Japan increases its dependence on coal-fired power plants, receding from decarbonization

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wonder-news.com

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Introduction

Energy transition is expected to open a new era of competition over cleaner energy. The US and EU countries have accelerated their transition toward lower-carbon fuels, moving beyond coal and pursuing decarbonization, while Japan lags far behind in the energy transition.

The Japanese government maintains a policy of continuously introducing high-efficiency coal-fired power plants despite the fact that 9 out of 33 nuclear power plants (NPPs) have started operations since 2015. Japan will be forced to rely "permanently" on coal-fired plants and NPPs unless it can solve structural issues in its energy system. If it continues to rely on power grids exclusively, Japan's energy sector can expect limited growth in renewables, particularly solar and wind power. The government's current energy policy, unveiled in July of this year, promised that renewable energy would be one of the major energy sources by 2030. But unless the current energy system changes dramatically, this most likely will be an empty promise.

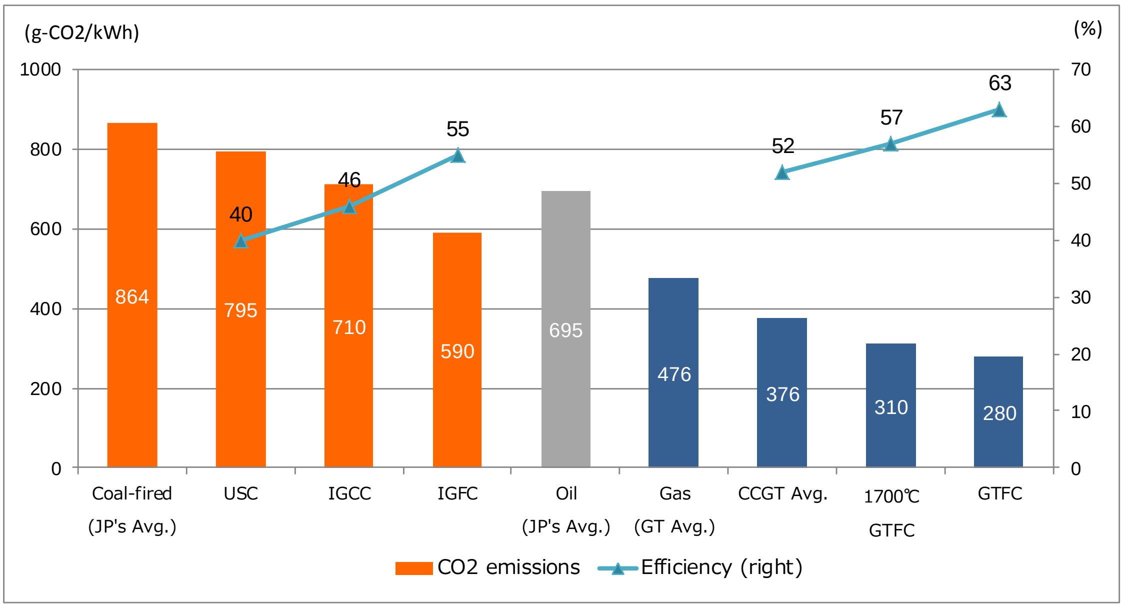
This report describes the current state of Japan's utility sector, explores why the utilities are reluctant to pursue an energy transition, and reveals how Japanese companies are addressing new energy systems.

1. Current Situation and the Outlook of Japan's Electric Power Industry

Clean Coal

Power companies in Japan reverted to coal-fired power plants even after the Paris Agreement, which entered into force in November 2016. Japanese power companies continue to place great emphasis on decreasing carbon dioxide (CO2) emissions by improving the efficiency of coal-fired power plants. Meanwhile, the US and EU countries are leading the energy transition from coal to natural gas and/or renewable energy.

Figure 1 CO2 Emission and Energy Efficiency of Thermal Power Plants by Fuels



USC＝Ultra-Supercritical, IGCC = Integrated coal Gasification Combined Cycle, IGFC = Integrated coal Gasification Combined Cycle, GT = Gas Turbine, CCGT = Combined Cycle Gas Turbine, GTCC = Gas Turbine Combined Cycle, GTFC = Gas Turbine Fuel Cell Combined Cycle

Note: IGCC (coal-fired plant) and 1700℃ GTFC (LNG power plant) are expected to start operations in fiscal year (FY) 2020. IGFC (coal-fired plant) and GTFC (LNG power plant) are mostly likely to start operations in FY 2025.

Source： *"Measures to accomplish energy mix for 2030", The Agency for Natural Resources and Energy*

(ANRE)[1], 2017

Japanese coal-fired power plants with reduced CO2 emissions herein are called "clean coal." The burning of coal, petroleum, and natural gas generates CO2 emissions at percentages of 100, 71, and 53, respectively[2]. The CO2 emissions associated with coal are nearly twice that of natural gas (**Figure 1**). Currently, many companies in Japan plan to construct ultra-supercritical (USC) coal-fired power plants. Although generation efficiency has improved, thanks to advances in technology, coal will never achieve the low CO2 emissions boasted by natural gas. Therefore, efficiency-improvement measures will have limited impact on the carbon footprint.

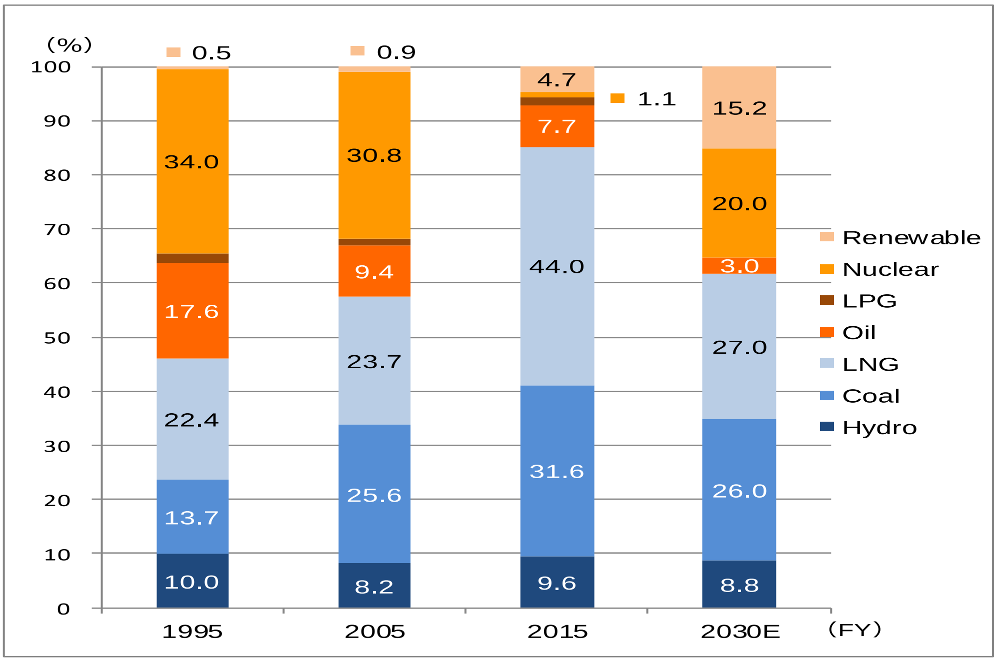
Power Utilities Revert to Coal-fired Power Plants in Japan

According to the basic energy policy for 2030 (released July 2018), coal-fired power plants will comprise 26% of generation capacity, retaining their status as a baseload power along with nuclear power (**Figures 2 and 3).** After the Paris Agreement took effect, eleven power companies—ten major power utilities and J Power, a major wholesale power company—released a plan to construct multiple new thermal power plants and few new natural gas power units by 2030. Meanwhile, these companies plan to build 22 units of coal-fired power plants, mostly employing a USC design (**Tables 1 and 2**), with a total capacity of 15.55 GW that will start operations in the early 2020s.

1 「*2030*年エネルギーミックス実現のための対策–原子力・火力・化石燃料・熱」資源エネルギー庁, 2017, p.32.

2 大前巌『二酸化炭素と地球環境 —利用と処理の可能性—』中央公論新社, 1999 年, p.141。

Figure 2 **Power Generation Mix**

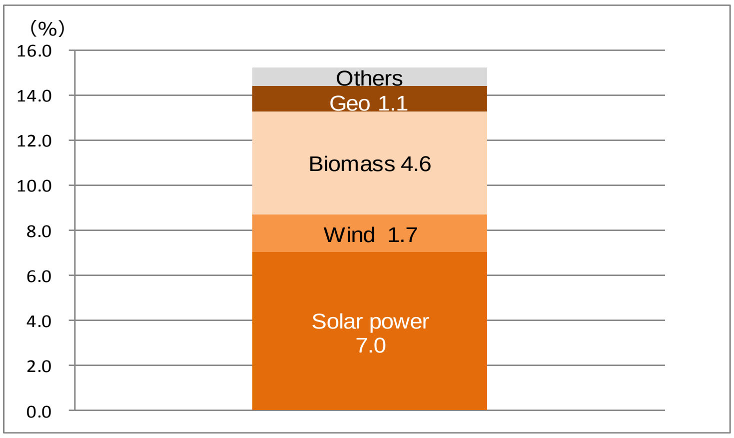


E = ANRE estimates

Note: The ANRE targets renewables, including hydropower generation that should account for a maximum of 24% by 2030. The figure shows hydropower separately to maintain data consistency.

Source: "FEPC INFOBASE 2017" FEPC[3] *and "Long-term energy demand and supply prospects" ANRE*[4]

Figure 3 **Breakdown of Renewable Energy (FY 2030 Estimates)**



Source: "Long-term energy demand and supply prospects", ANRE, April 28, 2015, p3

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3 See http://www.fepc.or.jp/library/data/infobase/ (as of 2018/9/6)

4 「長期エネルギー需給見通し 骨子案」資源エネルギー庁, April 28,2015, p.3, See http://www.enecho.meti.go.jp/committee/council/basic_policy_subcommittee/mitoshi/008/pdf/ (as of 2018/9/6)

Table 1 **Plans For New Coal-fired Power Plants**

Area	Pre-fecture	Plant name	Operator	Capacity (1,000 k W)	Commercial operation	Tech-nology
Kanto	Fukushima	IGCC Hirono	Toky Electric	500	early 2020	IGCC
	Fukushima	IGCC Nakoso	Toky Electric	500	early 2020	IGCC
	Ibaragi	Kashima Unit 2	J Power, Nippon Steel	650	2020/07	USC
	Ibaragi	Hitachinaka Joint Plant Unit 1	Toky Electric, Chubu Electric	650	FY2020	USC
	Chiba	Chiba Sodegaura Unit 1	Kyushu Electric, Tokyo Gas, Idemitsu	1,000	FY2025	USC
	Chiba	Chiba Sodegaura Unit 2	Kyushu Electric, Tokyo Gas, Idemitsu	1,000	FY2026	USC
	Kanagawa	Yokosuka, New Unit 2	Toky Electric, Chubu Electric	650	FY2024	USC
	Kanagawa	Yokosuka New Unit 1	Toky Electric, Chubu Electric	650	FY2023	USC
Tohoku	Akita	Akitakou Unit 1	Kanden Energy, Marubeni	650	2024/03	USC
	Akita	Akitakou Unit 2	Kanden Energy, Marubeni	660	2024/06	USC
	Akita	Noshiro Unit 3	Tohoku Electric	600	2020/06	USC
Chubu	Aichi	Taketoyo Unit 5	Chubu Electric	1,070	2022/03	USC
Kansai	Hyogo	KOBELCO Unit 1	KOBELCO	650	FY2021	USC
	Hyogo	KOBELCO Unit 2	KOBELCO	650	FY2022	USC
Chugoku	Hiroshima	Takehara New Unit1	J Power	600	2020/06	USC
	Shimane	Misumi Unit 2	Chugoku Electric	1,000	2022/11	USC
	Yamaguchi	Nishi-Okinoyama Unit 1	J Power, Osaka Gas, Ube Ind.	600	FY2023	USC
	Yamaguchi	Nishi-Okinoyama Unit 2	J Power, Osaka Gas, Ube Ind.	600	2025	USC
	Yamaguchi	Tokuyama East Unit 3	Tokuyama, Marubeni, Tokyo Century	300	2022/04	USC
Shikoku	Ehime	Saijo New Unit 1	Shikoku Electric	500	2023/03	USC
	Ehime	Soga	Chugoku Electric, JFE Steel, Tokyo Gas	1,070	2024	USC
Kyushu	Nagasaki	Matsuura Unit 2	Kyushu Electric	1,000	2020/06	USC

Note 1: As of August 2018

Note 2: Kanden Energy Solution is a subsidiary of Kansai Electric Power.

Source: wonder-news.com updates the data based on "The latest admission for the construction of new coal-fired power plants" the Ministry of the Environment [5]and "The list of new coal-fired power plants" Japan Coal Plant Tracker[6]

5 「最近の火力発電所設置工事における手続状況等」環境省, 2016 年 5 月 27 日, p.8-9

6 「新設一覧表」石炭発電所ウォッチ, See https://sekitan.jp/plant-map/ja (as of 2018/8/10)

Table 2 **Plans For New Natural Gas/LNG Power Plants**

Plant name	Utility company	Capacity (kW)	Fuel	Commercial operation
Joetsu Unit 1	Tohoku	572,000	Natural gas	2023
Yoshinoura Unit 3	Okinawa	251,000	LNG	2022
Yoshinoura Unit 4	Okinawa	251,000	LNG	2022
Himeji natural gas *	Kansai	1,800,000	Natural gas	2022
Anegasaki Unit 1,2,3	JERA	1,950,000	LNG	2023
Goi	JERA, JXTG	2,340,000	LNG	2023
Ishikariwan shinko Unit 2	Hokkaido	569,400	LNG	2027
Ishikariwan shinko Unit 3	Hokkaido	569,400	LNG	2030

JERA is a joint venture between Tokyo and Chubu Electric Power that operates thermal power plants.

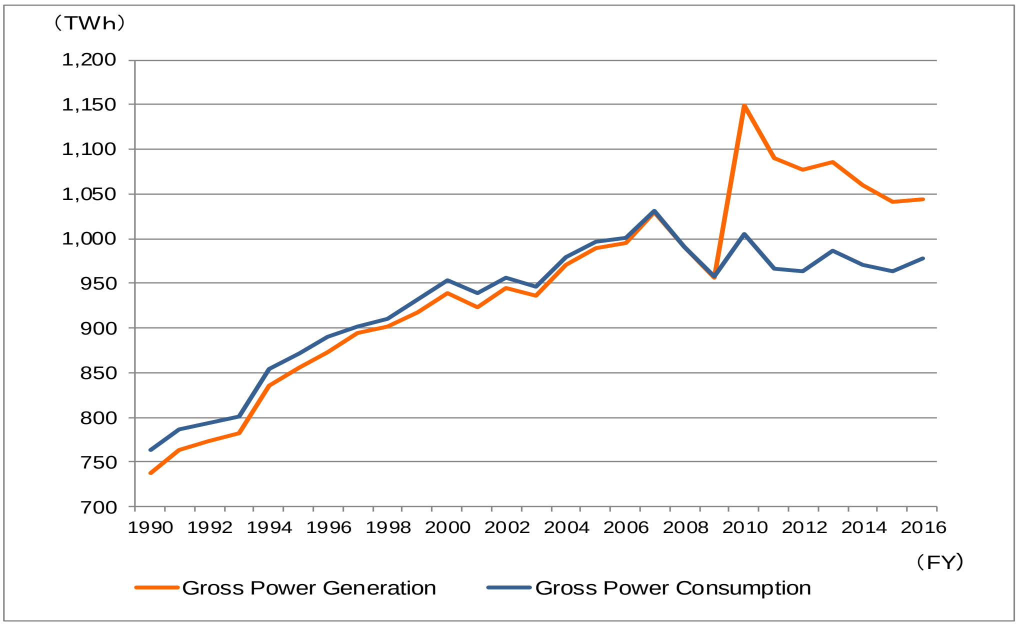
Note: ∗ 4 units of power plants with a 400,000 to 500,000 kW capacity per unit

Source: Securities Reports 2017/4/1-2018/3/31

Deregulation of Electricity Retail

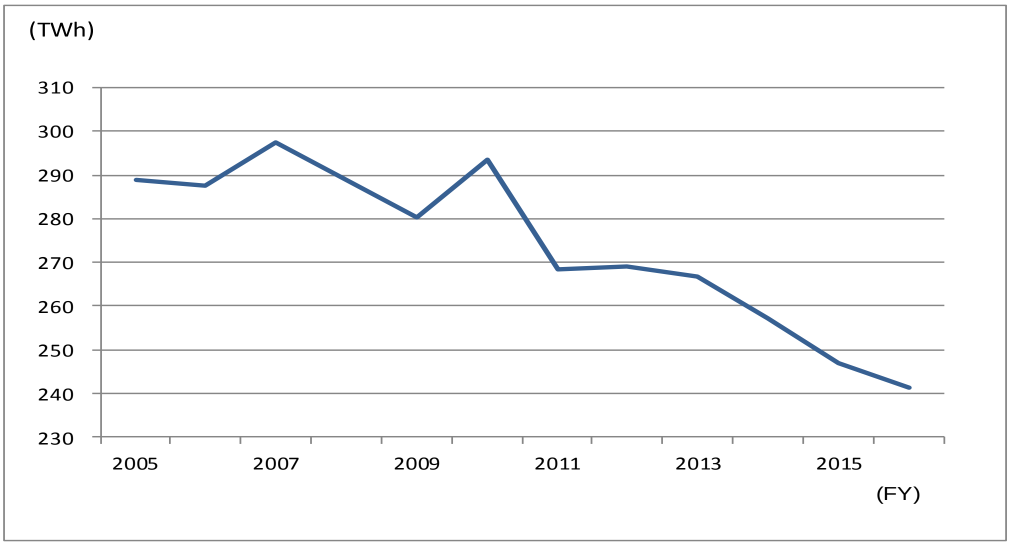
A surge in new coal-fired power plants was triggered by the deregulation of electricity retail, which started in April 2016. This policy change was enacted because ten major power utilities had been dominating power supply and retail in their respective service areas; deregulation aimed to open up the monopolized power market and encourage competition in the electricity sector by easing market entry for newcomers and lowering electricity prices.

Figure 4 Gross Power Generation and Gross Power Consumption (Japan)



Source: "Energy White Paper 2018" by ANRE[7], June 2018

Figure 5 Electricity Sales (Tokyo Electric Power)



Source: Tokyo Electric Power Company Holding[8]

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7 See http://www.enecho.meti.go.jp/about/whitepaper/2018html/2-1-4.html (as of 2018/9/6)

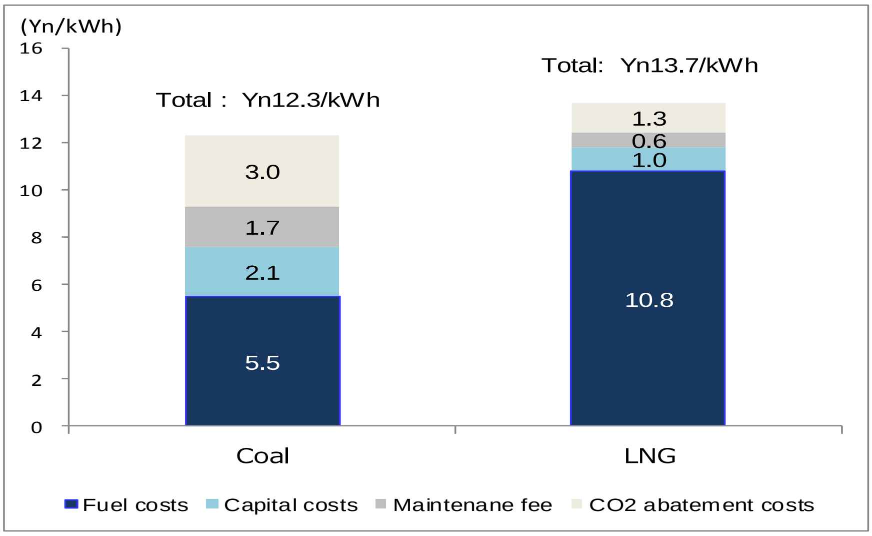
8 See http://www.tepco.co.jp/about/ir/financial/sales.html (as of 2018/9/6)

Newly planned coal-fired power plants were placed primarily on the Pacific coast, and nearly half of the projects are concentrated in the service area of Tokyo Electric (TEPCO) (Table 2). Growth in electricity consumption has been slowing for more than a decade, with the exception of years with high temperatures due to abnormal warming. Power consumption has plateaued or even slightly declined since it peaked in 2007 (**Figure 4**). Electricity sales in TEPCO's service area, which covers the Tokyo area and is one of the few areas in Japan with a continued population influx, have been declining since FY 2008 (**Figure 5**).

Coal Is the Cheapest Fossil Fuel

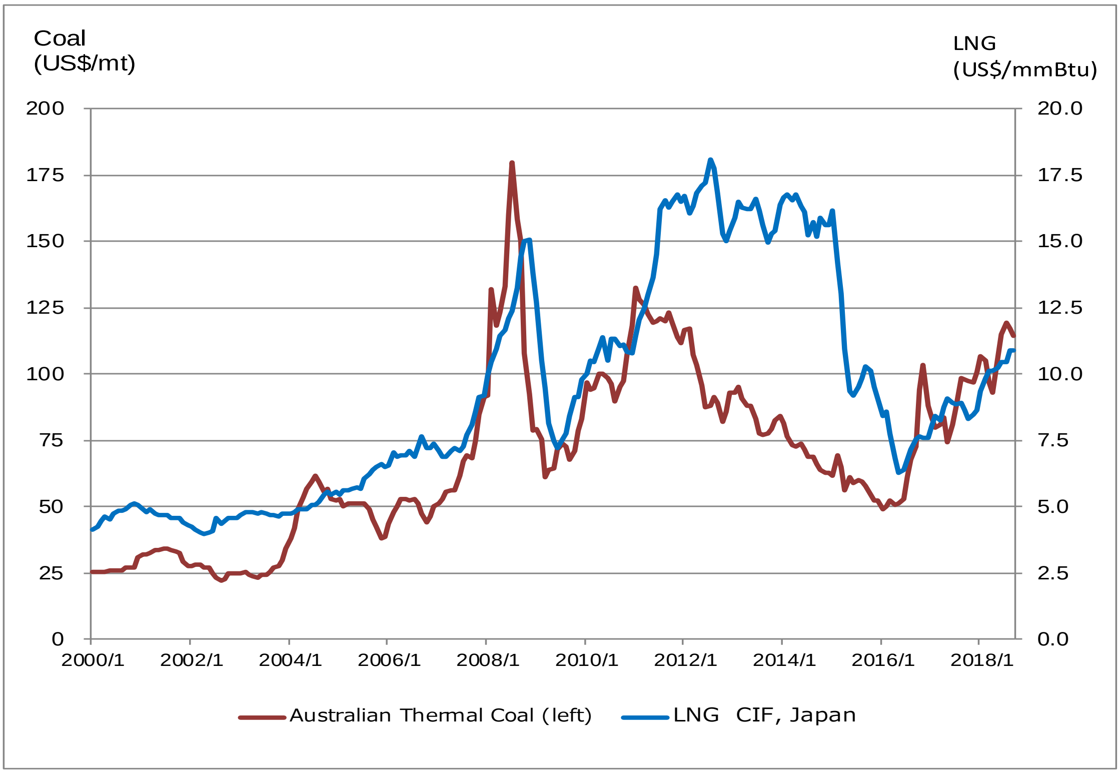
Coal-fired power plants are fascinated with cheap fuel. Power utilities take advantage of cost-competitive coal-fired generators to turn a profit while boasting lower energy prices than competitors in electricity retail (**Figure 6**). They can procure cheap coal since coal's fuel costs are about half that of liquefied natural gas (LNG) (**Figure 7**). Coal has vast reserves around the world, so it is easier for power companies to procure coal than petroleum or LNG. When power utilities build new thermal power plants, they prioritize profits over a reduction in CO2 emissions. They also forgo concerns about natural disaster risks—namely, that the Japanese archipelago is at risk for a megathrust earthquake originating in the Nankai Trough off the Pacific coast. It therefore would be prudent to diversify the locations of thermal power plants, placing some along the Sea of Japan in addition to the Pacific..

Figure 6 Generating Costs of Thermal Power Plants by Fuels



Source: "Costs for nuclear power plants" ANRE[9], Oct. 31, 2017

Figure 7 Fuel Prices (Coal vs. LNG, CIF, Japan)



Source: "World Bank Commodity Price Data[10]"

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9 「原発のコストを考える」資源エネルギー庁, See http://www.enecho.meti.go.jp/about/special/tokushu/nuclear/nuclearcost.html (as of 2018/9/6)

Relying on Aging Thermal Power Plants

Forty years is the benchmark of "aging" for power plants, but many thermal power plants have been operating for more than 50 years. As US shale gas production has increased since 2006, coal-fired plants have lost cost competitiveness. Since 2008, US power companies have shut down a record number of coal-fired power plants that were relative old and small, averaging 52 years and 105 megawatts (MW), while the remaining fleet of coal plants averages 39 years and 319 MW[11].

Table 3 Average Age of Thermal Power Plants in Each Power Company

	2018			2030E		
Utility company	**LNG**	**Oil**	**Coal**	**LNG**	**Oil**	**Coal**
Hokkaido	NA	35.6	37.4	7.5	33.3	44.8
Tohoku	16.3	37.4	31.7	24.5	49.4	38.9
Hokuriku	0.0	42.0	30.2	12.0	54.0	42.2
Chugoku	29.8	42.2	28.8	41.8	54.2	32.4
J Power	NA	NA	28.3	NA	NA	31.4
Shikoku	5.0	40.3	26.3	17.0	46.5	32.0
Chubu	28.9	28.9	22.2	36.5	36.5	34.2
Kyushu	36.8	38.8	21.0	48.8	50.8	21.7
Okinawa	4.2	36.0	19.5	13.2	48.0	31.5
Tokyo	25.8	39.1	15.0	35.8	48.5	18.5
Kansai	14.9	37.1	11.0	26.9	47.6	10.7
Average	**20.2**	**37.7**	**24.7**	**26.4**	**46.9**	**30.7**

E = wonder-news.com estimates

Source: Securities Reports 2017/4/1-2018/3/31

In Japan, the average age of operating coal facilities owned by major power utilities and J Power is shorter—about 25 years as of March 2018 (**Table 3**).

[10] See https://knoema.com/WBCPD2015Oct/world-bank-commodity-price-data-pink-sheet-monthly-update?tsId=1000150 (as of 2018/10/8)

[11] "Almost all power plants that retired in the past decade were powered by fossil fuels," EIA, Jan 9, 2018

Nevertheless, the conditions of aging facilities vary among power companies. The oldest coal-fired plants in Japan are Naie Unit 1 of Hokkaido Electric and Takasago Unit 1 of J Power, both of which have already surpassed 50 years of operation. Hokkaido Electric will suspend the Naie coal-fired plant operation after the launch of new LNG plants, slated for February 2019, but it has no plans to retire this aging coal plant.

The reasons are rooted in the tight financial condition of the utilities, most of which have no idea when their NPPs—which are under safety reviews by the Nuclear Regulation Authority (NRA)—will be able to restart operations. Currently, most power companies rely on aging thermal power plants to generate profits. Under normal circumstances, power companies would have replaced old plants with more highly efficient units to improve profit margins. Aging thermal power plants require much more maintenance to keep them running safely. The power company that succeeded in restarting NPPs was heavily invested in them beforehand. Meanwhile, the same company slashed capital spending for thermal power plants and reduced spending on power grids to the bare minimum. The situation is more or less the same in other utilities (**Figure 8**).

Prospects for Thermal Power Plants

Most Japanese oil-fired power plants will retire by 2030（**Figure 8**）. During the same period, power companies likely will apply to the NRA for a 20-year license renewal for their aging NPPs. Assuming that most NPPs restart operations by 2030, no new NPPs are built, and existing NPP units are decommissioned at their maximum lifespan of 60 years, we at wonder-news.com estimate that 30–35 units of NPPs will be in operation from the 2020s to 2040s, decreasing to about 20 units in the 2050s and 5 units in the 2060s.

Specifically, in the 2030s, we estimate that 31 units of NPPs will be in operation with a capacity of 30,000 megawatts (MW), and a subset of 11 units with a capacity of about 11,000 MW will reach the lifespan limit of 40 years[13]. The NRA review for the 20-year license renewal takes four to six years and requires the

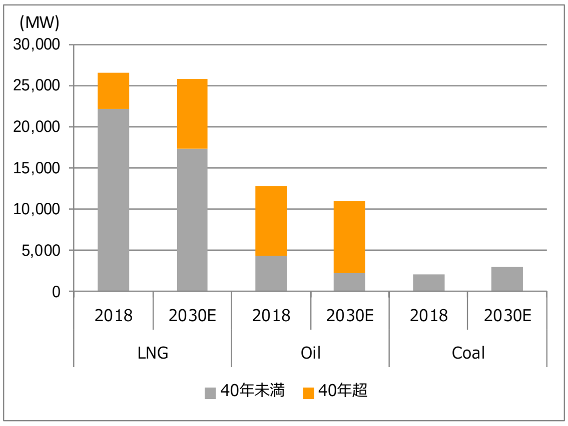
[13] Based on "Nuclear Power Reactors in the World", IAEA, 2017 Edition, p.12-14 (as of 2017/8/31), wonder-news.com updated and calculated data, reflecting the latest information on decommission and extension of NPPs in Japan (as of 2018/11/3).

plant owners to invest at least US$1 billion per unit.

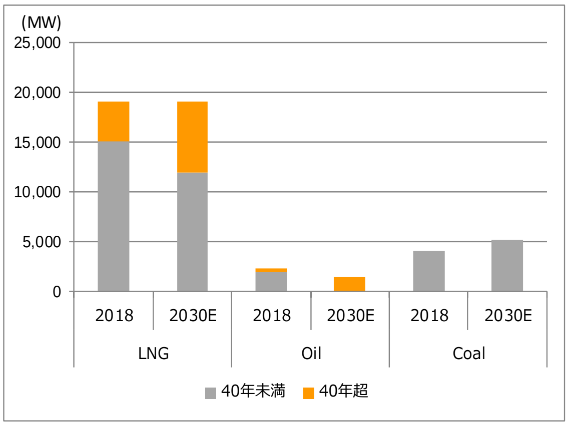
Aging is particularly serious in oil-fired power plants. **Figure 8** shows the change in the generation capacity by fuels of thermal power plants, accounting for new and retired plants. It is clear that by 2030, there will be a significant increase across utilities in oil-fired plants with more than 40 years of operation. IEA's 1979 Ministerial Meeting Communique bans the construction of new oil-fired power plants, and by 2030, the utilities will have to shut down many of the oil-fired power plants that are over 50 years old. As a result, the Japanese utilities are expected to rely increasingly on coal-fired plants.

Figure 8-1 Details of Thermal Power Plants by Fuels

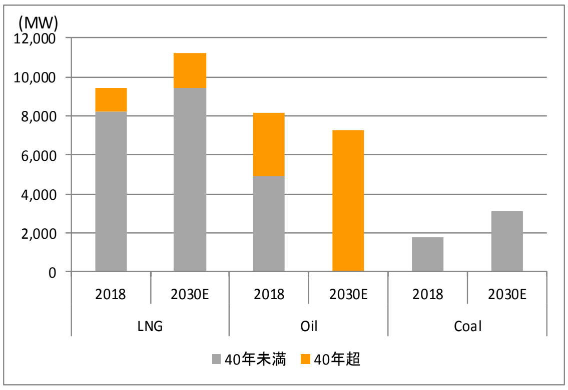
Tokyo Electric Power



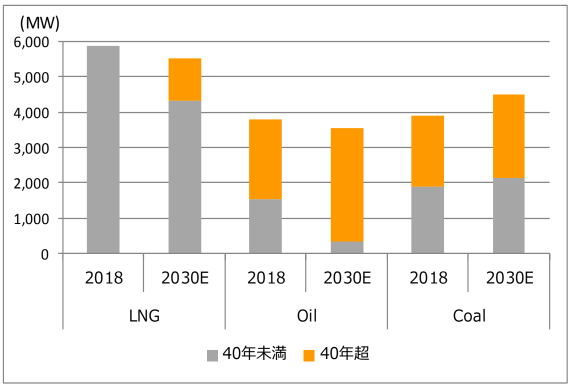
Chubu Electric Power



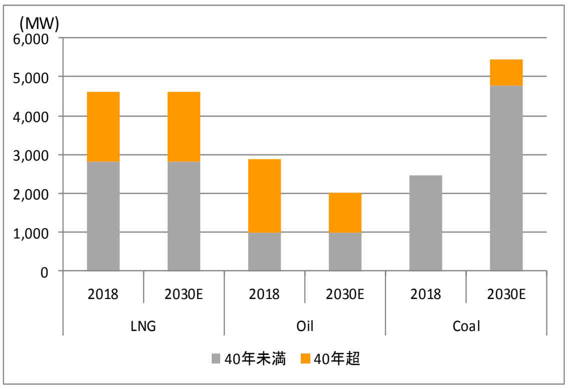
Kansai Electric Power



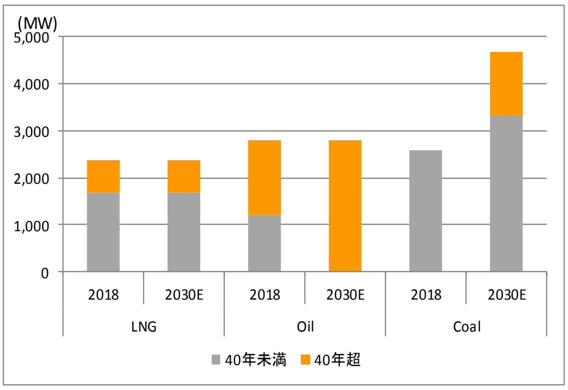
Tohoku Electric Power



Kyushu Electric Power



Chugoku Electric Power



Operating years : less than 40 years more than 40 years

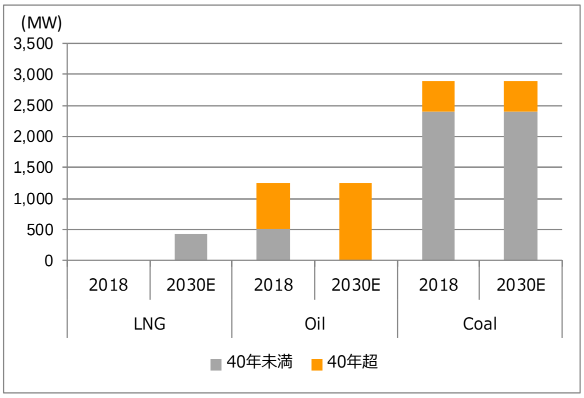
E＝wonder-news.com estimates

Note: More than 40 years means plants operating more than 40 years, but less than 60 years

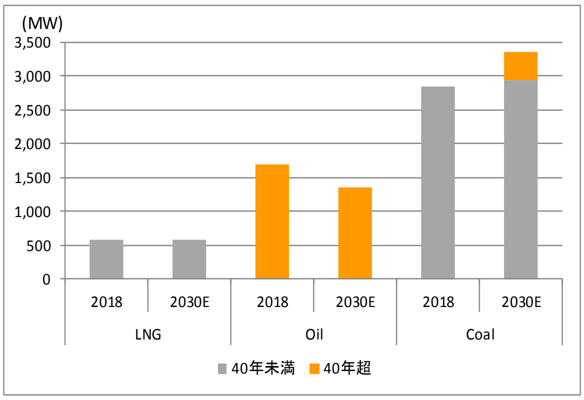
Source: Securities Reports 2017/4/1-2018/3/31

Figure 8-2 Details of Thermal Power Plants by Fuels

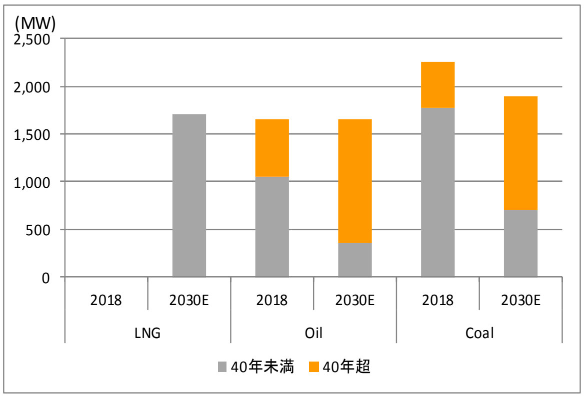
Hokuriku Electric Power



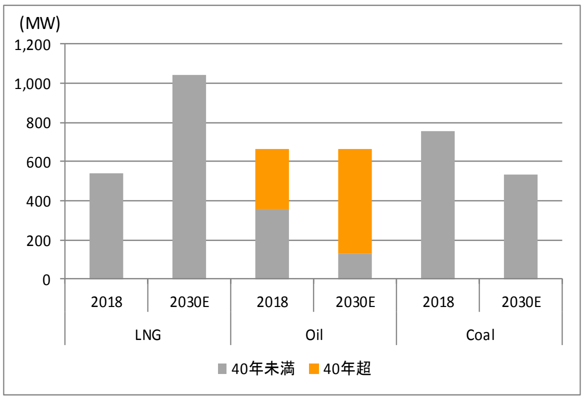
Shikoku Electric Power



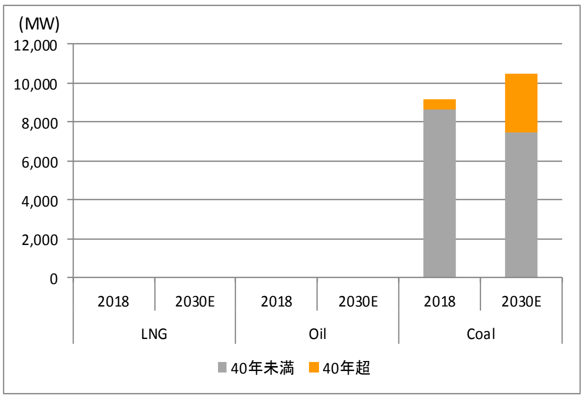
Hokkaido Electric Power



Okinawa Electric Power



J Power



Operating years : less than 40 years more than 40 years

E＝wonder-news.com estimates

Note: More than 40 years means plants operating more than 40 years, but less than 60 years

Source: Securities Reports 2017/4/1-2018/3/31

2. Structural Issues

Renewable Generation to Be a Main Electricity Source

According to the basic energy policy for 2030, released in July 2018, renewable energy will be a main energy source, accounting for a maximum of 24% in combination with hydroelectric power generation (**Figure 3**). Renewable energy sources like solar and wind power are intermittent and variable, which impedes the goal of achieving a balanced power supply at all times while remaining within the safe limits for the load, frequency, and voltage. Frequency instability can damage turbines and boilers of power stations and, in the worst cases, result in a blackout. It is necessary to have peaking power plants, like natural gas power plants, that can offer more generation flexibility and support the integration of the less-predictable renewables.

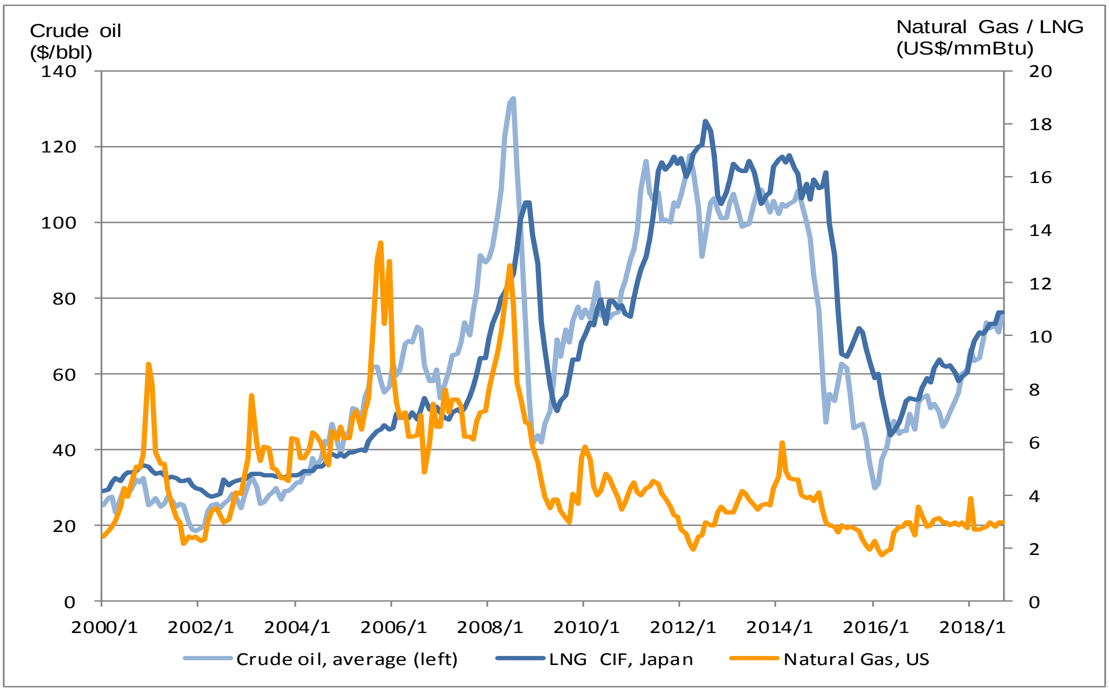
Most new thermal power plants built in the US since the early 1990s are fueled by gas and employ a combined-cycle gas turbines (CCGTs) design. CCGTs can ramp their production up and down much faster than coal-fired units, so they can ensure a stable power output in the face of variable demand for electricity and variable supply from renewable energy sources. Operators take advantage of CCGTs not only to shore up the weaknesses of renewables, but also to align the production of natural gas power plants more flexibly with the demand for electricity and movement of natural gas prices.

We now take a closer look at the issues relating to natural gas or LNG power plants in Japan, which are integral to the introduction and expansion of renewables and new energies.

High LNG Prices

The price of Japan’s imported natural gas is closely linked with crude oil prices (**Figure 9**). Japan relies heavily on crude oil imports from the Middle East. Rising geopolitical tensions in the Middle East will drive up oil prices, may disrupt the supply, and almost certainly will affect the price of Japan's imported natural gas. Japan imports more than 50% of its natural gas from the primary suppliers of Qatar (30%), Australia (16%), and Malaysia (5%). Japan concludes long-term LNG contracts with unfavorable terms—for example, destination clauses—that mandate where cargo can be delivered and limit the buyer from reselling excess gas. Expenses for the liquefaction process and its associated cost, insurance, and freight (CIF) are included in Japan's LNG purchase price. This further elevates the LNG price over the price paid by the US, which uses gas pipelines for gas transit.

Figure 9 **Price Movement of Japan's Imported LNG, Crude Oil, and US Natural Gas**



Source: "World Bank Commodity Price Data"

After the 2011 Fukushima accident, all utilities were forced to stop operating NPPs, relying instead on the full capacity of thermal power plants. At that time, Japan was the largest LNG-importing country and procured a huge volume of LNG at the spot market, which drove up LNG prices for about four years.

Diversify LNG Suppliers and Stabilizing the Price of LNG

If Japan had purchased LNG from the US, Japan would have secured more stable prices and a more diverse procurement portfolio. The US has been expanding shale gas production since 2006 and now offers competitive gas prices as one of the world's major natural gas export countries (**Figure 9**). Japan's biggest gas seller, Tokyo Gas Co., started importing LNG for the long term from the US in May 2018. The US natural gas price does not move in tandem with the crude oil price, so a reliance on the former could stabilize the price of LNG in Japan. LNG imports from the US are also free from resale restriction to third parties. This move could have created room to increase natural gas/LNG power plants in Japan.

Gas Pipelines

The countries relying on coal-fired power plants have one of two common issues: they either have no natural gas pipelines or haven't developed an extensive, nationwide network of gas pipelines. Japan falls in the latter category. Gas pipelines span about 250,000 km in Japan and are concentrated in three major cities: Tokyo, Nagoya, and Osaka. Since gas pipelines were built by each regional gas company, the pipelines are segmented[14]. Moreover, intercity pipelines between Tokyo and Nagoya have yet to be built, as do the links between LNG terminals. In particular, Hokkaido, Tohoku, Hokuriku, Chugoku, Shikoku, and Kyushu Electric Power companies have been forced to rely on NPPs and/or coal-fired power plants because they have few large, long-distance trunk lines in their areas that pipe gas from far-flung LNG terminals to cities (**Figure 8**).

14 「最近のエネルギー情勢を踏まえた北陸港湾の可能性」the Ministry of Land, Infrastructure, Transportation and Tourism, See http://210.148.110.37/library/happyoukai/h25/e (as of 2018/8/15)

Underground Natural Gas Storage

Japan possesses few underground facilities that can store a large quantity of natural gas. Underground storage is advantageous because it can store compressed gas for a much lower maintenance fee than an LNG tank, and it is less affected by earthquakes because the gas is stored deep underground. Japan has five underground storage sites, all of which are depleted natural gas or oil fields and are located in Niigata Prefecture, far from consumption cities.

Natural gas is also stored as LNG in refrigerated tanks above ground. This storage method requires costly maintenance fees to keep the tanks cold[15]. Most of the LNG terminals are located on the Pacific coast, where they are at risk of being compromised by a megathrust earthquake. It would be more strategic to disperse the terminals along the Sea of Japan, where they would be safe from this threat.

The US has the most underground natural gas storage in the world with over 450 active underground storage facilities, most of which are close to consumption centers. The US uses three principal types of underground storage sites: depleted natural gas or oil fields (80%), aquifers (10%), and salt formation (10%).[17] The capacity for underground natural gas storage in the US increased steadily between 2002 and 2014.

Germany has 49 underground natural gas storage facilities—the most of any country in Europe, followed by 13 storage sites in France and 12 in Italy[18]. In Germany, the most prominent types of natural storage are salt formation (60%), depleted natural gas or oil fields (24%), and aquifers (12%). In France, aquifers account for about 80% of reservoirs, and the remaining 20% is salt formations. Each storage type has its own physical characteristics (permeability and retention capability) and economics (site preparation and maintenance costs).

15島本辰夫「関原天然ガス地下貯蔵の現状とモニタリン計画」『石油技術協会誌』(第 77 巻、第 6 号)、November 2012, p. 422~427。See https://www.jstage.jst.go.jp/article/japt/77/6/77_422/_pdf/-char/ja (as of 2018/9/6)

17 Energy Infrastructure, See http://www.energyinfrastructure.org/energy-101/natural-gas-storage (as of 2018/9/6)

18 "Underground Gas Storage in the World – 2017 Status", CEDIAZ, July 2017, p.7, See http://www.cedigaz.org/documents/2017/ (as of 2018/9/6)

For countries with a large volume of natural gas reserves, underground natural gas storage enables utilities to provide a secure supply of natural gas to consumers at a stable price throughout a year. Reservoirs lead to a reduction in CO2 emission as well. In the US specifically, storage helps interstate pipeline companies balance system supply on their long-haul transmission lines.

3. New Energy Systems

Power to Gas

Networks of gas pipelines are most likely to be the key infrastructure of new energy systems. Growth in renewables like solar and wind power will be limited, forcing a reliance on power grids alone.

Power to Gas plans to use the gas grid as a composite system in which natural gas, biogas, hydrogen, and synthetic methane produced from renewable electricity will be combined to form one huge energy source[19]. Much more promising is the option of converting renewable electricity into gas and storing it in the gas pipelines. For long-distance energy transport, the gas infrastructure is more adequate than power transmission. The gas grid could be used as a backup power system, providing a stable gas supply to natural gas power plant operators and consumers in the wake of a natural disaster. Furthermore, gas grids make it possible to build an extensive supply chain network for "green" gas for transit, sales, and utilization.

Energy companies in Germany have already launched Power to Gas projects, and Germany has about 530,000 km of gas pipelines. The German government will weigh its investment in improving infrastructure for the delivery of gas in the next few years.

Gas grids also make it possible to eliminate CO2 emissions almost entirely from the transportation and industrial sectors. Hydrogen converted from excess electricity can be used for fuel cell vehicles while methane can be used for raw industrial materials. Gas grids may represent critical infrastructure to generate diverse business opportunities.

19 "Germany's Conventional Energy Sources", Federal Ministry for Economic Affairs and Energy See https://www.bmwi.de/Redaktion/EN/Dossier/conventional-energy-sources.html (as of 2018/9/6)

Coal to Hydrogen

While the EU looks beyond carbon, Japan clings to coal. Japan's current energy policies include converting coal to hydrogen gas. The Lignite Hydrogen Project, a joint project between the industries and governments of Japan and Australia, has been in action since FY 2015. In this project, Japan plans to produce gas, including hydrogen, from lignite in Victoria, Australia, and to import a large volume of liquefied hydrogen from Australia to Japan until FY 2020. Victoria has abundant lignite reserves; according to "Hydrogen Primary Strategy,"[20] the domestic hydrogen procurement volume is currently only 200 tons annually but is projected to increase to 4,000 tons in 2020 and 300,000 tons in 2030. In terms of both cost and the environment, hydrogen pipelines are the most promising option to transport large volumes of hydrogen within Japan. Thus, it is necessary for Japan to build extensive gas grids.

Hydrogen can be produced from diverse sources such as renewable energy and fossil fuels, specifically natural gas and coal. Today, 95% of the hydrogen produced in the US is made from natural gas.[21] Electricity from renewable sources such as wind, solar, geothermal, and biomass is also used to produce hydrogen, which is environmentally friendly and could reduce CO2 emissions. Currently, the vast majority of industrial hydrogen is produced from coal gasification or steam methane reforming (SMR). Lignite has a high water content and is highly pyrophoric when dry. Thus, it is difficult to transport, so lignite is mainly used in local power generators only. The advantage of lignite lies in its cost; at less than one-tenth the price of coal, lignite is a cheap raw material for the production of hydrogen.

Reduce CO2 Emissions and Develop Carbon Capture and Storage

Hydrogen generated from coal gasification needs a lot of energy and generates

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20 "Hydrogen Primary Strategy," Renewables and Hydrogen cabinet meeting, in Dec., 2017, See http://www.meti.go.jp/press/2017/12/20171226002/20171226002-1.pdf#search=%27 水素基本戦略%27 (as of 2018/9/6)

21 "Hydrogen resources", the Department of Energy, See https://www.energy.gov/eere/fuelcells/hydrogen-resources (as of 2018/9/6)

significant CO_2 emissions.[22] There are several challenges associated with using coal gasification to produce hydrogen at target costs with near-zero greenhouse gas emissions. Additional R&D is needed to 1) develop gasification technologies to produce CO_2-free hydrogen, 2) detach and collect the CO_2 released in the production process, and 3) develop Carbon Capture and Storage (CCS) technologies to retain the large quantities of waste CO_2 underground. CCS requires a large investment. Even if hydrogen can be generated from cheap lignite, the magnitude of the CCS-related cost remains unclear.

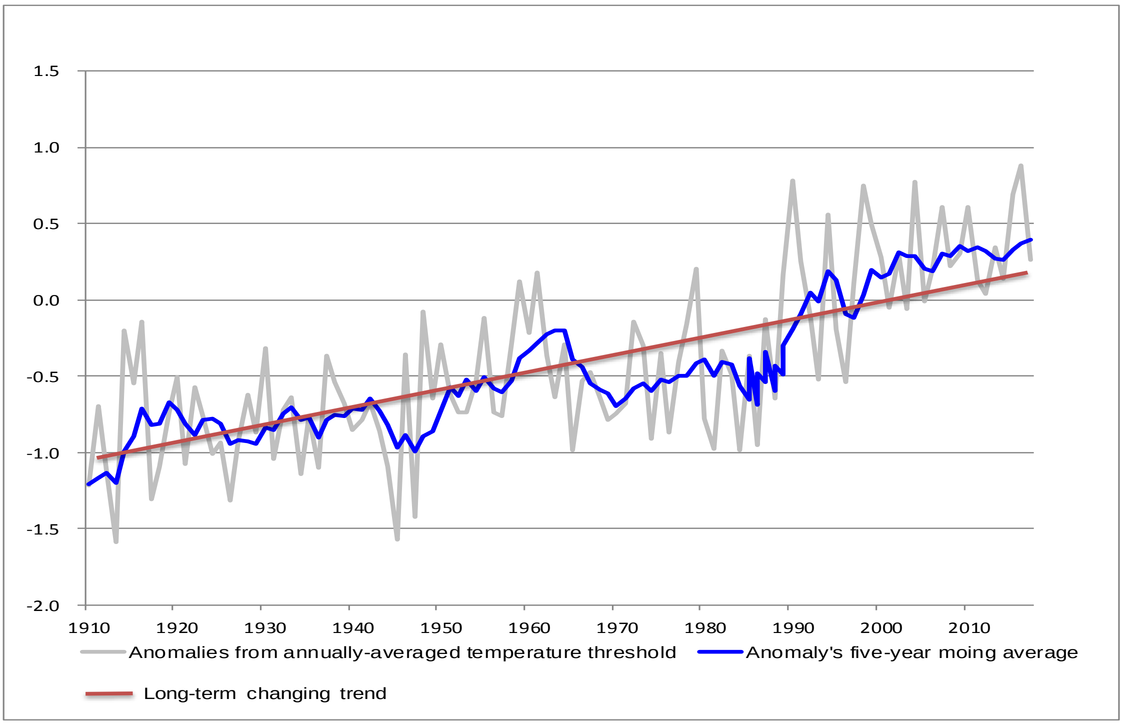
Around the world, there are limited areas and geological layers suitable for CCS. Large-scale, suitable sites for CCS are concentrated in North America, North Europe, East Asia, and Australia, where soil is stable. In view of quantity of CO_2 emissions, volume to store compressed CO_2 in the void of, for example, reservoir rock is limited. Moreover, a cost-benefit analysis merits consideration.

[22]"Producing industrial hydrogen form renewable energy", Cedric Philbert , IEA, April 18, 2017 (as of 2018/9/6)

4. Future Outlook

"Life-threatening heat" is an unfamiliar phrase for most Japanese, but weather forecasters announced it almost every day in the summer of 2018. In fact, Japan faced record heat this past summer. As shown in Figure 10, intense heat is not transient—rather, it foreshadows further temperature increases in the future. Severe natural disasters including intense heat, forest fires, rainstorms, torrential rain, floods, and damages to crops have battered many countries this year, raising grave concerns about the impact of global warming. Climate change represents an imminent, serious threat in people's minds.

Figure 10 **Japan's Average Temperature Anomalies**



Note: The average temperature in Japan is expected to increase by about 1.19℃ per century in the long term. Intense heat has become more frequent, especially since the 1990s.

Source: Japan Meteorological Agency[23]

While Japanese electric utilities struggle to restart their NPPs, the US and

[23] 「日本の平均気温の偏差の経年変化」気象庁, See https://www.data.jma.go.jp/cpdinfo/temp/an_jpn.html (as of 2018/9/6)

Europe are witnessing a “paradigm shift” in the energy sector as renewable energy has become a main source of energy. The Fukushima accident is often cited as motivation to shift energy strategies. Renewable energy to replace NPPs is now more highly valued as a sustainable energy, and nations and companies are embarking on a new era to improve the efficiency of cleaner energy from renewables.

What makes Japan’s global warming measures different from those of Europe and the US? One decisive difference is the perception of the timeframe. Most US and European governments and companies have provided 10- to 30-year policies and/or strategies to address climate change and transition to lower-carbon energy systems. Looking forward to 2050, government policies and corporate strategies reflect certain visions for the energy system and social infrastructure required to form a more secure, economic, and sustainable society. Renewable energy has been selected as a result of thorough examination.

By contrast, the Japanese tend to produce a three to five-year plan when asked to create medium-and long-term strategies. Most Japanese tend to pursue goals with relatively short timeframes, so the plans to build higher-efficiency coal-fired power plants might simply reflect this typical Japanese way of thought.

Nonetheless, it is necessary to integrate resilience for “adoption” to climate change into the energy supply system. As early as the mid-2020s, aging nuclear and thermal power plants could become serious issues in Japan. The utilities must build new power facilities with an optimal electricity power generation mix for a stable energy supply. Assuming a population decline over the long term, Japan should design 30-year plans (at a minimum) for well-planned energy supply systems that will protect and reduce the damages from natural disasters.

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