The Institute of Energy Economics, Japan

Economic and Energy Outlook of Japan for FY2020

Domestic situation affected by growing uncertainty of international developments

ETO Ryo, H. Okabayashi, N. Aizawa, C. Onda, T. Ohira, T. Murakami, Y. Shibata, S. Suehiro, A. Yanagisawa and K. Ito

Summary of economic and energy outlook [Reference Scenario]

Macro economy | Growth will decelerate up to FY2020

The Japanese economic growth will slow down until 2020 due to a stall in private investments. The negative impacts of the planned hike in VAT will be smaller than the previous one in FY2014. Industrial production will fall for the first time in four years, reflecting in part the slowdown of the Chinese economy. The trade deficit will shrink significantly, thanks to a fall in energy prices.

Energy supply and demand | Primary energy supply will increase slightly in FY2019 but will decrease slightly in FY2020. CO_2 will increase for the first time since FY2013

Despite a fall in industrial production concentrated on machinery, primary energy supply will increase slightly in FY2019 because of an increase in energy demand for space heating due to a return from a mild winter in the previous year (+0.3%). Reflecting a decline in material production and further progress in energy saving, primary energy supply will decrease slightly in FY2020(-0.3%). The trend away from fossil fuels towards nuclear and renewable energy will continue but at a much slower pace, reflecting the slow restart of nuclear power plants and the absence of counterterrorism facilities after FY2019.

In FY2019, CO_2 emissions will increase slightly for the first time after FY2013 due to a small growth in total energy consumption and a decrease in nuclear power generation. In FY2020, however, CO_2 emissions will be lower at 1,065 Mt which, according to the statistics, is the lowest level after FY1990. This corresponds to a reduction of -13.8% from FY2013.

Energy sales | Electricity sales will increase gradually and city gas sales will hit a record high due to increased sales to electric utilities, whilst fuel oil sales will decline for an eighth consecutive year and comprise just two-thirds of the record high

Overall electricity sales in FY2019 will increase by 0.6%. Lighting services will increase sharply due to colder temperatures, and power services will increase slightly reflecting a growth in the iron and steel production. In FY2020, electricity sales will increase by 0.4%. Power services will increase in line with the gradual expansion of production activities concentrating on machinery industry while lighting services should decrease slightly, due to the further penetration of energy-efficient equipment.

Total city gas sales in FY2019 will grow by 1.1% with increases for electric utilities, due to the operation of new city gas-fired power plants, and increase for space and water heating requirements in household due to a return from the previous year's milder winter. The sales of city gas for general industrial use will decrease reflecting the overall production decline. In FY2020, due to the increase in sales for electric utilities, the overall sales will hit a record high (+2.4%).

Table 1 | Summary of Reference Scenario

		Historical			Projection		Year-over-year		
		FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Energy	Primary energy supply (Mtoe)[1]	515.9	462.6	464.7	455.7	457.2	455.9	-1.9%	0.3%	-0.3%
	Oil[2] (GL)	232.3	205.1	202.8	192.8	190.9	187.0	-4.9%	-1.0%	-2.0%
	Natural gas[2] (Mt of LNG equiv.)	73.3	88.1	85.6	81.7	82.6	80.6	-4.5%	1.1%	-2.4%
	Coal[2] (Mt)	184.7	188.0	192.2	188.4	189.1	193.0	-2.0%	0.4%	2.0%
	Nuclear (TWh)	288.2	17.3	31.3	62.1	59.0	62.4	98.6%	-4.9%	5.7%
	Renewable electricity[3] (TWh)	111.2	154.9	169.4	176.8	187.2	195.6	4.4%	5.8%	4.5%
	FIT generation (TWh)	63.2	112.8	123.2	133.8	143.3	151.7	8.6%	7.1%	5.9%
	Self-sufficiency ratio	20.3%	8.2%	9.6%	11.9%	12.1%	12.7%	2.3p	0.2p	0.6p
	Electricity sales[4] (TWh)	(926.6)	850.5	863.2	852.6	857.3	860.3	-1.2%	0.6%	0.4%
	City gas sales[5] (Billion m³)	39.28	41.53	42.48	41.58	42.03	43.06	-2.1%	1.1%	2.4%
	Fuel oil sales (GL)	196.0	176.9	174.8	167.9	166.1	162.7	-4.0%	-1.1%	-2.1%
	Energy-related CO_2 emissions (Mt)	1,137	1,129	1,111	1,069	1,070	1,065	-3.8%	0.1%	-0.5%
	(Changes from FY2013)	-7.9%	-8.6%	-10.1%	-13.5%	-13.4%	-13.8%	-3.4p	0.1p	-0.4p
Prices	Crude oil, import, CIF ($/bbl)	84	48	57	72	65	61	26.7%	-10.1%	-6.8%
	LNG, import, CIF ($/MBtu)	11.3	7.0	8.5	10.6	10.0	9.2	24.9%	-5.9%	-7.9%
	Steam coal, import, CIF ($/t)	114	81	103	121	96	90	17.5%	-20.6%	-6.5%
	Coking coal, import, CIF ($/t)	175	111	147	160	149	135	8.9%	-7.2%	-9.4%
Economy	Real GDP (JPY2011 trillion)	493.0	522.0	531.8	535.5	539.1	542.0	0.7%	0.7%	0.5%
	Industrial production (CY2015=100)	101.2	100.6	103.5	103.8	103.5	103.9	0.2%	-0.2%	0.3%
	Balance of trade (JPY trillion)	5.3	4.0	2.4	-1.6	-0.2	-0.2	-166%	-86.8%	-26.9%
	Fossil fuel imports (JPY trillion)	18.1	13.1	16.3	19.1	16.9	15.5	17.5%	-11.2%	-8.6%
	Exchange rate (JPY/$)	86.1	108.4	111.1	110.6	110.3	110.0	-0.4%	-0.3%	-0.2%
	Cooling degree days	559	431	397	489	393	381	23.2%	-19.8%	-3.0%
	Heating degree days	1,079	965	1,071	866	1,025	1,018	-19.2%	18.4%	-0.7%

Notes:

1. Mtoe = 10^{13} kcal

2. Conversion factors for oil: 9,126 kcal/L; Natural gas: 13,043 kcal/kg; Steam coal: 6,139 kcal/kg; Coking coal: 6,928 kcal/kg until FY2012.
   Conversion factors for oil: 9,145 kcal/L; Natural gas: 13,016 kcal/kg; Steam coal: 6,203 kcal/kg; Coking coal: 6,877 kcal/kg since FY2013.

3. Including large hydro 30 MW or more. 4. Figures in parentheses are old statistical figures. 5. Conversion factor: 1 m³ = 10,000 kcal

Fuel oil sales in FY2019 will continue to decrease for many reasons, including a decline in the need for naphtha due to lower ethylene production, a decline in the use of oil-fired power plants, and a drop in gasoline sales due to the improvement in automobile fuel efficiency. On the other hand, kerosene sales for heating will increase due to a return from the mild winter in the previous year (-1.1%). In FY2020, while the sales of diesel oil will continue to increase slightly, the sales of naphtha will decrease due to more periodic maintenance at ethylene plants and a fall in the operation of oil-fired power plants. Overall, fuel oil sales will decline for an eighth consecutive year and will comprise just two-thirds of the peak.

Renewable power generation | The FIT power generation capacity will reach 78 GW at the end of FY2020

As a deadline was set for approved capacity to become operational under the revised FIT Act, some of the approved capacity, including non-residential solar PV facilities such as mega-solar plants, was cancelled, reducing the approved capacity from 105 GW in March 2017 to 90 GW in December 2018. The plants under construction are expected to become operational by the end of FY2020, with a FIT capacity of 78 GW (including solar PV for residential cut off from the financial support measures and 47 GW for non-residential solar PV). Accounting for 14% of Japan's total electricity generation in FY2020, renewable electricity generation will reach 151.7 TWh (70.3 TWh for solar PV, 39.2 TWh for small and medium-sized hydro, and 30.2 TWh for biomass-fired etc). On the other hand, in exchange for promoting the introduction of the system, the burden on consumers is increasing. If all of the 90 GW of approved equipment as of December

2018 were in operation, the cumulative cost to consumers, including operating and transition equipment, would be JPY60 trillion in the purchase period, equivalent to boosting electricity rates by JPY3,500/MWh – 15% for households and 21% for industries.

Topic |

1/ The effect of the completion of counterterrorism facilities and the restart of nuclear power plants

We assessed the impact of nuclear power generation on 3Es – economy, energy security and environment. In the High Case, which assumes the completion of counterterrorism facilities by the prescribed deadline, the cost of fossil fuel imports would be reduced by JPY100 billion, the self-sufficiency rate would be improved by 1.2 points, and CO_2 emissions would be reduced by 8 Mt. Smoothing the restart of the nuclear power generation contributes to achieving 3Es. Specifying the review standard and considering the inherent circumstances of each plant are important.

Figure 1 | Effect of the nuclear power generation [FY2020, compared with the Reference Scenario]
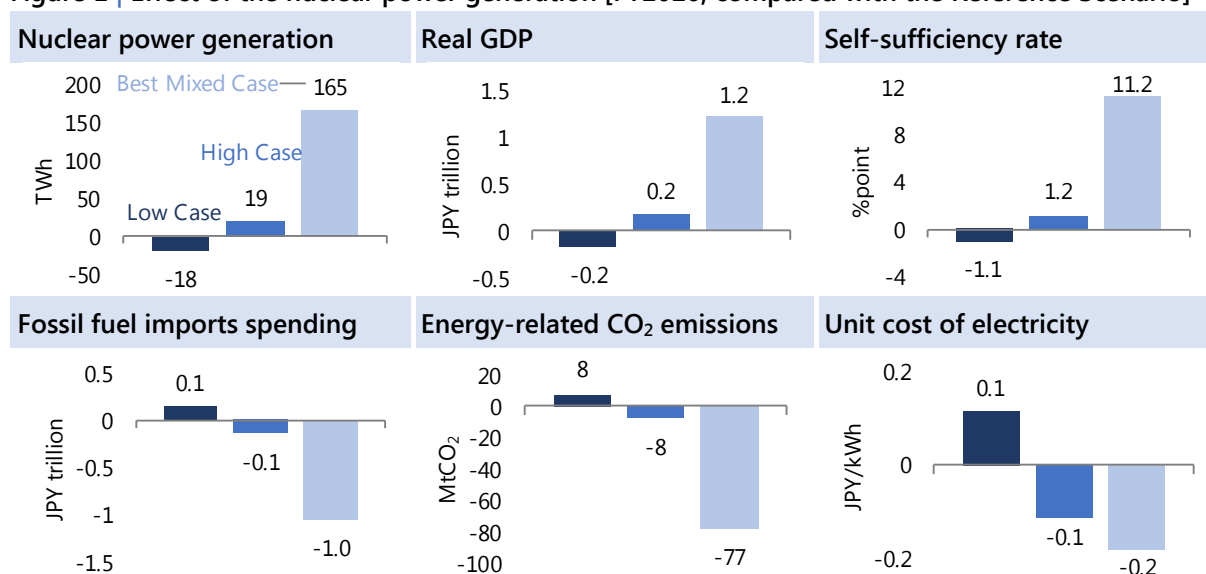
2/ The impacts of an oil price rise caused by increased geopolitical risks in the Middle East

If oil prices increase by $15/bbl from the Reference Scenario, due to the volatile Middle East with a focus on the relation between U.S. and Iran and if LNG prices increase accordingly, the growth of the Japanese economy would be held back by 0.2%. Among sales of energy, fuel oils fall the most and total primary energy supply drops by 0.4%, a larger fall than GDP. While energy saving has been progressing in Japan, the jump in fossil fuel dependency since the Great East Japan Earthquake still remains high, thus, Japan is among the countries vulnerable to any rise in oil prices. Lowering the costs of renewable energy, smoothing the restart of the nuclear power generation as well as introducing actions to reduce the tension in the Middle East are all important for lessening the risks.

3/ The impacts of a trade war on world's energy supply and demand

In the event that world GDP would decrease by 0.8%, due to a trade war, world primary energy consumption would be reduced by 0.7%. Coal would drop the most mainly due to a decrease in electricity demand in China. Oil and natural gas would decrease 670kb/d and 27Bcm respectively (0.7% for both). This could

potentially change the current flow of energy trade and the energy market will continue to be influenced by the trade war.

Note: Referring the analysis by IMF which simulated the economic impacts of the tariffs that have been imposed between the United States and several of its trading partners as well as some trade measures that have been announced or considered, but not imposed to. From the analysis, we cited the results where world economy slows down the most including the potential impacts on confidence and market reaction as well as direct impacts of tariffs

Introduction

While the Japanese economy scored an annualized growth rate of 2.1%, it was only thanks to a decline in imports that makes negative contributions to GDP. In March and April, the government's assessment of the coincident composite index described economic conditions as "worsening" for the first time in six years. Foreign demand slowdown amid trade disputes and China's economic deceleration is contributing to the deceleration of domestic demand including investment in plants and equipment.

The average crude oil import price remained above $70/bbl since May, hitting a low of $62/bbl in February as a coordinated production cut by the OPEC-plus group, the United States' oil embargo on Iran and other price-boosting factors have been countered by the U.S.-China trade war and other price-lowering factors.

Out of 27 Japanese nuclear power plants for which applications have been filed for examinations on their conformity with regulatory standards, 15 have cleared the examinations, including nine in operation at present. On June 12, the Nuclear Regulatory Authority clarified that it would order nuclear plants to halt operation if counterterrorism facilities fail to be completed by their respective deadlines.

As for solar photovoltaics power generation, 10-year contracts will begin to expire in November for households in Japan to sell surplus electricity generated by their solar PV panels at a fixed price under the Feed-in Tariff system. Although the price is expected to fall from JPY48/kWh in 2009 to JPY7-9/kWh, households' introduction of storage batteries for using electricity from their solar panels on their own is viewed as economically inefficient.

Key assumptions behind Reference Scenario

Global economy

We assume that the global economy will grow 3.3% in 2019 and 3.6% in 2020. After deceleration on the U.S.-China trade war and China's economic slowdown in the first half of 2019, the global economy will accelerate growth through 2020 on financial market sentiment improvement and China's economic stimulus package. The U.S. economy will decelerate growth but will reaccelerate it under accommodative monetary policy. Europe will see an economic pickup as accommodative monetary policy is coupled with exports that will increase on global economic acceleration after dragging down economic growth. If the United Kingdom's exit from the European Union comes without agreement in October 2019, however, it may cause social turmoil as a downside risk factor. In China where slowing exports exert downward pressure on economic growth, economic stimulus measures including cuts in value added tax and social insurance contributions begin to produce effects, allowing an economic growth target to be accomplished.

Crude oil/LNG/coal import CIF prices

Crude oil import CIF prices are assumed stabilizing gradually to average $65/bbl in FY2019 and $61/bbl in FY2020 based on the international crude oil price outlook below. In response to the crude oil price trend, LNG import CIF prices are assumed to average $10.0/MBtu in FY2019 and $9.2/MBtu in FY2020. Steam coal prices will level off after weakening substantially in the second half of FY2019. Coking coal prices will stabilize as steel demand growth slows down on China's economic growth deceleration. Steam coal import CIF prices are assumed to average $96/t in FY2019 and $90/t in FY2020. Coking coal import CIF prices are assumed to average $149/t in FY2019 and $135/t in FY2020. (Sources: Hashizume "Outlook for International Oil Market," Hashimoto

"Outlook for International Gas Market," Sagawa "Outlook for International Coal Market")

Exchange rate

We assume the average exchange rate to be around JPY110/USD in FY2019 and FY2020.

Tax

We assume that Japan will raise the standard valued added tax rate to 10% with a reduced rate introduced for selected goods, terminate the automobile acquisition tax and reflect environmental performance in the automobile and mini-vehicle taxes from October 2019.

Air temperature

According to the Japan Meteorological Agency's three-month weather forecast, we assume that summer in FY2019 will be slightly cooler than normal before air temperatures stand at normal levels. This means that summer in FY2019 will be considerably cooler (-0.9°C) than in the previous year and that winter will be colder (−0.9°C) than the warmer-than-normal winter in the previous year. In FY2020, summer will be as hot as in the previous year and winter will be as cold as in the previous year.

Nuclear power generation

In FY2019, the capacity factor for nuclear power plants in Japan will fall due to more frequent regular checks. In FY2020, five plants that have cleared regulatory standards conformity examinations are assumed to restart gradually. However, five operating plants will be halted gradually from March 2020 due to delays in the completion of counterterrorism facilities. The accumulated number of restarted nuclear plants in Japan will remain at nine at the end of FY2019, including one halted due to a delay in the completion of counterterrorism facilities. In the year,

the nine plants will operate for an average eight months and generate 59 TWh (accounting for 6.1% of total power generation). At the end of FY2020, the number of restarted nuclear power plants will increase by five to 14, including five halted due to delays in the completion of severe accidents measure equipment. In the year, these plants will operate for an average six months, generating 62.4 TWh (6.5%).

Macro economy

The planned VAT hike will have less impact than the previous hike in FY2014 due to various planned measures. Economic growth will decelerate through FY2020 as robust private non-residential investment slows down.

In FY2019, the planned VAT increase will have less impact on private consumption due to various measures. The introduction of free infant education and the revision of mobile phone charges will support economic growth. Private non-residential investment will decelerate as Olympics-related demand peaks out, with companies growing negative about investment against the backdrop of the U.S.-China trade war. Private demand's contribution to the GDP growth will halve to 0.4 percentage points. Public demand will contribute 0.2 points to the GDP growth as investment and consumption increase on post-disaster reconstruction, national resilience enhancement and healthcare expansion. Exports will expand at a slower pace reflecting an overseas economic deceleration trend. Imports will post a smaller increase than exports. Overseas demand will thus contribute 0.1 points to the GDP growth.

Fossil fuel imports will decrease by JPY2 trillion due to crude oil price drops, contributing to improving the trade balance.

In FY2020, private consumption will be robust thanks to employment and income improvements, with the impact of the VAT hike limited. Consumption may increase temporarily thanks to the Tokyo Olympics. Non-residential investment will decelerate growth despite strong construction demand amid metropolitan region redevelopment and automation and labour-saving investment as Olympics-related demand weakens. Private demand will contribute 0.3 points to the GDP growth and public demand 0.2 points. Electric machinery and other exports will increase on weakening concerns about the U.S.-China trade war and China's economic stimulus measures. Import growth will be slightly slower than export growth. Foreign demand will thus contribute less than 0.1 points to the GDP growth.

Fossil fuel imports will decline on crude oil price drops, slipping below 20% of total imports and 3% of nominal GDP.

Table 2 | Macroeconomic indicators

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Real GDP (JPY2011 trillion)	493.0	522.0	531.8	535.5	539.1	542.0	0.7%	0.7%	0.5%
Private demand	369.3	393.0	400.2	404.5	406.6	408.1	(0.8%)	(0.4%)	(0.3%)
Private consumption	286.6	295.8	298.9	300.2	301.6	303.1	0.4%	0.5%	0.5%
Private residential investment	13.9	16.2	16.0	15.3	15.7	15.4	-4.3%	2.2%	-1.6%
Private non-residential investment	67.6	80.8	84.4	87.4	88.6	89.2	3.5%	1.3%	0.7%
Public demand	122.6	131.7	132.5	132.3	133.7	134.9	(-0.0%)	(0.2%)	(0.2%)
Government consumption	98.1	106.0	106.4	107.4	108.2	109.1	0.9%	0.8%	0.8%
Public investment	24.7	25.8	26.0	24.9	25.4	25.7	-3.9%	1.9%	1.2%
Net exports of goods and services	1.3	-3.2	-1.3	-1.9	-1.7	-1.6	(-0.1%)	(0.1%)	(0.0%)
Exports of goods and services	74.7	85.9	91.4	92.6	93.1	94.0	1.3%	0.5%	1.0%
Imports of goods and services	73.4	89.1	92.7	94.6	94.8	95.6	2.0%	0.2%	0.9%
Nominal GDP (JPY trillion)	499.4	536.8	547.5	550.3	559.1	565.8	0.5%	1.6%	1.2%
Balance of trade (JPY trillion)	5.3	4.0	2.4	-1.6	-0.2	-0.2	-166%	-86.8%	-26.9%
Exports	67.8	71.5	79.2	80.7	82.3	83.1	1.9%	2.0%	0.9%
Imports	62.5	67.5	76.8	82.3	82.5	83.3	7.2%	0.3%	0.9%
Fossil fuels	18.1	13.1	16.3	19.1	16.9	15.5	17.5%	-11.2%	-8.6%
Oil	12.3	7.8	9.6	11.3	9.9	9.0	18.3%	-12.9%	-8.4%
LNG	3.5	3.3	4.1	4.9	4.6	4.1	19.4%	-5.5%	-10.3%
Current account (JPY trillion)	18.3	21.7	22.2	19.4	20.4	21.5	-12.4%	5.0%	5.2%
Domestic corporate goods price index (2015=100)	97.6	96.7	99.3	101.5	102.4	102.9	2.2%	0.9%	0.4%
Consumer price index (2015=100)	96.4	100.0	100.7	101.4	102.4	102.9	0.7%	1.0%	0.5%
GDP deflator (2011=100)	101.3	102.8	102.9	102.8	103.7	104.4	-0.2%	0.9%	0.7%
Unemployment rate (%)	5.0	3.0	2.7	2.4	2.5	2.4	[-0.3%]	[0.1%]	[-0.1%]

Notes: GDP components may not add up to the total GDP due to stock changes and minor data deviations.

( ) stands for contributions. [ ] stands for changes from the previous year.

Production activities

Japan's industrial production in FY2019 will decline for the first time in four years due mainly to China's economic slowdown. In FY2020, it will expand slightly in line with global economic recovery.

The industrial production index in FY2019 will decline by 0.2% from the previous year due mainly to China's economic slowdown for the first drop in four years. In FY2020, the index will increase by 0.3% on weakening concerns about the U.S.-China trade war and global economic recovery.

Crude steel production in FY2019 will increase on robust construction investment and the resolution of production facility troubles. In FY2020, crude steel will be the only industrial material to post a production increase.

In FY2019, domestic demand for crude steel will increase by 0.7% as construction investment mainly for redevelopment in the Tokyo metropolitan region expands. Export demand will rise by 2.9% as production capacity rises on the resolution of blast furnace troubles. As a result, crude steel production will expand by 1.7%. In FY2020, although a similar trend will continue, as domestic and overseas demand growth decelerate, crude steel production growth will slow down to 0.2%.

Japanese ethylene production will slacken due to U.S. shale gas-based ethylene production. In FY2020, increased regular plant repairs will affect production.

In FY2019, regular ethylene plant repairs will be limited. As cheap U.S. ethylene derivatives made from shale gas flow into the Asian market, however, inventory adjustment will continue. Japanese ethylene production in the year will decrease by 0.7% as both domestic demand and exports slacken. In FY2020, a similar trend will be combined with increased ethylene plant repairs to reduce Japanese ethylene production by 2.8% to less than 6 Mt for the first time in 27 years, since FY1993.

Cement production in FY2019 will increase on robust demand related to the Tokyo Olympics and urban redevelopment. In FY2020, it will slightly decrease on slack domestic demand.

Cement production in FY2019 will increase by 1.7% on robust demand related to the Tokyo Olympics and urban redevelopment. In FY2020, domestic demand will decline by 0.6% due to slowing demand related to the Tokyo Olympics, despite robust exports to Asia and Oceania. Nevertheless, cement production will remain above 60 Mt for four years on end.

Paper and paperboard production will fall slightly in the coming two years as paper demand plunges on structural factors such as a switch to electronic media and a population fall.

While paperboard demand increases on growing sales via the internet in Japan and China, paper demand will decrease on a switch to electronic media and a population fall. Paper and paperboard production will decrease by 0.3% in FY2019 and by 0.5% in FY2020.

Automobile shipments will be little affected by the VAT hike in FY2019. Production will rise on domestic and overseas demand recovery in FY2020.

The VAT tax hike's impact on automobile shipments in Japan in FY2019 will be offset by an automobile tax cut and other measures. Supported by robust exports to emerging countries, automobile production in the year will increase by 0.6%. In FY2020, production will grow by 0.9% to a seven-year high of 9.9 million units as domestic shipments and exports rise on global economic recovery.

Table 3 | Production activities

		Historical				Projection		Year-over-year		
		FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Production	Crude steel (Mt)	110.8	105.2	104.8	102.9	104.6	104.8	-1.9%	1.7%	0.2%
	Ethylene (Mt)	7.00	6.29	6.46	6.19	6.14	5.97	-4.2%	-0.7%	-2.8%
	Cement (Mt)	56.1	59.3	60.4	60.2	61.2	60.9	-0.2%	1.7%	-0.6%
	Paper and paperboard (Mt)	27.3	26.3	26.4	26.0	25.9	25.8	-1.4%	-0.3%	-0.5%
	Automobiles (Million units)	8.99	9.36	9.68	9.75	9.81	9.90	0.7%	0.6%	0.9%
Production indices	Mining and manufacturing (2015=100)	101.2	100.6	103.5	103.8	103.5	103.9	0.2%	-0.2%	0.3%
	Food and tabacco	100.7	100.8	100.2	99.7	97.7	96.9	-0.5%	-2.0%	-0.8%
	Chemicals	99.6	102.6	105.6	107.8	109.8	111.6	2.1%	1.8%	1.7%
	Non-ferrous metals	100.0	101.5	103.5	104.2	104.2	104.3	0.7%	0.0%	0.1%
	Machinery	99.4	100.3	105.0	105.6	104.5	105.1	0.5%	-1.1%	0.7%
Tertiary industry activity index (2010=100)		99.9	103.9	105.0	106.2	107.1	107.6	1.1%	0.8%	0.5%

Notes: Chemicals include chemical fibers.

Machinery includes general machinery, electrical machinery, information and telecommunications equipment, electronic parts and devices, precision machinery and metal products.

Primary energy supply

In FY2019, nuclear power generation will decrease from the previous year for the first time since FY2014 when no nuclear power plant was in operation. CO_2 emissions will rise for the first time since FY2013. In FY2020, LNG imports will slip below 80 million t for the first time since the Great East Japan Earthquake.

Primary energy supply in Japan in FY2019 will post a small increase of 0.3% from the previous year due to growing heating demand after the warmer-than-normal winter in the previous year, although a machinery industry production fall will exert downward pressure on energy supply. In FY2020, however, primary energy supply will decrease by 0.3% on an industrial material production cut and energy efficiency improvements.

Of domestic primary energy supply, new energy including solar photovoltaics, wind and biomass will substantially expand on the strength of the Feed-in Tariff system, accounting for 5% in FY2019 and 6% in FY2020. Non-residential solar PV will lead the expansion.

Nuclear power generation in FY2019 will decrease for the first time in five years to 59 TWh as the number of operating days for nuclear power plants falls due to more regular check-ups in the absence of plants to be restarted. While five nuclear plants are restarted in FY2020, five operating plants will be halted from late FY2019 to late FY2020 due to delays in the completion of counterterrorism facilities. Nuclear power generation in the year will thus be limited to 62.4 TWh, up 5.5% from the previous year.

Oil will decelerate a supply decline in FY2019 to 1.0%, the lowest since FY2013, as heating oil demand rises in reaction to the fall in the warmer-than-normal winter in the previous year despite slack production activities, energy efficiency improvements and fuel switching. In FY2020, oil will fall by 2.0% for the eighth straight year of decline as supply for final consumption and power generation decreases. Oil's share of primary energy supply will drop to 38%, halving from the level at the time of the first oil crisis.

Natural gas will increase by 1.1% in FY2019 for the first rise in three years. Supply for city gas will increase for the first time in two years in reaction to

the warmer-than-normal winter in the previous year. Supply for power generation will also rise as Hokuriku Electric Power Co. and Hokkaido Electric Power Co. launched their first LNG-fired power plants in November 2018 and February 2019, respectively, with no nuclear power plants planned to be restarted in FY2019. In FY2020, natural gas supply will decline by 2.4% despite an increase in supply for city gas as supply for power generation decreases on growth in coal, nuclear and new energy power generation. LNG imports will slip below 80 million t for the first time since the Great East Japan Earthquake.

Coal will increase by 0.4% in FY2019 as coke-making demand and final consumption increase in line with crude steel production recovery despite a decline in supply for power generation due to an excess of capacity retirement over new capacity for coal-fired power plants. In FY2020, coal supply will expand by 2.0% due to the launch of a 1 million kW coal-fired power plant in December 2019 and four plants with total capacity at 2.38 million kW in the first half of FY2020. Coal's share of primary energy supply will thus top 27% for the first time in a half century.

The energy self-sufficiency rate will rise by 0.2 percentage points to 12.1% in FY2019 and by 0.6 points to 12.7% in FY2020, growing slower than in the past three years.

Japan's energy-related CO_2 emissions will increase by 0.1% to 1,070 Mt in FY2019 for the first rise since FY2013. In FY2020, they will decline by 0.5% to 1,065 Mt., according to the statistics, is the lowest level after FY1990. From FY2013 as a standard year for an emission reduction target under the Paris Agreement, the FY2020 emissions represent a 13.8% decline.

Table 4 | Primary energy supply

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Primary energy supply (Mtoe)	515.9	462.6	464.7	455.7	457.2	455.9	-1.9%	0.3%	-0.3%
Coal	119.1	121.9	123.7	121.2	121.7	124.1	-2.0%	0.4%	2.0%
Oil	212.0	187.6	185.5	176.3	174.6	171.0	-4.9%	-1.0%	-2.0%
Natural gas	95.7	114.7	111.4	106.4	107.5	104.9	-4.5%	1.1%	-2.4%
LNG imports (Mt)	70.6	84.7	83.9	80.6	80.4	78.5	-4.0%	-0.2%	-2.4%
Hydro	17.7	16.6	17.5	16.9	17.0	17.0	-3.6%	1.0%	0.1%
Nuclear	60.7	3.7	6.8	13.5	12.8	13.5	97.3%	-4.7%	5.5%
New energy, etc.	10.7	18.2	19.8	21.5	23.5	25.2	8.8%	9.2%	7.4%
Self-sufficiency rate	20.3%	8.2%	9.6%	11.9%	12.1%	12.7%	2.3p	0.2p	0.6p
Energy intensity (FY2011=100)	105.1	89.0	87.8	85.5	85.2	84.5	-2.6%	-0.4%	-0.8%
Energy-related CO_2 emissions (MtCO$_2$)	1,137	1,129	1,111	1,069	1,070	1,065	-3.8%	0.1%	-0.5%
Change from FY2013	-7.9%	-8.6%	-10.1%	-13.5%	-13.4%	-13.8%	-3.4p	0.1p	-0.4p

Notes: New energy includes solar photovoltaics, wind, biomass, solar heat, and geothermal, etc.

Self-sufficiency rate is based on IEA standard.

Electricity sales and power generation mix (electric utilities)

In FY2019, electricity sales to lighting service users will increase due to temperature changes. Sales to power service users will slightly rise on growth in sales to the steel industry, despite a decline in manufacturing production. In FY2020, electricity sales to lighting service users will slightly fall on the diffusion of energy efficient appliances, with those to power service users increasing on manufacturing production recovery.

Electricity sales in FY2019 will rise by 0.6% from FY2018, restoring more than 40% of a loss in the previous year. Sales to lighting service users will increase by 1.5% in reaction to a fall amid the warmer-than-normal winter in the previous year. Those to power service users will slightly grow on production recovery in the steel industry, despite a production fall in machinery and other industries.

In FY2020, electricity sales will increase by 0.4%. Sales to lighting service users will post a small decrease of 0.1% on the penetration of light-emitting diode lamps and other energy efficient appliances, and solar PV, though with progress seen in the electrification of water heaters and kitchen equipment. Those to power service users will grow by 0.6% on production recovery in machinery and other industries.

From November 2019, first 10-year contracts for residential users to sell surplus electricity generated with solar PV to electric utilities under the FIT scheme will expire gradually[1]. As the penetration of storage batteries and electrification equipment or the elimination of solar PV panels fail to make fast progress in response to the expiration, however, the expiration will have little impact on electricity sales to lighting service users.

Due to the full liberalization of retail electricity sales, power producer and supplier companies' or new power market participants' share of electricity sales rose from 5.2% in April 2016 to 14.9% in March 2019. Their share of sales to lighting service users stood at 13.4%, indicating an uptrend. However, their share of sales to high voltage users levelled off at 23.9% (6.2% for extra-high voltage users).

In FY2019, nuclear's share of total power generation will level off at 6% as regular checks on operating nuclear plants increase with no plant restarted. Renewable energy sources (excluding hydro) will increase their share of the power mix by 0.9 points to 10% on the strength of the FIT scheme. Hydro's share will level off. As a result, the combined share of zero-emission power sources – hydro, nuclear and renewables (other than hydro) – will top 25% for the first time since the Great East Japan Earthquake. Fossil fuels' share of the power mix will fall by 0.6 points due primarily to a decline in oil, etc.

In FY2020, nuclear's share of the power mix will rise only by 0.3 points as five nuclear power plants are halted due to delays in the completion of counterterrorism facilities, despite the restart of five plants and fewer regular checks. Renewables' share will increase by 0.8 points to 11% due mainly to the expansion of non-residential solar PV capacity. Coal's share will post the largest growth of 1.1 points to 29% on the launch of a 1 GW coal-fired power plant in the second half of 2019 and four other plants with total capacity at 2.38 GW in the first half of FY2020. The share for oil, etc. will level off as a decline in oil-fired power generation is offset by output from a 0.62 GW city gas-fired plant starting commercial operation at the end of the first half of FY2019 and another 0.62 GW plant launching commercial operation at the end of the second half of the year. LNG's share of the power mix will fall by 2.2 points to 37% due to an increase in electricity from other sources.

---

[1] Subject to the expiration will be residential solar PV panels introduced on the launch of the FIT system in November 2009.

Table 5 | Electricity sales and power generation and purchases mix (electric utility use)

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Electricity sales (TWh)	(926.6)	850.5	863.2	852.6	857.3	860.3	-1.2%	0.6%	0.4%
Lighting service	304.2	271.8	279.3	270.3	274.3	274.0	-3.2%	1.5%	-0.1%
Power sercice	(622.4)	578.7	583.9	582.2	583.0	586.3	-0.3%	0.1%	0.6%
Extra-high and High voltage	(576.5)	540.3	544.9	544.6	545.3	548.3	0.0%	0.1%	0.6%
Low voltage	(45.9)	38.5	39.0	37.6	37.8	38.0	-3.5%	0.4%	0.6%
Electricity generated and purchased (TWh)	(1,028)	963.1	973.5	956.6	961.7	964.9	-1.7%	0.5%	0.3%
Hydro	(9%)	9%	9%	9%	9%	9%	-0.1p	0.0p	-0.0p
Fossil fuels	(62%)	83%	80%	75%	75%	74%	-4.2p	-0.6p	-1.1p
Coal	(25%)	29%	29%	28%	28%	29%	-0.8p	-0.2p	1.1p
LNG	(29%)	43%	41%	39%	40%	37%	-1.5p	0.2p	-2.2p
Oil, etc.	(8%)	11%	10%	8%	7%	7%	-1.9p	-0.7p	0.0p
Nuclear	(29%)	2%	3%	6%	6%	6%	3.3p	-0.4p	0.3p
Renewables (excluding hydro), etc.	(1%)	7%	8%	9%	10%	11%	1.1p	0.9p	0.8p

Notes: Figures in brackets are based on old statistical definitions, and discontinuous with other values.

"Electricity sales" is for electricity utility use, and does not include own use and specified supply.

"Electricity generated and purchased" is only for general electric utilities in FY2010, and its figures since FY2016 are estimated values.

Hydro includes pumped, and LNG includes city gas.

City gas sales (gas utilities)

City gas sales for power generation will substantially increase through FY2020. In FY2019, residential sales will increase after a hotter summer and a warmer winter in the previous year. In FY2020, city gas sales will hit a record high on a substantial rise in sales for power generation and a small increase in those for manufacturing.

City gas sales[2] in FY2019 will increase by 1.1% from the previous year as those for the residential and power generation sectors expand despite drops in those for the commercial sector and "others" and a small decrease in those for the manufacturing sector. In FY2020, city gas sales will hit a record high of 43.1 billion m^3, up 2.4%, as those for power generation substantially rise, with those for manufacturing recovering.

Residential gas sales in FY2019 will increase by 2.6% as a cooler summer and a colder winter than in the previous year boost water and space heating demand. In FY2020, they will post a small fall of 0.1% on the penetration of highly efficient water heaters and other energy efficient equipment and on progress in electrification.

Business gas sales (commercial and other sales) in FY2019 will decrease (-0.6% for commercial sales and -0.6% for others) due to a fall in demand for cooling and continuous energy efficiency improvements. In FY2019, business sales will decelerate a decline (-0.3% for commercial sales and -0.5% for others) in the absence of a decline in demand for cooling, despite continuous energy efficiency improvements.

Industrial gas sales in FY2019 will increase by 1.1% for the sixth straight year of growth. Sales for manufacturing will decline by 0.3% on slack machinery production. However, sales to electric utilities will rise by 7.0% to 320 million m^3 as the first city gas-fired power plant (with capacity at 0.62 GW) of the Mooka thermal power station launches operation at the end of the first half of the year. In FY2020, sales to electric utilities will record a substantial increase of 20.0% to 1.01 billion m^3 as the second city gas-fired power plant (with the same capacity) starts operation at the end of FY2019. In addition, sales for manufacturing will rise by 0.3% on production recovery. Industrial gas sales will thus account for all of the growth in city gas sales hitting a record high in FY2020.

New gas retailers' share of city gas sales increased from 8.2% in April 2017 to 11.2% in March 2019 due to the full liberalization of city gas retail sales. Their share of industrial gas sales levelled off at a relatively high level of 16.1%. Two years after the full liberalization, however, their share of residential sales rose firmly to 6.2% and that of commercial sales to 3.6%.

Figure 2 | Changes in city gas sales

---
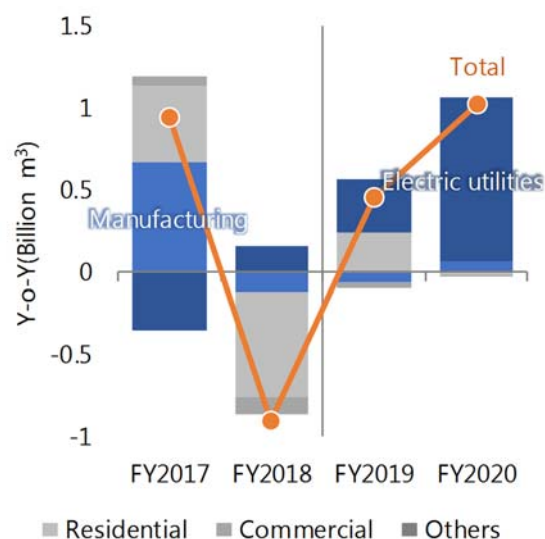
[2] Sales by gas utilities excluding former community gas utilities.

Table 6 | City gas sales (gas utilities)

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Total (Billion m^3)	39.28	41.53	42.48	41.58	42.03	43.06	-2.1%	1.1%	2.4%
Residential	9.79	9.41	9.88	9.24	9.48	9.47	-6.4%	2.6%	-0.1%
Commercial	4.75	4.32	4.37	4.26	4.23	4.22	-2.5%	-0.6%	-0.3%
Industrial	21.61	24.20	24.52	24.54	24.80	25.87	0.1%	1.1%	4.3%
Manufacturing	(20.18)	19.29	19.96	19.83	19.77	19.83	-0.6%	-0.3%	0.3%
Electric utilities	(1.43)	4.90	4.55	4.71	5.03	6.04	3.4%	7.0%	20.0%
Others	3.13	3.61	3.71	3.53	3.51	3.50	-4.7%	-0.6%	-0.5%

Notes: Converted at 1 m^3 = 41.8605 MJ (10,000 kcal). Figures in brackets are earlier statistical definitions.

Fuel oil/LPG sales and crude oil throughput

Fuel oil sales in FY2020 will decline for the eighth straight year, posting a one-third drop from the peak reached in FY1999. Excluding diesel oil in robust demand, fuel oil sales are falling.

Fuel oil sales in FY2019 will decline by 1.1% due to a fall in oil-fired power generation, the improvement of vehicle fuel efficiency and an ethylene production cut, although some reaction to the warmer winter in the previous year is seen. Sales in FY2020 will decrease by 2.1% for the eighth straight year of fall due to a sharp decline in naphtha sales amid more frequent regular repairs at petrochemical plants and a substantial fall in heavy fuel oil C sales for power generation, despite firm diesel oil sales, recording a one-third plunge from the peak of 246 million kL in FY1999.

Gasoline sales will continue a downtrend due to the expansion of fuel-efficient vehicles like hybrid and mini vehicles, falling by 1.8% in FY2019 to less than 50 million kL. In FY2020, gasoline sales will decrease by 2.0% to 48.8 million kL for the fifth straight year of decline, representing about 20% plunge from the peak of 61.5 million kL in FY2004.

Among fuel oil sales, naphtha sales have been relatively firm, affected less than other fuel oil products by energy efficiency improvements and fuel switching. In FY2019, however, naphtha will decrease by 0.5% as ethylene production is cut on competition from U.S. shale gas derivatives. In FY2020, naphtha sales will fall by 1.6% for the third straight year of decline due to more frequent regular plant repairs.

Kerosene sales will increase by 4.9% in FY2019 as demand for space heating rises after the warmer winter in the previous year. In FY2020, however, they will fall by 3.5% on fuel switching to city gas and electricity.

Diesel oil sales will grow by 0.2% each in FY2019 and FY2020 on an increase in demand for transportation through online sales and consumer-to-consumer transactions and in diesel vehicle ownership, despite further improvements in truck fuel and cargo transportation efficiency.

Heavy fuel oil A sales will drop by 3.1% each in FY2019 and FY2020 on fuel switching to city gas in the industry and buildings sectors. As the International Maritime Organization toughens SO_x regulations for shipping fuels from January 2020, demand for heavy fuel oil A and diesel oil may be stimulated.

Heavy fuel oil B and C sales for industrial use will continue to decrease due to fuel switching and energy efficiency improvement. Those for power generation will substantially decline on the suspension and elimination of oil-fired power plants. Total heavy fuel oil B and C sales will fall by 12.4% in FY2019 and by 12.6% in FY2020, posting a double-digit decline for the eighth straight year to less than 7 million kL.

LPG sales will rise by 0.8% in FY2019 as those for the buildings sector, accounting for half the total LPG demand, increase due to a temperature change. In FY2020, sales will decrease by 2.1% on progress in fuel switching to electricity and city gas in the buildings and industry sectors.

Crude oil throughput will decrease for the fourth straight year in line with a fuel oil sales decline, posting a 0.8% fall in FY2019 and a 1.8% drop in FY2020. In FY2020, it will slip below 3 million barrels per day for the first time since FY1987, standing far below the current atmospheric distillation capacity at 3.52 Mb/d.

Table 7 | Fuel oil / LPG sales and crude oil throughput

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Fuel oil sales (GL)	196.0	176.9	174.8	167.9	166.1	162.7	-4.0%	-1.1%	-2.1%
Gasoline	58.2	52.5	51.8	50.6	49.7	48.8	-2.3%	-1.8%	-2.0%
Naphtha	46.7	44.8	45.1	43.9	43.7	43.0	-2.6%	-0.5%	-1.6%
Jet fuel	5.2	5.3	5.0	5.2	5.2	5.3	3.7%	0.5%	0.3%
Kerosene	20.4	16.3	16.6	14.5	15.2	14.7	-12.9%	4.9%	-3.5%
Diesel oil	32.9	33.3	33.8	33.8	33.8	33.9	-0.1%	0.2%	0.2%
Heavy fuel oil A	15.4	12.0	11.5	11.1	10.7	10.4	-3.9%	-3.1%	-3.1%
Heavy fuel oils B and C	17.3	12.8	10.8	8.8	7.7	6.7	-18.9%	-12.4%	-12.6%
For electric utilities	7.7	7.9	6.0	4.0	3.5	2.9	-34.3%	-12.8%	-17.6%
For other users	9.7	4.8	4.8	4.8	4.2	3.9	0.4%	-12.2%	-8.5%
LPG sales (Mt)	16.5	14.4	14.8	14.2	14.3	14.0	-4.1%	0.8%	-2.1%
Crude oil throughput (GL)	208.9	190.6	184.2	176.7	175.3	172.1	-4.1%	-0.8%	-1.8%

Renewable power generation (FIT power source)

While FIT contracts expire for some solar PV panels, renewable energy-based power generation capacity will expand to 78 GW.

Renewable energy-based power generation capacity approved under the Feed-in Tariff scheme reached 105 GW in March 2017. As FIT approval for some non-residential solar PV capacity (such as mega-solar plants) was cancelled due to the establishment of a deadline for making approved FIT capacity operational, the approved capacity decreased to 90 GW (including 72.7 GW for solar PV, 7.1 GW for wind and 8.7 GW for biomass) in December 2018.

If FIT capacity totalling 90 GW is operational, the cumulative burden on consumers will come to JPY60 trillion [3], including components for operational and transferred facilities [4]. The estimated burden amounts to an electricity bill hike of JPY3.5/kWh – 15% for the residential sector and 21% for industry and other sectors. However, the estimated burden represents a substantial fall from JPY70 trillion for the case without cancellation of approved facilities, indicating some achievement of the revised FIT Act. Furthermore, if some 6 GW in biomass capacity seen as difficult to operate due to fuel procurement problems is excluded, the estimated burden can be cut to JPY46 trillion. In FY2019 when FIT contracts for residential solar PV panels will begin to expire, businesses will expand for third parties' purchases of surplus electricity from residential solar PV panels and the promotion of private consumption of such electricity, with government panels considering fundamental revision of the FIT scheme. Progress will be made in renewable power generation capacity expansion independent from the FIT scheme.

While no substantial increase can be expected in approved FIT capacity in such circumstances, facilities under construction are expected to become operational, boosting installed renewable energy-based power generation capacity (including capacity subject to FIT contract expiration) to 78.2 GW at the end of FY2020. Particularly, installed non-residential solar PV capacity will expand to 46.6 GW, accounting for a majority of the total installed FIT capacity. As a long time is required for launching wind power generation after approval due to environmental assessment and other procedures, installed wind power generation capacity will be limited to 4.6 GW. Renewable energy-based power generation in FY2020 will total 151.7 TWh (including 70.3 TWh for solar PV, 39.2 TWh for small and medium-sized hydroelectric plants, 30.2 TWh for biomass and 8.6 TWh for wind), accounting for 14% of Japan's total power generation.

The FIT Act for temporary special measures is set to be fundamentally revised by the end of FY2020. Discussions are being made on the revision. It will be important to design systems meeting the characteristics and status of each renewable energy source to develop renewables into a major stable power source over a long term.

---

[3] The remaining FIT periods for transferred facilities are taken into consideration. The marginal avoidance cost is estimated based on various documents. The capacity factor is assumed at 24.8% for wind, 13.7% for solar PV, 70% for geothermal energy, 45% for hydro and 70% for biomass.

[4] Transferred facilities are those that were installed before the introduction of the FIT scheme and later subjected to the scheme.

Figure 3 | Cumulative burden of FIT scheme over purchasing period (capacity approved or in operation at the end of December 2018)
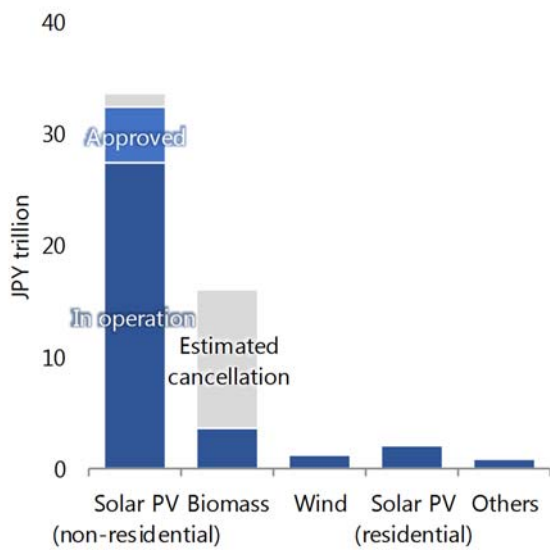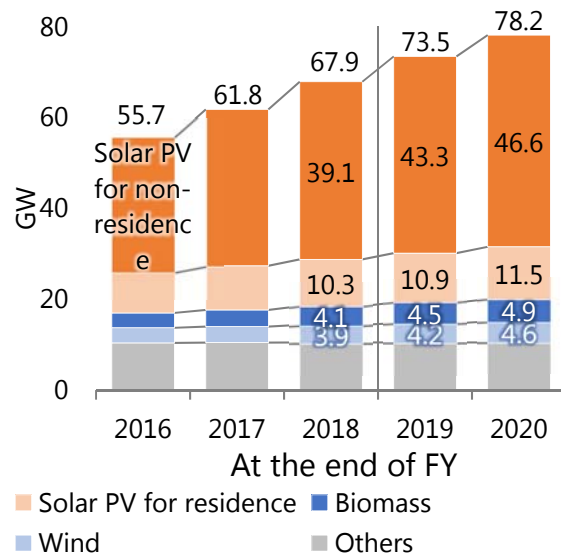
Figure 4 | Installed FIT power generation capacity (based on operation)

Note: Purchasing period is 10 years for solar PV (residential), 15 years for geothermal and 20 years for others.

Note: Including capacity subject to FIT contract expiration

Topic [1] Effects of counterterrorism facility completion and nuclear plant restart delays

Nuclear energy greatly contributes to 3E's

This chapter assesses the effects on the so-called 3E's (economic efficiency, stable energy supply and environmental friendliness) of different nuclear power generation.

In the Reference Scenario, the number of nuclear power plants in operation at the end FY2020 would remain unchanged from nine at present as five plants now in operation are halted due to delays in the completion of counterterrorism facilities. In addition, we have projected the "High Case" where the five

plants now in operation would remain in operation with their counterterrorism facilities completed within their respective deadlines and the "Low Case" where the five plants assumed to restart in FY2020 in the Reference Scenario would fail to do so. We have also developed the "Best Mixed Case" based on a 2030 power mix in the "Long-term Energy Supply and Demand Outlook" by the Ministry of Economy, Trade and Industry, setting the power generation mix share at 21% for nuclear, 23% for renewables and 56% for fossil fuels.

Table8 | Effects of differing nuclear power generation [FY2020]

		Low Case	Reference Scenario	High Case	Best Mixed Case	Changes from Reference		
						Low	High	Best Mixed
Nuclear assumptions	Restarted nuclear reactors	4	9	14	..	-5	+5	..
	Power generation (TWh)	44.2	62.4	81.4	227.0	-18.2	+19.0	+164.6
	Share in generation and purchases	4%	6%	7%	21%	-2p	+2p	+15p
Economy	Electricity unit cost[1] (JPY/kWh)	7.2	7.1	6.9	6.9	+0.1	-0.1	-0.2
	Fuel cost	4.4	4.3	4.2	3.6	+0.1	-0.1	-0.8
	FIT purchasing cost	2.7	2.7	2.7	3.3	0.0	0.0	+0.6
	Total fossil fuel imports (JPY trillion)	15.6	15.5	15.3	14.4	+0.1	-0.1	-1.0
	Oil	9.1	9.0	9.0	8.9	+0.0	-0.0	-0.1
	LNG	4.2	4.1	4.0	3.3	+0.1	-0.1	-0.8
	Trade balances (JPY trillion)	-0.3	-0.2	0.0	0.8	-0.1	+0.1	+0.9
	Real GDP (JPY2011 trillion)	541.8	542.0	542.1	543.2	-0.2	+0.2	+1.2
Energy and environment	Primary energy supply							
	Oil (GL)	187.8	187.0	186.4	183.7	+0.8	-0.7	-3.3
	Natural gas (Mt of LNG eq.)	82.6	80.6	78.4	65.6	+2.0	-2.2	-15.0
	Self-sufficiency rate	9.0%	10.2%	11.4%	21.4%	-1.1p	+1.2p	+11.2p
	Energy-related CO_2 (Mt)	1,072	1,065	1,057	987	+8	-8	-77
	Changes from FY2013	-13.2%	-13.8%	-14.4%	-20.1%	+0.6p	-0.6p	-6.3p

1. Sum of fuel cost, FIT purchasing cost and grid stabilising cost divided by total power generation.

As for economic efficiency, fossil fuel imports in the High Case would be JPY100 million less than in the Reference scenario. Those in the Best Mixed Case would be JPY1 trillion less. If crude oil and LNG prices rise on changes in the international situation, savings from a cut in dependence on fossil fuel-fired power generation would be even greater. Due to less fossil fuel imports that bring about greater disposable income, real GDP would be JPY200 billion more in the High Case and JPY1.2 trillion more in the Best Mixed Case.

The electricity unit cost in the High Case would be JPY0.1/kWh less than in the Reference Scenario. The cost in the Best Mixed Case would be JPY0.2/kWh

less. The cost saving in the Best Mixed Case would be limited because growth in FIT costs for renewable energy promotion would reduce fuel cost savings.

At a time when geopolitical risks in the Middle East are increasing, interests are growing in energy security. The energy self-sufficiency rate as an energy security indicator would be 1.2 points higher in the High Case and 11.2 points higher in the Best Mixed Case.

CO_2 emissions as an environment indicator would be 8 Mt less in the High Case and 77 Mt less in the Best Mixed Case. From FY2013, the base year for Japan's emission reduction target for the Paris Agreement, emissions would decline by 14.4% in the High Case

and by 20.1% in the Best Mixed Case[5]. The facilitation of nuclear plant restarts would thus contribute to the 3E's.

Column: Counterterrorism facility completion delayed through prolonged examinations and enlarged construction scales

Counterterrorism facilities for nuclear power plants are designed to prevent radioactive materials from being released abnormally even in the event of aircraft crashes or terrorist attacks. They are required to be installed within five years after construction plans for nuclear reactor facilities are approved. As electric utilities have sought to further enhance safety, however, counterterrorism facility construction has grown greater in scale and more difficult than earlier expected. Electric utilities see difficulties in completing these facilities before their respective deadlines, expecting that the completion would be delayed for one to three years. Of the nine nuclear power plants now in operation, therefore, one could be halted in March 2020 and four others gradually within FY2020. If the five are halted, power generation losses are estimated to total about 20 TWh (amounting to about 2% of total power generation) in FY2020 and about 30 TWh (about 3%) in FY2021.

When a decision was made in 2015 to set a five-year deadline after nuclear reactor facility construction approval for installing counterterrorism facilities, construction was assumed to take 52 months, meaning that eight months would be left for examinations to meet the deadline. In response to public comments in December 2015 on how to deal with delays in the installation of such facilities, the Nuclear Regulatory Authority explained that it would take necessary measures after checking the status when a deadline is approaching.

Considering the above, utilities asked the NRA to take necessary measures at a meeting of nuclear facility owners on April 17, 2019. In response, the NRA on April 24 gave a policy of asking a nuclear power plant to be halted if a counterterrorism facility for the plant fails to be completed within the deadline. More specifically, the NRA decided on June 12 to ask a nuclear plant to be halted if its counterterrorism facility fails to pass a pre-operation test at least six weeks before the deadline and give a relevant utility an opportunity for presenting explanations and to order a plant to be halted if its counterterrorism facility fails to pass a pre-operation test at least one week before the deadline.

Factors behind counterterrorism facilities' expected failure to be completed by their respective deadlines include enlarged construction scales and prolonged examination periods including about 39 months for Unit 1 of the Sendai Nuclear Power Station and about 41 months for Unit 2. There are various opinions about the fact that examinations on counterterrorism and other nuclear facilities take much more time than assumed initially. When the present regulatory standards were implemented in 2013, then NRA Chairman Tanaka estimated that examinations on nuclear plants' conformity with the regulatory standards would take some six months. However, examinations on the nine restarted nuclear plants took an average 1,401 days (close to four years). While any rough examinations must be avoided, it is important for the NRA to give priority to functional examinations while securing each plant's conformity with the standards established with consideration given to safety.

---

[5] Japan has set a target of cutting greenhouse gas emissions in FY2030 by 26% from FY2013 and energy-related CO_2 emissions out of the GHG emissions by 25%. The target would be accomplished not only through the low-carbonisation of power generation as taken up here but also through energy efficiency improvements and the low-carbonisation of the final energy consumption sector.

Topic [2] Impacts of oil price rises caused by increased geopolitical risks in the Middle East

A $15/bbl oil price hike would reduce Japan's real GDP by 0.2% and boost its fossil fuel imports by more than JPY3 trillion. Be prepared to face risks.

In the Reference Scenario, crude oil import CIF prices for Japan are assumed to average $65/bbl in FY2019 and $61/bbl in FY2020, indicating gradual stabilization. However, attacks on tankers in the Bay of Oman near the Strait of Hormuz on June 13, Iran's shoot-down of a U.S. reconnaissance drone on June 20 and an attempted U.S. retaliatory attack on the next day led oil market participants to expect that uncertainties about the Middle Eastern situation including U.S.-Iran relations would boost crude oil prices. So, we developed and assessed a "higher crude oil price case" where the average crude oil price would be $15/bbl higher than in the Reference Scenario from August 2019, with LNG prices being higher in line with oil prices (see Hashizume "Outlook for International Oil Market" for details).

An oil price hike of $15/bbl through FY2020 would push Japan's corporate goods price index up by 1.4% and the consumer price index up by 0.6%, boosting burdens on corporations and households. Given import price hikes, Japan's GDP would be pushed down by

0.2%. More than one-third of Japan's economic growth in FY2020 would be lost. Particularly, non-residential investment would be pushed down. Cost hikes through the oil price increase would discourage corporations from investing. Industrial production would decline by 0.3% in FY2020, slipping below the FY2018 level.

Among energy sales, fuel oil sales would post the largest decline of 0.6% from the Reference Scenario. Primary energy supply and CO_2 emissions in Japan would decrease by 0.4%, faster than GDP.

Although Japan has made progress in boosting energy efficiency, its dependence on fossil fuels increased sharply after the Great East Japan Earthquake and has remained high. Japan is thus one of the countries that are the most vulnerable to oil price hikes. It is important for Japan to cut renewable energy costs and facilitate the restart of nuclear power plants to prepare for risks.

Table 9 | Impacts of a $10/bbl oil price hike

		Historical	Reference scenario		Higher Oil Price Scenario			
							Changes from Refernce	
		FY2018	FY2019	FY2020	FY2019	FY2020	FY2019	FY2020
Prices	Crude oil, import, CIF ($/bbl)	72	65	61	76	76	17.3%	24.8%
	LNG, import, CIF ($/MBtu)	10.6	10.0	9.2	10.8	11.3	8.9%	23.2%
Economy	Real GDP (JPY2011 trillion)	535.5	539.1	542.0	538.6	541.1	-0.1%	-0.2%
	Industrial production (CY2015=100)	103.8	103.5	103.9	103.4	103.6	-0.1%	-0.3%
	Domestic corporate goods price index (2015=100)	101.5	102.4	102.9	103.2	104.4	0.8%	1.4%
	Consumer price index (2015=100)	101.4	102.4	102.9	102.7	103.5	0.2%	0.6%
	Balance of trade (JPY trillion)	-1.6	-0.2	-0.2	-1.8	-2.0	(-1.6)	(-1.8)
	Fossil fuels	19.1	16.9	15.5	19.1	18.6	(2.2)	(3.1)
Energy	Primary energy supply (Mtoe)[1]	455.7	457.2	455.9	456.4	454.1	-0.2%	-0.4%
	Oil[2] (GL)	192.8	190.9	187.0	190.2	186.0	-0.4%	-0.5%
	Natural gas[2] (Mt of LNG equiv.)	81.7	82.6	80.6	82.5	80.1	-0.1%	-0.6%
	Coal[2] (Mt)	188.4	189.1	193.0	189.0	192.7	-0.1%	-0.1%
	Self-sufficiency ratio	11.9%	12.1%	12.7%	12.1%	12.8%	0.0p	0.0p
	Electricity sales (TWh)	852.6	857.3	860.3	856.9	857.6	0.0%	-0.3%
	City gas sales[3] (Billion m³)	41.58	42.03	43.06	41.98	42.84	-0.1%	-0.5%
	Fuel oil sales (GL)	167.9	166.1	162.7	165.4	161.7	-0.4%	-0.6%
	Energy-related CO_2 emissions (Mt)	1,069	1,070	1,065	1,068	1,061	-0.2%	-0.4%

Notes:
1. Mtoe = 10^{13} kcal
2. Conversion factors for oil: 9,145 kcal/L; Natural gas: 13,016 kcal/kg; Steam coal: 6,203 kcal/kg; Coking coal: 6,877 kcal/kg since FY2013.
3. Conversion factor: 1 m³ = 10,000 kcal

Topic [3] Impacts of a trade war on global energy supply and demand

Global primary energy consumption would decline by 0.7% on trade war escalation. Energy consumption falls in the United States and China accounting for 40% of global energy consumption would have great influence on global consumption.

The trade war that began with the United States' imposition of tariffs on steel and aluminium imports has gradually escalated while including some pauses. For example, the United States has asked China to correct unfair trading practices such as the disrespect of intellectual property rights, forced technology transfers and the preferential treatment of Chinese companies, indicating complicated problems that could not be resolved with the elimination of a bilateral trade imbalance. At their meeting in late June, the top U.S. and Chinese leaders agreed on Washington's holding off of the fourth round of tariff hikes to expand additional tariffs to almost all Chinese products, the resumption of bilateral working-level talks and the relaxation of U.S. sanctions on Huawei Technologies Co. However, the United States and China have levied additional tariffs on each other's products, leaving the future course of their trade dispute in the balance.

This chapter assesses the impacts of the trade war on global energy supply and demand. Regarding economic impacts as the assumption, we referred to the International Monetary Fund's analysis on the impacts of U.S. tariffs hikes and Chinese countermeasures[6], quoting a scenario in which the direct impacts of tariff hikes and market sentiment deterioration would force the global economy to incur the fastest deceleration including a real GDP drop of a 0.8% in the global economy, a 1.4% in China, a 0.9% in the United States, a 0.7% in Japan and a 0.5% in the European Union,

Global primary energy consumption would decline by 0.7%, with a remarkable fall in Chinese coal consumption

Manufacturing would be directly affected by the tariff hikes while being closely related to non-residential investment which is sensitive to economic trends. In China, manufacturing features a great presence in the economy and energy consumption. Therefore, China would post the fastest energy consumption fall in the world at 1.3%, close to the Chinese GDP drop. In contrast, an energy consumption drop in the United States that has initiated the trade war would be limited to 0.6%. This is because the U.S. economic decline would be limited to about 70% of the Chinese level and U.S. macroeconomic conditions including personal vehicle ownership and services are difficult to be directly linked to energy consumption changes. Japan would post an energy consumption fall of 0.4%,

slower than the GDP fall. Global primary energy consumption would be greatly affected by China's consumption fall, logging a 0.7% decrease, close to the global economic decline.

Figure 10 | Impacts on primary energy consumption
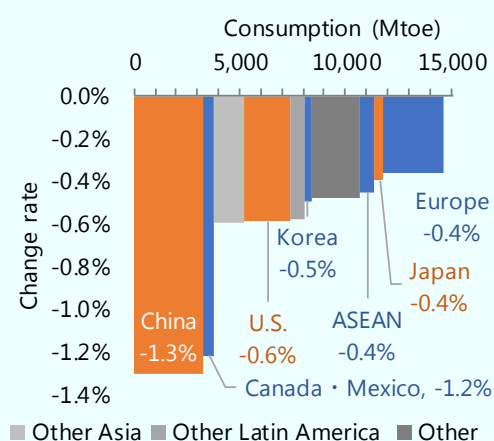
Of the primary energy consumption decline, coal would account for 41%, oil for 32% and natural gas for 23%. The coal share is far more conspicuous than coal's present share of energy consumption at 27%. This is because energy consumption on power generation and manufacturing would decline in China that accounts for half of global coal consumption.

Figure 11 | Impacts on world primary energy consumption

---
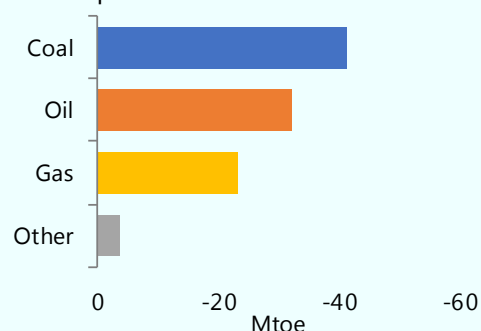
[6] International Monetary Fund "World Economic Outlook, October 2018" Additional tariffs are assumed at 25% on iron and steel, 10% on aluminium and 25% on $517 billion worth of Chinese goods (almost equivalent to the first-fourth rounds of tariff hikes).

Oil consumption would decline by 670 kb/d due primarily to a fall in China's transportation sector

Global oil consumption would decline by 670 kb/d or 0.7%, with the decrease focusing on transportation fuels. China would see an oil consumption decline of 210 kb/d or 1.6% particularly on consumer sentiment deterioration affecting growth in vehicle ownership, accounting for 30% of the global decline. The United States would post an oil consumption fall of 100 kb/d or 0.6%, with the fall concentrating in the transportation sector. Some half of the oil consumption drop for "others" would represent international bunkers related to international shipping and aviation. Japan would log the smallest fall among major economies at 10 kb/d or 0.3%. Oil consumption for transportation would fall as much as that for petrochemical materials.

図12 | Impacts on oil consumption

World: -670kb/d
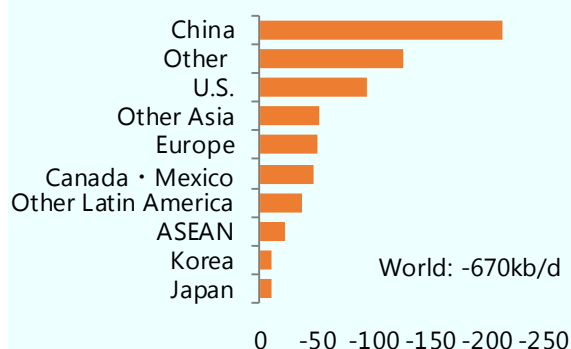
Global natural gas consumption would decrease by 27 Bcm centring on Western countries

Global natural gas consumption would decrease by 27 Bcm or 0.7%. The United States would see a fall of 6 Bcm or 0.7% centering on the power generation sector that depends on natural gas for 30% of power generation. Europe would be less economically affected than the United States or China. As Europe accounts for more than 30% of global natural gas consumption, however, its natural gas consumption fall would be 6 Bcm or 0.5%, close to the U.S. drop. China's natural gas consumption fall would be 1.3%, but limited to 4 Bcm in volume due to the below 10% of natural gas dependency. Unlike the coal and oil cases, China's fall in natural gas consumption would be smaller in volume than in the United States and Europe. In Japan, a natural gas consumption fall would focus on the buildings sector.

図13 | Impacts on natural gas consumption

World: -27Bcm
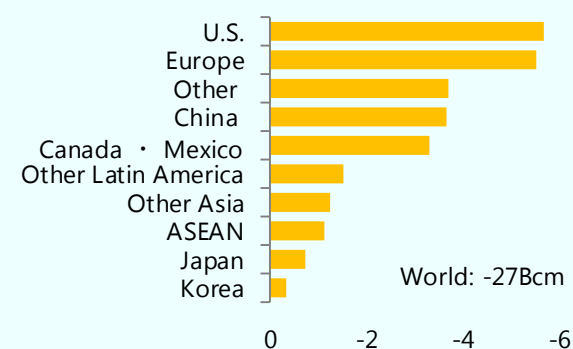
Coal consumption would decrease by 1.1% due primarily to a large drop in China's power generation sector.

Global coal consumption would decrease by 59 Mtce or 1.1%. Of the decline in volume, two-thirds or 39 Mtce would come in China, amounting to a 1.4% drop. As coal-fired power plants account for 70% of total power generation in China, an electricity consumption drop in the manufacturing and other sectors would lead to a decline of 26 Mtce or 1.7% in coal consumption for power generation. In the United States and Japan where coal-fired power plants account for about 30% of total power generation, with the manufacturing sector's presence being smaller than in China, coal consumption drops would be limited to 5 Mtce (1.0%) and 1 Mtce (0.5%).
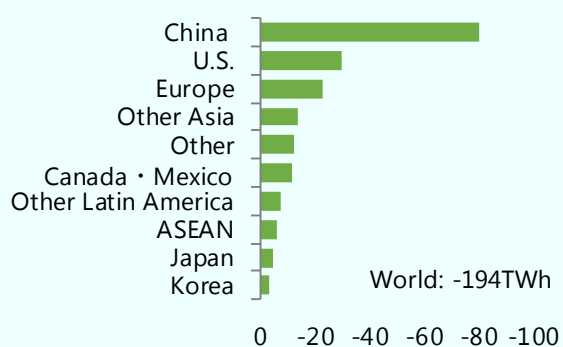
図14 | Impacts on coal consumption

World: -59Mtce
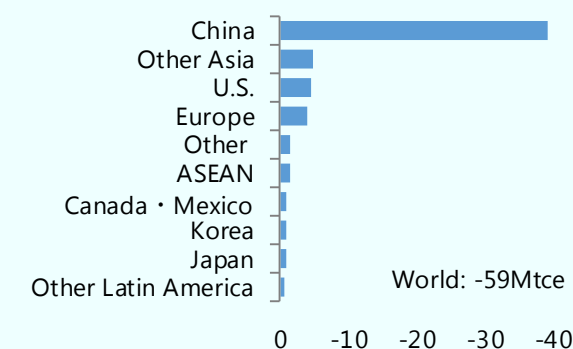
Power generation would fall by 195 TWh due primarily to a plunge in power consumption in China's manufacturing sector

Global power generation would drop by 194 TWh or 0.7%. In China, power generation would decline by 80 TWh or 1.1% due mainly to a decrease of 43 TWh in power consumption in the manufacturing sector. In the United States and Japan where the buildings sector's electrification rates are higher than in China, power generation would decrease by 30 TWh or 0.6% and by 5 TWh or 0.5%, respectively, due chiefly to power consumption falls in the buildings sector.

図15 | Impacts on power generation

China
U.S.
Europe
Other Asia
Other
Canada・Mexico
Other Latin America
ASEAN
Japan
Korea

World: -194TWh

0   -20 -40 -60 -80 -100

Energy markets would grow more uncertain amid a U.S.-China struggle for global supremacy

Trade disputes generally decelerate economic activities. Since China and the United States as the world's first and second largest energy consumers are at the centre of trade disputes, global energy consumption would be reduced commensurate with their economic sizes. U.S. LNG and oil exports could increase on a U.S. energy consumption decline and the increase could be combined with China's growing reluctance to trade with the United States to bring about new energy trade flows. Global energy markets will remain susceptible to the trade war. As the abovementioned energy demand falls exert downward pressure on fossil fuel prices, business and market sentiment deterioration may push these prices down further.

Contact :report@tky.ieej.or.jp