue to increase in importance. Since the situation will differ by energy source and region, it will be necessary to consider strategy with a good understanding of areas and energy sources.

Table 4 Evaluation of Growth Potential of Each Energy Source (World)

Energy Source	Reference Scenario	Advanced Technologies Scenario	Outlook for 2025	Challenges
Renewable Energy	Excellent	Excellent	Major growth as the pillar of measures against climate change, also partly due to declining cost.	Excessive competition Integration cost
Nuclear and Hydro Power	Good	Good	Demand expands with switch to electricity, but not at the same level as renewable energy. Development of new nuclear power plants such as SMR.	Maintenance and updates Difficulty in establishing new facilities Safety and economic efficiency
Natural Gas	Excellent	Good	Demand expected to increase as a relatively clean fossil fuel.	Adaptation in developing countries View of gas as a fossil fuel
Oil	Excellent	Good	Demand remains in the transportation sector, especially in developing countries.	Development of fuel efficient vehicles and EV
Coal	Poor	Bad	Solid demand in Asia. Possibility of a sudden decrease due to the pressure to reduce.	Non-coal fired power Divestment

Source: Compiled by the author based on IEEJ Outlook 2020

4. Examples of Responses by the World's Fossil Fuel Companies

As pressure for lower carbon and decarbonization increases, what types of strategy will the world's fossil fuel companies implement? This section will examine their responses to change and identify the options that the Japanese oil industry can model their initiatives going forward.

4.1 Oil Majors [4, 5]

First, the main responses of the world's oil majors focused on this section are summarized below (see Table 5).

(1) Shell

Shell is moving ahead with energy conversion, having established ambitious decarbonization targets and policy. It announced a target to achieve net zero emissions of greenhouse gases by 2050 (Scope 1 and Scope 2 – aiming to achieve net zero emissions from its own product manufacturing). In this manner, Shell appears committed to strengthening initiatives to address climate change issues. Furthermore, it aims to reduce GHG emissions from energy products it sells (Scope 3) 30% by 2035 and 65% by 2050.

Upstream, Shell is strengthening its gas business in particular, shifting from oil to gas. In 2016, it acquired BG Group of the UK, enhancing its trading functions and expanding its value chain to the mid and downstream. Shell accounts for the world's largest share of LNG supply as a private-sector company.

In renewable energy, Shell is focusing particularly on wind power, with projects being promoted in North America and the Netherlands. In 2020, it commenced construction of an offshore wind farm in the Netherlands without subsidies together with Eneco (the Netherlands). Recently, Shell has also been moving ahead with the development of floating offshore wind power.

Shell is working to grow its EV charging network as well. In 2017, it acquired NewMotion (the Netherlands) and now owns Europe's largest charging network.

Shell is also actively moving ahead with its carbon capture and storage (CCS) business, implementing projects and research and development in Australia, Canada and Norway, among other countries. Shell also participates in The Oil and Gas Initiative (OGCI)[ii] through which it promotes carbon storage and utilization.

Table 5 Initiatives of Oil Majors

	Shell	BP	Total	ExxonMobil	Chevron
Decarbonization target	2050 Net Zero Scope 1-3 Targets	2050 Net Zero Scope 1-3 Targets	2050 Net Zero Scope 1-3 Targets	Scope 1-2 Targets	Scope 1-2 Targets
Natural gas business	Acquired BG Group (UK) Enhancing value chain	Emphasis on focus areas, profitability and low GHG emissions	Acquired Engie (France) Strengthening value chain	Stepping up efforts	Stepping up efforts
Wind and solar power business	Increasing offshore wind power Solar power in the U.S. and Brazil	Strength in wind power in the U.S. Acquired Lightsource,(France) the largest solar company in Europe	Focusing on solar business Acquired Eren (France) and a joint project with Macquarie (Australia) in the wind power business	No prominent assets	Stepping up efforts through a partnership with Algonquin (Canada)
Bio-fuel business	Initiatives in Brazil	Initiatives in Brazil	Bio diesel Bio jet fuel	Algae refining project	Bio diesel Bio jet fuel
EV, storage battery and hydrogen	Largest EV charging network in Europe Expanding hydrogen sales network	Expanding charging network with DiDi (China) and joint venture with Reliance (India) Expanding investment in hydrogen	Acquired Saft (France) Constructing the largest battery storage facility in France	Research on hydrogen power generation with fuel cells	Development of hydrogen stations
CCS business	Stepping up efforts Northern lights project	Stepping up efforts	Stepping up efforts Northern lights project	Stepping up efforts	Major CCS initiative in Australia, and research on direct air capture (DAC)
Alliance affiliation	OGCI member	OGCI member	OGCI member	OGCI member	OGCI member
In-house carbon pricing	Implemented	Implemented	Implemented	Implemented	Implemented
Compensation-linked environmental targets	Present	Present	Present	Not present	Present

Source: Compiled by the author based on various reference materials.

(2) BP

BP has also set ambitious targets. It aims for net zero emissions of greenhouse gases across all of its businesses by 2050. In addition, BP is working to reduce carbon intensity of the energy products it sells by 50%. Furthermore, according to its clean energy transformation plan announced in August 2020, BP plans to cut oil and gas output by 40% by 2030 compared to 2019.[6] Also, it plans to expand investment in fields such as renewable energy, CCS, and hydrogen to 5 billion US dollars per annum.

Upstream, BP positions natural gas and LNG as core sectors, while focusing on production at assets with high profitability and low greenhouse gas emissions.

In regard to renewable energy, BP has become the main player in wind power in the United States. In 2020, BP acquired wind power assets on the East Coast from Equinor (Norway), strengthening its wind power business.

In addition, BP is also focusing on EV related businesses. BP established a joint venture company with DiDi, a major vehicle hire app in China, and is working to expand its charging network. In 2019, BP entered the fuel retailing business in India and established a joint venture company with Reliance, with a plan to build EV charging stations in the country. In 2020, it was working to build rapid charging stations in Germany as well.

BP's new CEO Bernard Looney, who took over in February 2020, is stepping up initiatives toward decarbonization and carbon reduction in rapid succession. He has announced a concept of shifting from an International Oil Company (IOC) to an Integrated Energy Company (IEO).

(3) Total

The total has also established ambitious targets. With the goal to become net zero in its operations around the world by 2050 (Scope 1 and 2), it aims to achieve net zero emissions in Europe including emissions from customer use of the products it sells (Scope 3).[7]

In 2017, Total acquired Engie, a French utility company. It is seeking to grow and optimize in each domain of the LNG value chain, and is committed to expanding its gas business in all domains from upstream, including gas-fired thermal power generation and bunkering, to downstream.

As for the renewable energy business, Total is focusing on the solar business in particular, and in 2011 it acquired SunPower of France, which at the time was the third largest solar company in the world. It is also developing the business in the United States, Mexico, South Africa, Chile, and other countries. In 2019, Total approved a large-scale project with Marubeni in Qatar in the Middle East, and it has made inroads into Spain as well. It has also entered the solar power generation market in Japan. Furthermore, Total entered the wind power business in 2017 with its acquisition of Eren of France. In 2020, it announced that it would take part in an offshore wind farm project of South Korea together with Macquarie of Australia. In October 2020, Total announced that it would spend 3 billion US dollars with the aim of increasing investment in its power division including renewable energy to more than 20% of total capital investment.[8]

Total also has a storage battery business. In 2019, it commenced construction on the largest storage battery facility in France. In 2020, Total created a joint venture company for in-vehicle storage batteries with Groupe PSA of France, which is a global car manufacturer. Total is strengthening its presence in EV charging networks, with the acquisition of the UK's largest EV charging network (Bluepoint London) in 2020 and other initiatives. Total is also actively working on CCS and CCUS, having identified their importance.

Total's CEO Pouyanne says, "Total aims to sell energy," indicating the company is seeking to become a supplier of a wide range of energy.

(4) ExxonMobil

ExxonMobile is taking a somewhat different approach than European oil majors. It is focusing on deep sea resource exploration and development as well as upstream development for LNG, etc. In addition, it does not have any prominent assets in terms of renewable energy.

As a response to the environment, ExxonMobile is focusing on the development of low carbon technologies and bio fuels. As for low carbon technologies, it is working to reduce greenhouse gases in upstream oil and natural gas exploration and development processes. Among these, ExxonMobile is developing methane emissions monitoring technology and emission reduction technology. In terms of bio fuels, it is conducting R&D into algae-derived bio fuels, continuing research aimed at large-scale production. It is also conducting CCS research and development.

(5) Chevron

Chevron is investing in CCS technology, including large-scale CCS for an LNG project in Australia, becoming actively involved in this area. It has also established targets for reducing flaring during development processes and lowering methane emissions. With an eye on the future, Chevron is engaging in EV charging station networks and direct air capture (DAC) of CO2. In addition, Chevron is involved in the technological development of renewable fuels such as bio diesel and bio jet fuel.

4.2 Oil Refinery Companies

Next, this section will look at developments among the world's refiners. First is SK Innovations, South Korea's largest refiner. This company engages in businesses from upstream exploration and development to refining, chemicals, and lubricants. In recent years, SK Innovation has begun manufacturing batteries for EVs, making it the first in South Korea to establish a mass production system. Its production bases are located not only in South Korea, but also in China, Hungary and other locations. It plans to expand its manufacturing bases in Europe and China, while constructing a manufacturing base in the United States. It is also focusing on other businesses including information and electronic materials. In this manner, SK Innovation is offering new materials while utilizing its technical process from existing businesses.

Reliance of India is a conglomerate that engages mainly in petrochemicals but is also involved in oil and gas exploration and development, retail, infrastructure, and bio-technology, among other businesses. In retailing, it has become a leading player and India's largest retailer spanning foods, home electronics and fashion, etc. Reliance has also made inroads into other fields as well including digital services, media and entertainment. It has a presence in mobile data networks,

contents, and movie-related entertainment domains, which have grown to the point of accounting for around 20% of the company's earnings (FY2018). In this manner, Reliance is building up its business portfolio by expanding into fields outside of its core oil and chemicals businesses.

Finally, there is Valero of the United States. Valero is a dedicated oil refining company, with the largest oil refining capacity in the entire United States. It also operates refineries in Canada and the UK, and has a total capacity of 3.1 million b/d, making this single company on par with the 3.51 million b/d capacity of all Japanese refiners combined. Utilizing this refining capacity and operational capabilities, Valero is not only selling products downstream, but also optimizing product exports to demand areas from its portfolio across the Atlantic. In this way, Valero has built a business model that generates massive profits by trading with regions including Europe and Latin America. Valero is also focusing on biodiesel and bioethanol businesses. It supplies these to California, with its growing environmental awareness, as well as to premium low carbon markets in Canada and Europe. Valero is using existing assets of its own business for trading, etc. to generate profits.

4.3 Mineral Resource Companies

As a reference for the response to coal assets, this section reviews the moves of mineral resource companies. Starting with Glencore of Switzerland, it is a multinational company engaging in mine development and commodity trading. Its business fields are wide ranging and include metals (copper, zinc, lead, nickel and alloys, etc.), energy (coal and oil) and agricultural products. Up to 2018, the company had expanded its coal business around the world, but in 2019 it announced the plan to restrict its current level of coal production output and not to expand it any further. It has also not denied the possibility of divesting its coal assets. Glencore foresees growth fields to be mineral and metals to satisfy the demand for fuel cells and EVs.

Peabody of North America is the largest coal company in the United States. After filing for bankruptcy in 2016, Peabody restructured and emerged in 2017 after shrinking the size of its operations. The reason for its bankruptcy was the increased use of natural gas following the shale boom in the United States, causing the shift from coal to natural gas in power generation, and an increase of renewable energy following a decline in prices. Peabody is working to promote understanding about the role of coal in electricity and steel making, and intending to expand usage of progressive coal-related technologies including HELE technology [iii] and develop CCUS technologies. Until now, the thermal coal business in the United States has been Peabody's core business, but it plans to expand the coking coal business going forward.

Rio Tinto is a multinational corporate group based in the UK and Australia engaged in mining and resource fields. It is an integrated resource company with operations in coal, uranium and diamonds, etc., in addition to iron ore and non-ferrous metals. Its coal business was located in Australia, the United States and Mozambique in Africa. However, citing little hope for stable profits, it exited the United States in 2011 and sold off its Mozambique coal assets in 2014. In 2018, it sold all of its coal concessions in Australia, marking the complete exit from the coal business. Rio Tinto was the first major mineral resource company to exit the coal business. Rio Tinto says it will allocate its portfolio to fields such as lithium used as a raw material for storage batteries and aluminum for vehicle development, leading to improved fuel economy.

BHP Billiton, based in the UK and Australia, is the world's largest mining company. It has operations in iron, coal, oil, other metals such as bauxite, and mining products. BHP Billiton is the world's largest supplier of coking coal, and it has thermal coal operations in Australia and Colombia. In 2019, it indicated that it would exit the thermal coal business in the near future.

Mineral resource companies have shown their future direction in the form of exiting the coal business, restricting production output, and shifting to coking coal, indicating they are attempting to respond to environmental concerns and rising pressure for decarbonization. In addition, it has also been found that these companies are paying closer attention to minerals related to fuel cells and EVs.

5. Review of Countermeasures of the Japanese Oil Industry

The above overview of the initiatives promoted by each company has provided several options that Japanese oil companies should consider. European companies are carrying out a broad range of efforts toward long-term goals while announcing ambitious targets. In terms of other refiners, companies are engaging in new materials such as storage batteries and electronic materials, strengthening surrounding

domains such as retailing and digital services, and carrying out initiatives utilizing existing assets, such as trading. As for coal, companies are shifting to coking coal or restricting production output, or exiting altogether, indicating a direction of the restraining business while working on higher value products. Implementing all of these options at the same time is unrealistic, so the priority ranking of these initiatives for the Japanese oil industry will be considered in the sections below.

5.1 Review of Countermeasures Based on the Market Potential of Each Sector

Section 1 and Section 2 of this paper revealed the major regional differences in the market potential of each energy form. In light of this point, the current section will put a new focus on the market potential of each energy source. Looking at compatibility with the resources of the Japanese oil industry at the same time, the keys to success for the industry will be explored in terms of which region and sector the industry should prioritize.

Table 6 contains the regional market potential of each energy source and the compatibility of low carbon and decarbonization technologies with the oil industry. Regarding compatibility, naturally, oil has the greatest compatibility, while for natural gas, coal and renewable energy, evaluations are “poor to good” because of the different situation of each oil company. The evaluation for important low carbon and decarbonization technologies is “poor” because they are still not superior as of the current point in time. Looking at the market potential, oil will decline in Japan, but the scale of the oil business in Japan is large and its importance will continue to remain. In addition, in Asia forecasts predict growth in oil demand, indicating Japanese oil companies should expand into the region. Meanwhile, given the market potential and compatibility of natural gas and coal, these sectors do not offer good options as countermeasures. Although compatibility is not high for renewable energy and low carbon technologies, growth in these sectors is expected in Japan, Asia and developed countries, so Japanese oil companies should look to these sectors.

Table 6 Regional Growth Potential and Compatibility of the Oil Industry by Energy Source

Field/Region	Future growth potential			Compatibility with oil industry resources
	Japan	Asia	Developed countries	
Oil	Poor	Good	Poor	Excellent
Natural gas	Poor	Good	Poor	Poor to Good
Coal	Bad	Poor	Bad	Poor to Good
Renewable energy	Excellent	Excellent	Good	Poor to Good
Low/decarbonization technology/products	Excellent	Excellent	Excellent	Poor

Source: Compiled by the author based on various reference materials

The key to the Japanese oil industry is strengthening its earnings base in Japan, its core market, despite declining demand, and at the same time selling oil product, which is still growing in the Asian market and increasing sales in overseas markets. Furthermore, the Japanese oil industry will need to address electrification while stepping up initiatives in the renewable energy sector which is expected to offer great market potential. As for renewable energy, the companies in the industry should focus particularly on offshore wind projects in Japan and making inroads into suitable markets mainly in Asia. Working on low carbonization and decarbonization technologies is essential to continue selling fossil fuels. Since technological development takes time, they should get involved from an early stage. Particularly, carbon recycling (CCS and CCU) not only reduces CO2, but is also considered to be an important initiative for the effective use of assets already owned by the oil industry.

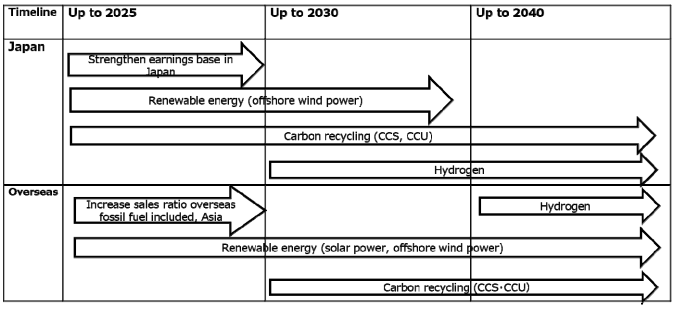
5.2 Prioritization of Countermeasures

Next, the prioritization of countermeasures will be considered. Looking at the timeline, the time until 2025 will be classified as short-term, until 2030 medium-term and until 2040 long-term (see Table 7).

First, over the short term, Japanese oil companies should strengthen their earnings through their domestic oil product business. At the same time, to increase the share of overseas sales, they should expand into Asia in particular. In renewable energy, they should focus on offshore wind power in Japan, and address renewable energy and electrification. In addition, while it takes time for technological development, they should start on carbon recycling (CCS and CCU) with the expectation of

long-term growth. Through these efforts, they can increase the share of overseas sales over the medium term and increase efforts for renewable energy and electricity. During this period, a certain timeline will be established for carbon recycling and the commercialization of hydrogen. In this manner, over the long term, Japanese oil companies should establish a corporate structure where new technologies and new businesses offset the decline in sales of fossil fuels.

Table 7 Prioritization of Countermeasures



5.3 SWOT Analysis

In this paper, SWOT analysis was conducted in order to consider which strengths specifically the Japanese oil industry should utilize in response to these countermeasures, and the results are summarized in Table 8. Utilizing the strengths outlined here will provide an important perspective in implementing countermeasures.

Table 8 SWOT Analysis of the Japanese Oil Industry

■Opportunity	・Increased demand in Asia ・Renewable energy ・Decarbonization, low carbonization technology (CCS, CCUS) ・Enhanced efficiency and customer contact points through digitization
■Threat	・Decreased demand due to population decline, EV, and switch to electrical power ・Pressure on fossil fuels from decarbonization
■Strength	・Track record of fulfilling responsibility of stable supply ・Nationwide service station network and distribution network ・Supplied energy together with the community ・Experience with handling complex process treatment and large volume of hazardous materials such as petroleum and petrochemicals ・Many years of business transactions with the Middle East ・Examples of expansion in Asia (lubricant, petrochemicals, fuel oil) ・Sales results overseas
■Weakness	・Refinery: Aging facilities, which are also smaller than neighboring countries ・Business scale: Inferior in scale to major companies ・Response to change since it had enjoyed stable long-term demand and handled products without quality deterioration ・Small business scale in sectors beside petroleum

Source: Compiled by the author based on various reference materials

6. Examination of Important Countermeasures

6.1 Domestic Oil Business

This section will delve deeper into several countermeasures that deserve attention. First, is the domestic oil business cited as a short-term initiative. The major underlying assumption will be the promotion of further enhancements of efficiencies following progress in business integration and an improved business environment. In addition, the utilization of digital technology and IoT will be necessary. For example, digital technology and IoT can be used to sustain oil supply of service stations required as a lifeline to marginal communities. In order to supplement oil demand of each household, sensors can be attached to each tank (heating oil, LP gas, etc.) to gather data. This data can, in turn, be analyzed to understand demand and carry out efficient delivery, which will secure a certain degree of demand for the supply side. Japanese oil companies will be able to explore the possibility of supply from locations with a slight distance from depopulated areas. For the demand side, there is also the merit of product delivery. Since regular communication will be created, there is the latent potential of regional revitalization and promoting peripheral businesses (i.e., businesses for seniors, etc.) through myriad consultative activities. With sensor performance and lower costs, if a system and agreement on data acquisition and cooperation with the community can be established, this will open the door to potential initiatives. Similarly, another possibility is that sensors can be attached to vehicle fuel tanks on a construction site to refuel those vehicles running low on fuel.

Even in urban centers, one approach may be to use service stations to appeal to people who find it inconvenient to fuel up. There is also the potential for marketing using customer contact points. Coupons can be utilized for each target using an app to encourage customers to visit service stations. In addition, there is the potential for data analysis to be used to conduct tailored approaches for each customer, leading to cross selling (which is to have customers purchase other products together) of non-oil products, car washes and vehicle inspections to increase sales. Customer time can be shortened as well by advancing digital payments and building a mechanism to complete payment when finished filling by linking the vehicle and pump at the time of filling.

6.2 Offshore Wind Power

The long-term outlook indicates that renewable energy is expected to grow, but within this sector, offshore wind power is an area of particular interest. Under the Fifth Strategic Energy Plan, Japan will aim to make renewable energy a mainstay power source while securing adjustment capabilities in response to lowering costs, grid constraints and the variable nature of output from renewable energy. Within this, wind power is expected to account for around 1.7% of the country's energy mix in 2030, with the installed capacity forecast being 10 GW, of which offshore wind power will account for 0.8 GW. With sites suited to the introduction of onshore wind power in short supply, the plan states that it will be vital to expanding the introduction of offshore wind power generation.[9]

The target for installed capacity in the Fifth Strategic Energy Plan is conservative, but Japan has the world's sixth largest exclusive economic zone, meaning there is a high potential for wind power in Japan. According to the Japan Wind Power Association, the potential for fixed offshore wind power is 128GW, while the potential for floating is 424GW.[10]

In Europe, the market leader, the cost of offshore wind power is declining due to the establishment of rules on the use of territorial waters and the introduction of a tender system. In Japan, the development of rules on the use of territorial waters had been an issue, but in 2019, the Act on Promotion of Use of Territorial Waters for Offshore Renewable Energy Generation Facilities (Offshore Wind Promotion Act) was established, providing positive headway in the development of the business environment. The Offshore Wind Promotion Act secures business stability by designating areas where the implementation of offshore wind power projects is feasible, selecting operators by public auction, creating a system enabling long-term exclusivity, and ensuring an exclusivity period (30 years) required including FIT period and necessary construction period before and after that. In addition, a committee was established to facilitate coordination with local communities. For designated development zones, discussions are held with relevant ministries and agencies, and the national government is involved in the coordination of first use, improving the predictability of business operators.[11] Moreover, the Act aims to lower costs through competition to make prices subject to public offering selection criteria. In July 2020, Noshiro City, Mitane Town, and offshore Oga City in Akita Prefecture, offshore Yurihonjo City (north and south) in Akita Prefecture, offshore Choshi City in Chiba Prefecture, and offshore Goto City in Nagasaki Prefecture were designated as four promotion areas.[12] The maximum tender price for three of these promotion areas was set at 29 yen/kWh in September 2020.

(1) Overview of Suggestion for Japanese Oil Companies

Offshore wind power is a technology with a small track record outside of Europe. Even in Europe, bottom-mounted offshore wind turbines are the mainstream (because of the geographic characteristic of extensive shallow waters), and there are few floating offshore wind turbine projects with the technology not having been established. The potential for wind power generation in Japan established by the Japan Wind Power Association suggests that floating offshore wind turbine is expected to become the mainstream because of the limited amount of shallow territorial waters with strong winds. Japanese oil companies should quickly establish a track record in Japan where it is easy for them to conduct business, and then expand into Asia because of its locational advantages. There are expected needs in Asia's developing countries because of growing interest in the environment and climate. The potential for expanding offshore wind power includes (1) supply of renewable electricity; (2) lower carbon emissions of oil business; and (3) hydrogen production. Lowering carbon emissions of the oil business involves supplying electricity to oil fields at the time of upstream exploration and development. In addition, hydrogen production is a potential long-term approach that uses electricity generated for hydrogen production even when there are grid connectivity constraints.

(2) Specific Action Plan

At the current point in time, the Japanese oil industry lacks the knowledge to engage in the development of offshore wind projects on a standalone basis. Therefore, it will need to find the right partners while utilizing its relationships with existing businesses to form a consortium. It will also be beneficial to participate in investments in overseas projects to increase experience and gain know-how while working with European companies including those bottom-mounted offshore turbine projects. At the same time, Japanese oil companies will need to build a track record in domestic projects. Additionally, using M&A could be an effective approach to accelerate initiatives by purchasing technologies and experience.

Key points of interest in moving ahead with this business will be the availability of transmission line connections and approaches. Given current challenges, the government is taking the lead in forming push-type transmission networks, and developments in this regard should be closely monitored. In addition, the economics will also need to be closely monitored as the transition from the FIT to FIP systems is making progress.

(3) Reason for the Japanese Oil Industry to Engage in Wind Power

In addition to business opportunities and the large potential of Japan, there are several areas promoting affinity with the Japanese oil industries' involvement in offshore wind power generation. Companies already have knowledge in onshore wind power, and the oil business is not area specific and companies have engaged in business nationwide, meaning they are capable of pursuing offshore wind power anywhere in Japan. They also have strengths in having engaged in business together with local companies and communities at their manufacturing bases including refineries throughout Japan. This experience is considered to be an advantage when engaging in the offshore wind power business in which one key point for success is to realize close working relationships with local stakeholders. As indicated in Table 9 below, there are examples of Japanese oil companies participating in offshore wind power projects both within and outside of Japan. These are expected to grow going forward.

Table 9 Examples of Wind Power Generation Projects involving the Japanese Oil Industry

Company	Examples
Idemitsu Kosan	・2019 Developed a 88,000 kW floating offshore wind turbine in Norway (also supplies power to the oil field of which the company holds rights)
ENEOS	・2019 Participated in offshore wind power generation project in Taiwan with an investment in a 640,000 kW offshore wind turbine (investment rate 6.75%) ・2020 Invested with Tohoku Electric Power in the Japan Renewable Energy offshore wind power generation project in Akita (tentatively 155,000 kW)
Cosmo Eco Power	・2019 Began environmental evaluation process for offshore wind power generation project off the coast of Ishikari, Hokkaido, 1 million kW

Source: Compiled by the author based on promotional materials of each company

6.3. Carbon Recycling

Carbon recycling is a medium- to long-term initiative worth noting. In this initiative, CO_2 emissions released into the atmosphere are reduced by separating, recovering and storing CO_2, and then the recovered CO_2 is considered as a resource that can be converted into materials or fuel by mineralization, artificial photosynthesis and methanation for reuse. As the reduction in CO_2 emissions is required in order to continue selling fossil fuels, carbon recycling is believed to be a necessary approach for the Japanese oil industry that contributes to climate change measures. Since it takes time to develop the technology, it is ideal to strengthen approaches at an early stage, leading to realizing the sale of carbon neutral oils in the future.

As outlined in the road map of the Carbon Recycling Promotion Office under the Ministry of Economy, Trade and Industry, there are two types of initiatives, namely short-term initiatives with the aim to achieve early penetration of carbon recycling, and other initiatives aiming for its medium- to long-term penetration.[13] Short-term initiatives include lowering costs for CO_2 separation, recovery, utilization, and storage, utilization in EOR,[iv] as well as separation and recovery by each plant. Moreover, from a short-term perspective, it is desirable to begin replacements with alternatives that have a high added-value, with the sectors of chemicals (e.g. polycarbonates), liquid fuel (e.g. jet fuel), and concrete products (e.g. roadblocks) offering the most potential. In the medium- to long-term, it is viewed that initiatives will be expanded in general-purpose products with high demand.

(1) Required Steps and Approaches for Actualization

Looking strictly at CCS alone, there are only two cases of implementation in Japan. The first example is a demonstration test conducted in Nagaoka City, Niigata Prefecture in which 10,000 tons of CO_2 was stored in an aquifer during the period of 18 months starting in 2003.[14] The second example is a demonstration test conducted in Tomakomai, Hokkaido, which involved injecting CO_2 released from a hydrogen production facility within the Hokkaido Refinery of Idemitsu Kosan into a reservoir. A cumulative total of 300,000 tons has been injected and stored between 2016 and 2019, and the storage in the reservoir was confirmed to have remained stable even after the injection had stopped.[15] Going forward, the number of demonstration tests should increase with the development of technology for CO_2 separation, recovery and storage. Simultaneously, the development of conversion technology for CO_2 recovered should also be undertaken. During the stage of technological development, efforts to enhance economic efficiency, such as lowering the recovering cost of CO_2, are also sought after. At the same time, since CCS does not generate any

profit, it is necessary to consider incentives for introducing CCS based on economic efficiency, as well as reviewing legal and tax structures, to support it.

(2) Other Challenges

It is possible to inject recovered CO_2 into oil wells after mining in countries that produce resources. However, since Japan is not a country that can conduct resource mining in its surrounding areas, there is limited space for CO_2 storage. Looking for a suitable storage location in the inland area of Japan, would require obtaining consent from the residents in the community, and incur a large cost, such as construction costs. For this reason, it is essential to also develop technology for undersea injection. Rather than seeking suitable locations for storage within Japan, it is also crucial to expanding businesses and cooperation with other oil producing countries. CCS will be implemented in oil producing countries to offset the imported crude oil. This allows oil companies to sell low carbon gasoline through carbon neutral crude oil. In addition, this initiative can be a win-win approach that enables oil producing countries to improve their crude oil recovery rate by using CO2 in enhanced oil recovery technology, while avoiding stranded oil assets.

(3) Accessible Strengths of the Japanese Oil Industry

The Japanese oil industry has a long-standing business relationship with oil producing countries in the Middle East. The implementation of CCS and CCU with these countries, taking advantage of the trust relationship built through long-term transactions, is considered an approach that harnesses the strength of the oil industry. In addition, their long-standing experience in handling a large amount of petroleum products, as well as refining and manufacturing petrochemical products should serve as strengths leading to the development of CCU technology. Therefore, the Japanese oil industry should work more actively on CCS and CCU, enhance relevant expertise for future demand, and be involved in developing necessary technologies and systems.

6.4 Required Actions of Each Player

What initiatives are required of each relevant player in order to carry out the effective methods for improving the situation described above? Companies are first and foremost expected to make the best efforts in carrying out the activities that they can undertake as individual entities. To start, Japanese oil companies should actively engage in demonstration tests of carbon recycling, which requires long-term implementation. From there, with the development of technologies, these companies should sort out the systems needed to ensure profitability. Each company should also take a flexible approach in addressing their areas of deficiency (technical or financial) through collaboration with other companies (beyond their industry). In addition, it is necessary to consider forming partnerships and establishing a system with oil producing countries and overseas players. Moreover, these companies need an approach toward more actively communicating and collaborating with the government.

The commercialization of carbon recycling technology, which requires long-term efforts, is important not only for the Japanese oil industry but also the country’s manufacturing industries as a whole. Therefore, the government should provide assistance to foster the advancement of technology. Some examples for consideration include, increasing the amount of research and development support, expanding the scale of demonstration test projects, and making arrangements for international demonstration test projects. Moreover, measures such as applying emissions reduction and making carbon pricing evaluation to carbon recycling can be effective in promoting commercialization. The government may also play the role of coordination (cases involving local governments, contents shared between ministries, projects across countries) and intermediary (for private companies to overcome obstacles in capital or human resources) in providing essential policy support.

7. Conclusion

The operating environment for Japan's oil industry is undergoing enormous change, with growing pressure on implementing measures for climate change and decarbonization. While domestic demand for oil decreases, the need for electricity and renewable energy is expected to grow in Japan. Globally, the outlook of demand differs by each region. In Asia, the increased demand will be met with fossil fuel, while renewable energy also increases.

Although there are various responses from fossil fuel companies, it is unrealistic to take measures addressing all directions. Therefore, it is desirable to implement measures in the order of

priority with respect to time. For the short term, companies should secure their earnings base in Japan, where the industry has been reorganized. At the same time, companies can expand overseas to increase the share of overseas sales. From there, they should expand their efforts in renewable energy with particular attention to offshore wind power generation.

For the medium- to long-term, as efforts must be put into carbon recycling, companies need to carry out long-term initiatives to address various challenges in technical, geographical, and economic aspects. Collaboration on initiatives with the government and other companies both in Japan and overseas will become essential in order to overcome these challenges. The future of the Japanese oil industry lies in developing sustainability while working on each initiative, leveraging each company's strengths.

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Footnotes

i. The Reference Scenario is a scenario in which the trending changes thus far are continued amidst the background of energy and environmental policies to date. There is no radical energy conservation or low carbon policy launched (business as usual). The Advanced Technologies Scenario is a scenario in which each country sets out robust energy and environmental policies in order to secure a stable energy supply and strengthen climate change countermeasures, leading to maximizing the success of the policies.
ii. Oil and Gas Climate Initiative (OGGI) is an initiative launched by global major oil and gas companies to promote measures against climate change. There is a total of 13-member companies, including BP, Chevron, CNPC, Eni, Equinor, ExxonMobil, Occidental Petroleum, Pemex, Petrobras, Repsol, Saudi Aramco, Shell, and Total.
iii. HELE are technologies that offer high-efficiency and low emissions.
iv. EOR, short for Enhanced Oil Recovery, is an advanced recovery technology represented by CO2 injection method.

Contact: report@tky.ieej.or.jp