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Economic and Energy Outlook of Japan for FY2020

Leveled off Japan's economic growth and shift to low carbon

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Summary of economic and energy outlook [Reference Scenario]

Macro economy | Economy will marginally grow depending on public demand

While foreign demand in FY2020 will turn to contribute positively in line with global economic recovery, private demand will show signs of slowing down. For three years in a row, public demand is contributing the most to an increase. Industrial production will slightly rise, however, it will not reach the level of FY2017. The balance of trade will turn to be positive, thanks to a fall in fossil fuel prices.

Energy supply and demand | Primary energy supply will decrease for the third year in a row and CO_2 will decrease for its seventh year in a row, but both will be reduced by less than 1% for the second year in a row.

Primary energy supply in Japan in FY2019 decreases by 0.3% from the previous year due to an industry production fall, although growing heating demand after the warmer-than-normal winter in the previous year will exert upward pressure. In FY2020, primary energy supply will decrease by 0.4% on an ethylene production cut and energy efficiency improvements. (-0.4%). The trend away from fossil fuels towards non-fossil fuel will continue but while production from renewables will increase before the deadline of the penalty set for the FIT, nuclear will increase a much slower pace due to delays in the completion of counterterrorism facilities.

In FY2020, however, CO_2 emissions will decrease by 0.5% to 1,048 Mt which is lower than 1,050Mt for the first time, according to the statistics after FY1990. This corresponds to a reduction of -15.1% from FY2013, which means that 60% of the reduction target of energy-related CO_2 emissions set for FY2030 will be achieved in FY2020.

Energy sales | Electricity sales will increase gradually. City gas sales will not reach a record high despite increased sales to electric utilities. Fuel oil sales will decline for an eighth consecutive year and will consist of just two-thirds of the record high

Overall electricity sales in FY2019 increase by 0.1%. Lighting services increase in reaction to a fall amid the warmer-than-normal winter in the previous year, and power services decrease reflecting a production fall in the iron and steel production and machinery. In FY2020, electricity sales will increase by 0.4%. Power services will increase in line with the recovery of production activities concentrating on machinery industry while lighting services should decrease slightly, on the further penetration of energy-efficient appliances.

Overall total city gas sales in FY2019 are flat. There are decreases for general industries with production fall and for commercial and others due to a cooler summer. Sales increase for electric utilities, due to the operation of new city gas-fired power plants, and for space and water heating requirements in household due to a return from the previous year's milder winter. In FY2020, although sales for industries will increase due to the increase in sales for electric utilities and because of the recovery of production, the overall sales

(+2.0%) will be less than the record high of FY2017 due to a slowdown in fuel switching to city gas and a warmer winter than when the sales were the highest.

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	463.1	465.1	456.1	454.1	452.4	-1.9%	-0.4%	-0.4%
	Oil[2] (GL)	232.3	205.1	202.8	192.8	190.5	186.0	-4.9%	-1.2%	-2.4%
	Natural gas[2] (Mt of LNG equiv.)	73.3	88.1	85.6	81.7	81.1	79.1	-4.5%	-0.7%	-2.4%
	Coal[2] (Mt)	184.7	188.0	192.2	188.1	187.4	191.9	-2.1%	-0.4%	2.4%
	Nuclear (TWh)	288.2	17.3	31.3	62.1	61.0	63.5	98.6%	-1.9%	4.2%
	Renewable electricity[3] (TWh)	111.2	154.9	169.4	178.4	191.3	203.3	5.3%	7.2%	6.3%
	FIT generation (TWh)	63.2	112.8	123.2	135.2	147.2	158.0	9.8%	8.9%	7.3%
	Self-sufficiency ratio	20.2%	8.2%	9.5%	11.8%	12.0%	12.5%	2.3p	0.2p	0.4p
	Electricity sales[4] (TWh)	(926.6)	850.5	863.2	852.6	853.6	856.7	-1.2%	0.1%	0.4%
	City gas sales[5] (Billion m^3)	39.28	41.53	42.48	41.58	41.58	42.43	-2.1%	0.0%	2.0%
	Fuel oil sales (GL)	196.0	176.9	174.8	167.7	165.8	161.7	-4.1%	-1.1%	-2.5%
	Energy-related CO_2 emissions (Mt)	1,137	1,129	1,110	1,060	1,053	1,048	-4.5%	-0.6%	-0.5%
	(Changes from FY2013)	-7.9%	-8.6%	-10.1%	-14.2%	-14.7%	-15.1%	-4.0p	-0.5p	-0.4p
Prices	Crude oil, import, CIF ($/bbl)	84	48	57	72	68	66	26.7%	-6.4%	-1.8%
	LNG, import, CIF ($/MBtu)	11.3	7.0	8.5	10.6	9.5	8.9	24.9%	-10.4%	-5.7%
	Steam coal, import, CIF ($/t)	114	81	103	121	100	87	17.5%	-17.4%	-12.6%
	Coking coal, import, CIF ($/t)	175	111	147	160	135	120	8.9%	-15.5%	-11.4%
Economy	Real GDP (JPY2011 trillion)	493.0	522.0	532.0	533.7	537.2	540.1	0.3%	0.7%	0.6%
	Industrial production (CY2015=100)	101.2	100.6	103.5	103.8	101.3	101.8	0.2%	-2.4%	0.5%
	Balance of trade (JPY trillion)	5.3	4.0	2.4	-1.6	-2.9	0.4	-166%	83.1%	-112.6%
	Fossil fuel imports (JPY trillion)	18.1	13.1	16.3	19.1	16.8	15.9	17.5%	-11.8%	-5.9%
	Exchange rate (JPY/$)	86.1	108.4	111.1	110.6	108.8	108.0	-0.4%	-1.7%	-0.7%
	Cooling degree days	559	431	397	489	439	382	23.2%	-10.2%	-13.1%
	Heating degree days	1,079	965	1,071	866	982	1,017	-19.2%	13.5%	3.5%

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 m^3 = 10,000 kcal

Despite the impact of a colder winter than in the previous year, fuel oil sales in FY2019 continue to decrease reflecting lower oil-fired power generation, the improvement of vehicle fuel efficiency, and fuel switching to other energies (-1.1%). Although sales of diesel oil and jet fuel will remain firm, fuel oil sales in FY2020 will further decrease by 2.1% for the eighth consecutive year 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. The FY2020 sales will be equivalent to two-thirds of the FY1999 peak of 246 million kL.

Renewable power generation | The FIT power generation capacity will reach 83 GW at the end of FY2020

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 89 GW in June 2019. If the FIT capacity totalling 89 GW becomes operational, the cumulative burden on consumers will come to JPY60 trillion, including components for operational and transferred facilities. The estimated burden amounts to an electricity bill hike of JPY3.4/kWh – 15% for the residential sector and 21% for industry and other sectors. The facilities under construction are expected to become operational, boosting installed renewable energy-based power generation capacity (including capacity subject to FIT contract expiration) to 83 GW by the end of FY2020. The completion is accelerated by the

deadline of the penalty set for the FIT act. Renewable energy-based power generation in FY2020 will total 152.3 TWh (including 76.2 TWh for solar PV, 39.6 TWh for small and medium-sized hydroelectric plants, 30.2 TWh for biomass etc.), accounting for 15% of Japan's total power generation.

Topic |

1 Residential energy consumption by use

Residential energy consumption after the Great East Japan Earthquake is on a downward trend with the penetration of energy-efficient appliances and actions for energy saving exceeding the increases in the number of households. However, in FY2019, residential energy consumption increases 2.1% with increases in space heating and water heating due to a colder winter relative to the previous year. In FY2020, residential energy consumption will slightly decrease 0.2% with less cooling requirements due to a cooler summer from the previous year and improvements of energy efficiency in the power, etc. Following a slight decrease in FY2019, energy consumption for cooking will slightly increase in FY2020 reflecting an increase in the number of households and partly offset by lower demand due to lifestyle changes.

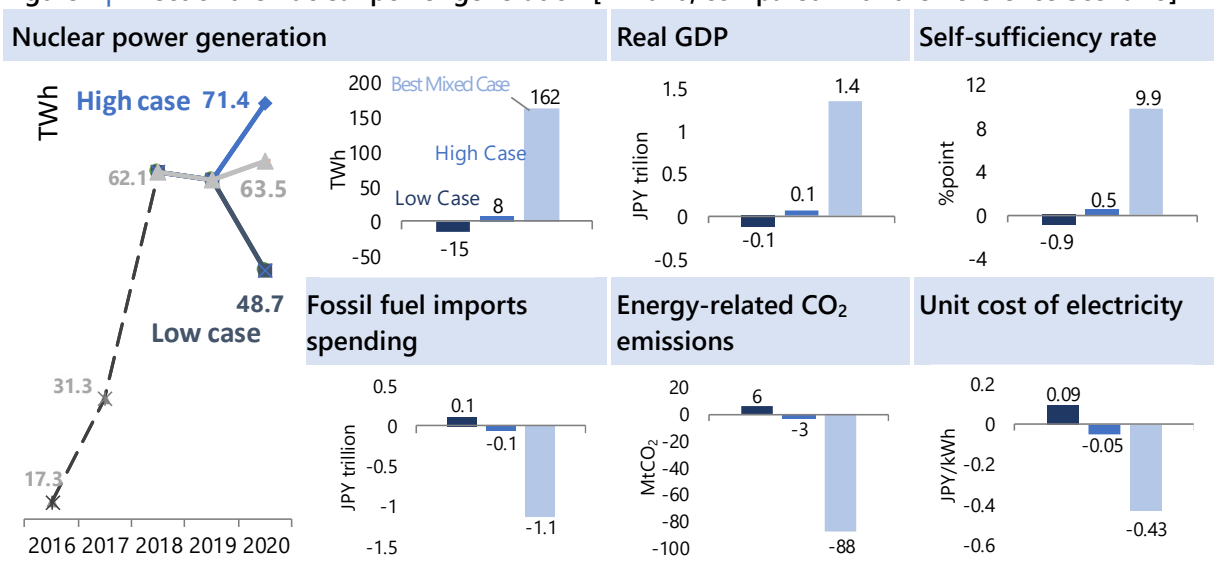
2 Impacts of regulation of sulfur content in ship fuel on domestic vessel

Under worldwide regulations set by the International Marine Organization (IMO), the sulfur content in ship fuel will be regulated from the current maximum of 3.5% to less than 0.5% after Jan 2020. Sales for domestic vessels are 3.17 GL in FY2019 and will be 3.09 GL in FY 2020 out of which 0.71 GL and 2.15 GL of Very Low Sulfur Fuel Oil(VLSFO) satisfies the new regulations. With the efforts of both public and private entities, the VLSFO will be supplied stably. If the price of VLSO is similar to LSC fuel oil C for power utilities, the price will rise by JPY3.6/ L and the total fuel costs will increase by 11.3 billion JPY(6.3%). If the price increase is equivalent to fuel oil A, it will rise by JPY9.7/ L , and for a total fuel costs increase of 30.1 billion JPY (17.1%). 79 kt of SO_2 will be reduced in FY2020, thus, the reduction costs will be JPY140～379 thousands/tSO_2. Switching to VLSFO does not contribute to reduce other gases such as CO_2. Thus, paying attention to markets of oil and domestic vessel and implementing appropriate environmental measures will be important.

3 Impacts of the completion of counterterrorism facilities and of the delays in nuclear plant restarts

We assessed the impacts of nuclear power generation on 3Es – economy efficiency, energy security and environment. In the High Case, where the three plants now in operation would remain in operation with their counterterrorism facilities completed within their respective deadlines, the cost of fossil fuel imports would be reduced by JPY60 billion, the self-sufficiency rate would be improved by 0.5 points, and CO_2 emissions would be reduced by 3 Mt. Plants which have a deadline for the completion of their counterterrorism facilities after FY2020 will increase. Smoothing the restart of the nuclear power generation with functional examinations contributes to achieving 3Es.

Figure 1 | Effect of the nuclear power generation [FY2020, compared with the Reference Scenario]



Introduction

The Japanese economy in the third quarter of 2019 posted a real growth rate of 0.6% in gross domestic product for the third straight quarter of positive growth. While external demand made a negative contribution of 0.2 percentage points to the growth due to a global economic slowdown, domestic demand more than offset the negative contribution. While reconstruction and restoration demand after the typhoon and other natural diasters are expected for the immediate future, attention should be paid to weak consumption following a consumption tax increase in October 2019 and an external demand slowdown amid the U.S.-China trade dispute and China's economic deceleration.

The average crude oil import price for Japan peaked at $73 per barrel in June and fell below $65/bbl by the end of September. It currently remains around $65/bbl as upward pressure from joint oil production cuts by the Organization of Petroleum Exporting Countries (OPEC) and some non-OPEC oil-producing countries and the United States' Iran oil embargo counters, downward pressure from the U.S.-China trade war and the United Kingdom's pending exit from the European Union.

Applications have been filed for examinations of 27 nuclear power plants for conformity to new regulatory standards in Japan. Of them, 15 have cleared the examinations, including nine that are in operation. While some plants in operation are likely to suspend operation if counterterrorism facilities fail to be completd by the deadline, those that have cleared the examinations are expected to restart operation one after another.

As the feed-in tariff (FIT) scheme for solar photovoltaics power generation at households began to expire in November, the tariff plunged from JPY48/kWh in FY2009 to a JPY8-12/kWh range, with storage batteries failing to diffuse due to their lack of economic efficiency.

Key assumptions behind the Reference Scenario

Global economy

Global economic growth is assumed at 3.0% for 2019, the lowest in the 2010s, and at 3.4% for 2020. In 2019, manufacturing production will sink to the lowest level since the global financial crisis due to the prolonged U.S.-China trade war, leading mainly the U.S. and Chinese economies to decelerate. Through 2020, however, the global economy will pick up, driven by economic growth in emerging market countries. As the United States plans to reduce fiscal spending, tax reduction effects since 2017 are fading away. The U.S. economy will rebound on accommodative monetary policy, though with economic expansion slowing down. Europe will pick up as exports increase slightly on the global economic growth rebound after dragging down the European economy. The United Kingdom could realize its exit from the European Union in January 2020, but confusion from failure to develop relevant regulations could exert downward pressure on the European economy. China will continue an economic deceleration trend due to the U.S.-China trade dispute and its debt reduction policy in 2020, though with economic stimuli producing effects.

Crude oil/LNG/coal import CIF prices

Crude oil import prices for Japan are assumed to average $68/bbl in FY2019 ($69/bbl in the first half and $66/bbl in the second) and $66/bbl in FY2020, based on the international crude oil price outlook below, levelling off from the second half of FY2019. The average LNG import price for Japan is assumed to fall from $9.5/MBtu in FY2019 to $8.9/MBtu in FY2020 due to an end to crude oil prices' downtrend and growing LNG imports from the United States. Steam coal import prices are projected to level off after weakening in the second half of FY2019. Coking coal import prices are assumed to grow stable on a steel demand growth slowdown amid China's economic growth deceleration. Steam coal import prices are assumed to average $100/t in FY2019 and $87/t in FY2020. Coking coal import prices are projected to average $135/t in FY2019 and $120/t in FY2020. (IEEJ Morikawa "Outlook for International Oil Market," Hashimoto "Outlook for International Gas Market," Sagawa "Outlook for International Coal Market.")

Exchange rate

We assume the dollar's average exchange rate with the yen to stand at JPY108/USD in both FY2019 and FY2020.

Air temperature

According to the Japan Meteorological Agency's three-month weather forecast, we assume that winter in FY2019 will be warmer than normal before temperatures are normal. FY2019 summer was cooler (-0.5°C) than the previous summer. FY2019 winter will be colder (-0.6 °C) than the previous winter that was warmer than normal. Summer in FY2020 will be cooler (-0.5°C) than the previous summer. Winter in FY2020 will be slightly colder (-0.2°C).

Nuclear power generation

Nuclear power plant operations in FY2019 will be slightly less than in the previous year due to more regular checks. While four nuclear power plants that have cleared regulatory standards conformity examinations restart one after another in FY2020, three plants now in operation are assumed to be shut down on a delay in the completion of counterterrorism facilities from August 2020. At the end of FY2019, the number of nuclear power plants restarted after their shutdown on the Great East Japan Earthquake will

remain unchanged at nine. In FY2019, they will operate for an average eight months and generate 61.0 TWh (accounting for 6.4% of total power generation). At the end of FY2020, the cumulative number of nuclear plants restarted after the shutdown will increase by four to 13 but three now in operation will be shut down due to the delay in the completion of counterterrorism facilities. In FY2020, nuclear plants will operate for an average six months and generate 63.5 TWh (accounting for 6.6%).

Macro economy

After a domestic demand rise more than offsets an external demand fall for the Japanese economy in FY2019, the economy will continue small growth depending on public demand in FY2020, with private demand weakening despite an external demand recovery on a global economic pickup.

Japan's GDP will post a real economic growth rate of 0.7% in FY2019. Affected by the U.S.-China trade dispute, manufacturers' exports will slow down, with external demand contributing a negative 0.4 percentage points to the growth. The Japanese economy will be supported by domestic demand including post-disaster reconstruction, healthcare and other public demand that will contribute 0.6 percentage points to the GDP growth. The consumption tax hike's impact on private consumption will be limited in the whole of the year. Non-residential investment will be firm, including construction and intellectual property investment.

In FY2020, Japan's real GDP growth will decelerate to 0.6%. Private consumption will be supported by growth in foreign tourists' consumption but negatively affected by temporary restrictions on distribution, production and sales during the Tokyo Olympics. The effects of consumption tax hike countermeasures including consumption stimuli will fade away. Consequently, private consumption will decelerate growth. Non-residential investment will slow down its growth, while increasing on growing construction related to redevelopment in the Tokyo metropolitan region and to increasing foreign tourists, as well as rising intellectual property investment for automation and labour-saving purposes amid labour shortages. As residential investment plunges in the wake of the consumption tax increase, private demand's contribution to the overall GDP growth will be limited to 0.1 percentage points. Exports including vehicles and electric machines will increase on the receding of concern about the U.S.-China trade war and on growth in emerging market economies. Imports will decelerate growth. External demand will contribute 0.2 percentage points to the overall GDP growth. Public investment will rise on reconstruction after typhoon damage and on a national resilience enhancement program. Government consumption will expand on a free infant education program and healthcare expansion. Public demand will thus contribute 0.3 percentage points to the overall growth, remaining the largest contributor for three years on end.

Japan's fossil fuel imports will decrease by 11.8% in FY2019 and by 5.9% in FY2020 thanks to price falls, allowing the trade balance to post a surplus in FY2020 for the first time in three years.

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	532.0	533.7	537.2	540.1	0.3%	0.7%	0.6%
Private demand	369.3	393.0	400.5	401.4	403.6	404.0	(0.2%)	(0.4%)	(0.1%)
Private consumption	286.6	295.5	298.9	299.0	300.1	300.7	0.1%	0.4%	0.2%
Private residential investment	13.9	16.2	15.9	15.1	15.4	14.8	-4.9%	1.8%	-3.7%
Private non-residential investment	67.6	80.8	84.3	85.7	87.4	88.2	1.7%	2.0%	0.9%
Public demand	122.6	131.7	132.3	133.4	136.8	138.6	(0.2%)	(0.6%)	(0.3%)
Government consumption	98.1	106.0	106.3	107.3	109.9	111.0	0.9%	2.4%	1.0%
Public investment	24.7	25.8	26.0	26.1	26.9	27.6	0.6%	3.1%	2.5%
Net exports of goods and services	1.3	-3.2	-1.2	-1.7	-3.8	-3.0	(-0.1%)	(-0.4%)	(0.2%)
Exports of goods and services	74.7	85.9	91.4	92.9	91.6	93.1	1.6%	-1.3%	1.6%
Imports of goods and services	73.4	89.1	92.6	94.6	95.5	96.1	2.2%	0.9%	0.7%
Nominal GDP (JPY trillion)	499.4	536.9	547.6	548.4	554.5	562.1	0.1%	1.1%	1.4%
Balance of trade (JPY trillion)	5.3	4.0	2.4	-1.6	-2.9	0.4	-166%	83.1%	-112.7%
Exports	67.8	71.5	79.2	80.7	77.1	78.8	1.9%	-4.4%	2.1%
Imports	62.5	67.5	76.8	82.3	80.1	78.4	7.2%	-2.7%	-2.1%
Fossil fuels	18.1	13.1	16.3	19.1	16.8	15.9	17.5%	-11.8%	-5.9%
Oil	12.3	7.8	9.6	11.3	10.3	9.9	18.3%	-9.1%	-3.9%
LNG	3.5	3.3	4.1	4.9	4.2	3.8	19.4%	-13.9%	-8.2%
Current account (JPY trillion)	18.3	21.7	22.2	19.2	19.1	22.6	-13.2%	-0.7%	18.0%
Domestic corporate goods price index (2015=100)	97.6	96.7	99.3	101.5	102.2	103.0	2.2%	0.6%	0.8%
Consumer price index (2015=100)	96.4	100.0	100.7	101.4	102.0	102.5	0.7%	0.6%	0.5%
GDP deflator (2011=100)	101.3	102.9	102.9	102.8	103.2	104.1	-0.2%	0.5%	0.8%
Unemployment rate (%)	5.0	3.0	2.7	2.4	2.4	2.4	[-0.3%]	[-0.0%]	[0.0%]

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

Industrial production will turn up on an export recovery amid a global economic pickup in FY2020 but fail to restore the FY2017 level.

In FY 2019, the industrial production index will fall by 2.4% from the previous year due to the U.S.-China trade dispute and natural disasters for the first decrease in four years. In FY2020, the index will rise by 0.5% on the receding of concern about the trade dispute.

Crude steel production will decrease on sluggish demand in construction and manufacturing industries in FY2019 and increase on rising construction investment related to redevelopment in the Tokyo metropolitan region in FY2020.

In FY2019, domestic demand for crude steel will decrease by 1.7% on weak construction investment for redevelopment in the Tokyo metropolitan region and sluggish manufacturing production. Exports will fall by 0.4% on stagnant demand in China. Crude steel production will thus drop by 1.2%. In FY2020, crude steel production will increase by 1.1% as domestic demand rebounds on robust construction investment for recovering redevelopment in the Tokyo metropolitan region and external demand expands on brisk Asian demand.

Ethylene plants will operate almost at their full capacity in FY2019, with production growth set aside for exports. In FY2020, ethylene production will stagnate on competition from U.S. ethylene from shale gas and an increase in regular plant repairs.

In FY 2019, ethylene plants will operate almost at their full capacity with less regular repairs, leading exports to increase because of weak domestic demand. Production will rise by 3.5%. In FY2020, cheap U.S. derivatives from shale gas will flow into the Asian market and more ethylene capacity in Japan will be subjected to regular repairs, forcing Japan's ethylene production to decline by 4.0%.

Cement production will decrease on a delay in redevelopment in the Tokyo metropolitan region in FY2019 before increasing on growing demand for disaster prevention and reduction facilities in FY2020.

Cement production in FY2019 will decrease by 1.1% as natural disasters and labour shortages force construction periods to be prolonged for redevelopment in the Tokyo metropolitan region. In FY2020, cement production will increase by 0.7% on growing demand for disaster prevention/reduction facilities under a national resilience enhancement program. Exports to Asia and Oceania will be robust.

Paper and paperboard production will slightly decrease in FY2019 and FY2020 due to structural factors such as a switch to electronic media and a population fall.

While paperboard production increases due to increasing sales via the Internet and production capacity growth in FY2020, paper production will decline on a switch to electronic media and a population decline. Paperboard and paper production will drop by 1.7% in FY2019 and by 0.8% in FY2020.

Automobile production will decline on a vehicle inspection scandal in FY2019. It will turn to increase on a domestic and overseas demand recovery in FY2020.

In FY2019, automobile production will decrease by 0.7% on a vehicle inspection scandal, though with the impact of a consumption tax increase being limited. Exports will increase as automakers switch from production in the United Kingdom to domestic production ahead of the country's exit from the European Union. In FY2020, production will increase by 0.9% as exports rise on a global economic pickup and domestic shipments expand robustly.

Table 3 | Production activities

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Primary energy supply (Mtoe)	515.9	463.1	465.1	456.1	454.1	452.3	-1.9%	-0.4%	-0.4%
Coal	119.1	121.9	123.7	121.2	120.7	123.5	-2.0%	-0.4%	2.3%
Oil	212.0	187.6	185.5	176.3	174.2	170.1	-4.9%	-1.2%	-2.4%
Natural gas	95.7	114.7	111.4	106.4	105.6	103.0	-4.5%	-0.7%	-2.4%
LNG imports (Mt)	70.6	84.7	83.9	80.6	79.0	77.0	-4.0%	-1.9%	-2.5%
Hydro	17.7	16.6	17.5	16.9	16.9	17.1	-3.4%	0.0%	1.0%
Nuclear	60.7	3.7	6.8	13.5	13.2	13.8	97.3%	-1.9%	4.2%
New energy, etc.	10.7	18.7	20.2	21.8	23.4	25.0	8.2%	7.2%	6.7%
Self-sufficiency rate	20.2%	8.2%	9.5%	11.8%	11.8%	11.8%	2.3p	0.0p	0.0p
Energy intensity (FY2011=100)	105.1	89.1	87.8	85.9	84.9	84.1	-2.2%	-1.1%	-0.9%
Energy-related CO_2 emissions ($MtCO_2$)	1,137	1,129	1,110	1,060	1,053	1,048	-4.5%	-0.6%	-0.5%
Change from FY2013	-7.9%	-8.6%	-10.1%	-14.2%	-14.7%	-15.2%	-4.0p	-0.5p	-0.4p

Notes: New energy includes solar photovoltaics, wind, biomass, solar heat, and geothermal, etc.
Self-sufficiency rate is based on IEA standard.

Primary energy supply

Primary energy supply will decrease in FY2020 for the third straight year. CO_2 emissions will decline for the seventh straight year, though with an annual fall slipping below 1% for the second straight year.

In FY2019, primary energy supply in Japan will decrease by 0.4% from the previous year on a decline in production by machinery and other manufacturers, despite more heating demand after a warmer winter in the previous year. In FY2020, it will fall by 0.4% on an ethylene production drop and energy efficiency improvements, despite a recovery in production by machinery and other manufacturers.

New energy including solar, wind and biomass energies will increase as massive non-residential solar PV plants approved under the FIT scheme launch power generation before the deadlines of March 2020 for those with capacity at less than 2 MW and September 2020 for larger ones. The FIT guarantee period will be shortened for those failing to meet the deadlines. New energies will account for 5% of total primary energy supply in Japan in FY2019 and for 6% in FY2020.

Nuclear power generation will decline by 1.9% in FY2019 as regular plant checks increase in the absence of new plant restarts. In FY2020, four nuclear plants will restart operation, but three others will halt operation on a delay in the completion of counterterrorism facilities. Nuclear power generation will increase by 4.2% (63.5 TWh), managing to rise beyond the FY2018 level.

Oil will limit its fall in FY2019 to 1.2%, the slowest since FY2013, as more heating demand after a warmer winter in the previous year and an ethylene production increase mitigate the effects of sluggish industrial production, energy efficiency improvements and fuel switching. In FY2020, it will decrease by 2.4% for the eighth straight annual drop as both final oil consumption and oil-fired power generation decline. Oil's share of Japan's total primary energy supply will less than halve from 75.5% at the time of the first oil crisis to 37.6%.

Coal will decline by 0.4% in FY2019 as supply for both power generation and industrial production decreases. In FY2020, it will increase by 2.3% as supply for both purposes expands on the launching of commercial operations at new coal-fired power plants and a crude steel production rise. Two new coal-fired plants with capacity totalling 1.6 GW in the second half of FY2019 and five more with capacity totalling 25.5 GW will go on stream in FY2020.

Natural gas will decrease by 0.7% mainly for power generation in FY2019 as renewable energy expands. LNG imports will slip below 80 million tons for the first time since the Great East Japan Earthquake. In FY2020, it will fall for the fourth straight year despite an increase in supply for city gas production as coal-fired, renewable energy and nuclear power generation increase. However, the year's supply will still be 9.3% more than in FY2010 before the Great East Japan Earthquake triggered massive natural gas supply.

Japan's energy self-sufficiency rate will rise by 0.2 points in FY2019 and by 0.4 points in FY2020 to 12.5%. However, the growth will be slower than in the past three years.

Japan's energy-related CO_2 emissions will decrease by 0.6% to 1,053 Mt in FY2019 and by 0.5% to 1,048 Mt in FY2020, slipping below 1,050 Mt for the first time since FY1990 when comparative data began to be statistically available. The FY2020 emissions will represent a 15.1% decline from the standard year of FY2013 for the Paris Agreement, meaning that Japan will attain 60% of its target cut of 25% in energy-related CO_2 emissions from FY2013 to FY2030.

Table4 | Primary energy supply

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Primary energy supply (Mtoe)	515.9	463.1	465.1	456.1	454.1	452.3	-1.9%	-0.4%	-0.4%
Coal	119.1	121.9	123.7	121.2	120.7	123.5	-2.0%	-0.4%	2.3%
Oil	212.0	187.6	185.5	176.3	174.2	170.1	-4.9%	-1.2%	-2.4%
Natural gas	95.7	114.7	111.4	106.4	105.6	103.0	-4.5%	-0.7%	-2.4%
LNG imports (Mt)	70.6	84.7	83.9	80.6	79.0	77.0	-4.0%	-1.9%	-2.5%
Hydro	17.7	16.6	17.5	16.9	16.9	17.1	-3.4%	0.0%	1.0%
Nuclear	60.7	3.7	6.8	13.5	13.2	13.8	97.3%	-1.9%	4.2%
New energy, etc.	10.7	18.7	20.2	21.8	23.4	25.0	8.2%	7.2%	6.7%
Self-sufficiency rate	20.2%	8.2%	9.5%	11.8%	11.8%	11.8%	2.3p	0.0p	0.0p
Energy intensity (FY2011=100)	105.1	89.1	87.8	85.9	84.9	84.1	-2.2%	-1.1%	-0.9%
Energy-related CO_2 emissions ($MtCO_2$)	1,137	1,129	1,110	1,060	1,053	1,048	-4.5%	-0.6%	-0.5%
Change from FY2013	-7.9%	-8.6%	-10.1%	-14.2%	-14.7%	-15.2%	-4.0p	-0.5p	-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)

Electricity sales in FY2020 will increase gradually for the second straight year as industrial sales rise on a manufacturing production pickup, though with residential sales falling slightly on the spread of energy efficient appliances. Non-fossil electricity sources' share of the power generation mix will expand beyond 27%, with the renewable energy share widening far faster than the nuclear share.

In FY2019, electricity sales growth will be limited to 0.1%. Sales to lighting service users will increase by 0.9% due to a colder winter than in the previous year. Sales to power service users will decline by 0.2% as steel and automobile production stagnates.

In FY2020, electricity sales will increase by 0.4%, but fall short of restoring the level for FY2017 that featured a global economic pickup and a colder winter in Japan. Sales to lighting service users will fall by 0.4% due to a hotter summer in the previous year and the diffusion of solar PV power generation and energy-saving products such as light-emitting diode lamps, despite progress in the electrification of heating and cooking. Electricity sales to power service users will increase by 0.7% thanks to a pickup in steel and automobile production.

Although the period for utilities' purchase of electricity from renewable energy under the FIT scheme began to expire in November 2019, the diffusion or retirement of storage batteries and electrification equipment may fail to make any rapid progress, with traditional utilities and new power producer/supplier companies purchasing solar PV electricity mainly within a JPY8-12/kWh tariff range. The expiration may thus exert little impact on electricity sales to lighting service users.

The electricity retail deregulation led power producer/supplier companies' share of total electricity sales to rise from 5.2% in April 2016 to 16.0% in August 2019. Such share rose to 16.5% for lighting service users and 13.3% for low voltage users, while levelling off at 23.1% for high voltage users and 5.6% for extra-high voltage users.

Nuclear energy's share of total power generation will level off through FY2020 as the effects of four nuclear plants' restart are offset by that of three plants' shutdown to be caused by a delay in the completion of their counterterrorism facilities. Massive non-residential solar PV plants approved under the FIT scheme will launch power generation under a rule that would shorten the FIT electricity guarantee period for FIT-approved plants failing to start operation by the deadlines in 2020. As a result, zero-emission power sources' share of total power generation will increase to 27.2%, still 11p lower than 38.2% for FY2010 before the Great East Japan Earthquake affected nuclear power generation.

While many coal-fired power plants are decommissioned in FY2019, new plants with capacity equivalent to 9% of total capacity at the end of FY2019 will launch commercial operation in or after the second half of FY2019 (two plants (Matsuura Unit 2 and Noshiro Unit 3)) with capacity at 1.6 GW will launch commercial operation in the second half of FY2019 and five plants (Takehara Unit 1, Kashima Unit 2, IGCC Nakoso, Kushiro and Hitachinaka Kyodo Unit 1) with capacity at 2.55 GW in FY2020). Consequently, coal's share of total power generation will rise by 0.9p to 28.7% in FY2020. The share for oil, etc. will level off as a 0.62 GW city gas-fired power plant starts commercial operation at the end of March 2020 after another's launching at the end of September 2019, despite a decline in power plants fired by fuel oil C and crude oil. LNG's share will fall to 36.3% in FY2020 due to an increase in other power generation sources. The share will still be 7 points higher than 29.3% in FY2010 before the Great East Japan Earthquake affected nuclear power generation and led to a sharp rise in LNG-fired power generation.

Table5 | 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	853.6	856.7	-1.2%	0.1%	0.4%
Lighting service	304.2	271.8	279.3	270.3	272.7	271.6	-3.2%	0.9%	-0.4%
Power sercice	(622.4)	578.7	583.9	582.2	580.9	585.1	-0.3%	-0.2%	0.7%
Extra-high and High voltage	(576.5)	540.3	544.9	544.6	543.5	547.6	0.0%	-0.2%	0.8%
Low voltage	(45.9)	38.5	39.0	37.6	37.5	37.5	-3.5%	-0.4%	0.1%
Electricity generated and purchased (TWh)	(1,028)	963.5	973.7	956.7	955.9	959.2	-1.7%	-0.1%	0.3%
Hydro	8.5%	8.7%	9.3%	9.1%	9.1%	9.2%	-0.1p	0.0p	0.1p
Fossil fuels	(62%)	83%	80%	75%	74%	73%	-4.2p	-1.3p	-1.4p
Coal	(25%)	29%	29%	28%	28%	29%	-0.8p	-0.6p	0.9p
LNG	(29%)	43%	41%	39%	38%	36%	-1.5p	-0.8p	-2.2p
Oil, etc.	7.5%	11%	9.6%	7.7%	7.8%	7.7%	-1.9p	0.1p	-0.1p
Nuclear	(29%)	1.8%	3.2%	6.5%	6.4%	6.6%	3.3p	-0.1p	0.2p
Renewables (excluding hydro), etc.	1.1%	6.7%	7.8%	8.9%	10%	11%	1.1p	1.4p	1.1p

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 to power utilities will substantially increase through FY2020. Those to manufacturing users will expand on a pickup in manufacturing production. Due to temperature changes and the deceleration of fuel switching to city gas, however, overall city gas sales in FY2020 will fail to restore the past peak.

City gas sales[1] in FY2019 will level off from the previous year as increases in sales for residential users and power utilities counter decreases in those for commercial, manufacturing and other users. In FY2020, city gas sales will expand by 2.0% to 42.4 billion m^3 thanks to a further rise in those for power utilities and an increase in those for manufacturing users amid a manufacturing production pickup. Due to a warmer winter than in FY2017 and the deceleration of fuel switching to city gas, however, FY2020 sales will fall short of the past peak recorded in FY2017.

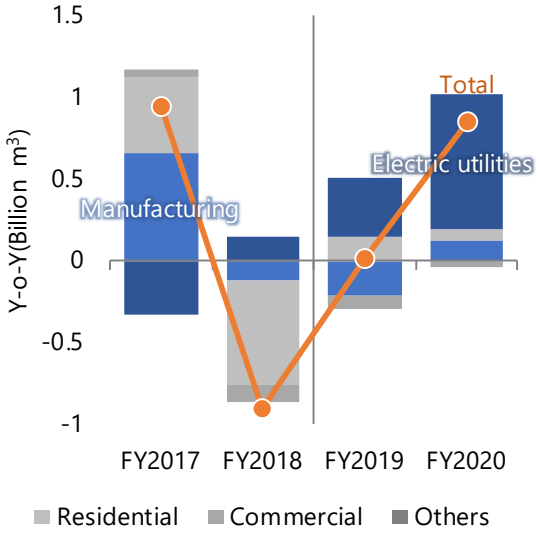
Of residential sales, those for cooking will continue decreasing due to the spread of induction heating cookers. Those for water and space heating will come under downward pressure from the diffusion of more energy efficient water heaters and all-electric homes but will increase due to lower summer and winter temperatures in FY2019 and FY2020 than in FY2018. Overall residential sales will thus rise both in FY2019 (up 1.6%) and FY2020 (up 0.7%).

Business sales (commercial and other sales) will follow a downtrend on the continued spread of energy-efficient equipment. They will decrease for the third straight year (commercial sales will fall by 1.9% in FY2019 and by 1.0% in FY2020 and other sales by 5.9% and 3.7%) as air-conditioning demand declines on lower summer temperatures in FY2019 and FY2020 than the previous year.

Industrial sales in FY2019 will increase by 0.6%. Those for manufacturing users will fall by 1.0% on stagnant steel and automobile production. After the Mooka thermal power station's Unit 1 (with capacity at 620 MW) launched operation at the end of the first half of FY2019, however, those to power utilities will expand by 360 million m^3 or 8.1%. After the power station's Unit 2 (with the same capacity) starts operation at the end of FY2019, they will increase by 820 million m^3 or 17.4%. In addition, those for manufacturing users will rise by 0.6% on a production pickup, leading overall industrial sales to go up for the seventh straight year. Most of the total sales growth will be attributable to the industrial sales. In the absence of plans to launch large city gas-fired power plants, however, industrial sales growth will peak in FY2020.

Under the full deregulation of city gas retail sales, new gas suppliers' share of city gas sales rose from 8.2% in April 2017 to 14.9% in August 2019. Such share for industrial sales levelled off at 19.5% before resuming an uptrend in the past three months. New gas suppliers' share came to 8.7% for residential sales in two years and a half after the full deregulation and to 4.0% for commercial sales, continuing to rise robustly.

Fig.2 | Changes in city gas sales



[1] 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	41.58	42.43	-2.1%	0.0%	2.0%
Residential	9.79	9.41	9.88	9.24	9.39	9.47	-6.4%	1.6%	0.7%
Commercial	4.75	4.32	4.37	4.26	4.18	4.13	-2.5%	-1.9%	-1.0%
Industrial	21.61	24.20	24.52	24.54	24.69	25.63	0.1%	0.6%	3.8%
Manufacturing	(20.28)	19.63	20.29	20.16	19.95	20.07	-0.6%	-1.0%	0.6%
Electric utilities	(1.34)	4.56	4.24	4.38	4.74	5.56	3.4%	8.1%	17.4%
Others	3.13	3.61	3.71	3.53	3.33	3.20	-4.7%	-5.9%	-3.7%

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, dropping by one-third from the peak in FY1999. Gasoline will be the largest decrease among fuel oil categories for the first time in eight years.

Fuel oil sales in FY2019 will decrease by 1.1% from the previous year due mainly to a drop in oil-fired power generation, vehicle fuel efficiency improvements and switching to other fuels, although heating demand will rise after a warmer winter in the previous year. In FY2020, jet fuel and diesel oil sales will remain firm, but naphtha sales will decline on more regular check-ups on petrochemical plants, with heavy fuel oil C sales for power generation plunging further. Overall fuel oil sales in FY2020 will decrease by 2.5% for the eighth straight year of decline, falling by one-third from the peak of 46 million kL in FY1999.

Gasoline sales will continue a downtrend on growth in hybrid, mini and other fuel-efficient vehicles. They will decrease by 2.3% to less than 50 million kL in FY2019. In FY2020, they will fall by 2.6%, posting the largest drop among fuel oil categories for the first time in eight years. From the peak of 61 million kL in FY2004, gasoline sales will decline by more than 20%.

Naphtha sales will be relatively brisker than other fuel oil sales because of their less vulnerability to energy efficiency improvements or fuel switching. In FY2019, naphtha sales will increase by 1.0% as ethylene production grows on export expansion thanks to less regular check-ups on ethylene plants. Due to more regular check-ups, however, they will decrease by 2.7% in FY2020.

Kerosene sales in FY2019 will increase by 4.1% as heating demand expands after a warmer winter in the previous year. In FY2020, they will drop by 0.5% due to fuel switching to city gas and electricity, despite a rise in heating demand.

Diesel oil sales increase by 0.3% in FY2019 and by 0.2% in FY2020 as an increase in demand for cargo traffic through internet sales and consumer-to-consumer sales and a rise in diesel vehicle ownership more than offset the effects of fuel and transportation efficiency improvements for trucks.

Heavy fuel oil A sales will drop by 4.9% in FY2019 and by 4.5% in FY2020 due to fuel switching to city gas in industry and commercial sectors. While the International Maritime Organization (IMO) toughens a regulation on the SO_x content in ship fuel from April 2020, a transition from high-sulphur heavy fuel oil C to low-sulphur heavy fuel oil C will be smooth, without little heavy fuel oil C being replaced with heavy fuel oil A or diesel for ship fuels.

Heavy fuel oil B/C sales for industrial use will keep on decreasing due to progress in fuel switching and energy efficiency improvements. Those for power generation will substantially decline on the shutdown or retirement of oil-fired power plants. Total heavy fuel oil B/C sales will plunge by 14.7% in FY2019 and by 16.4% in FY2020, posting a double-digit decline for the eighth straight year and sinking to less than a quarter of the FY2012 level that was the highest after the Great East Japan Earthquake.

LPG sales will increase by 0.7% in FY2019 as residential demand increases on temperature changes and demand for LPG for petrochemicals rises on an increase in ethylene plant operations. In FY2020, they will decline by 1.3% due to fuel switching to electricity or city gas in the buildings and industry sectors.

Crude oil throughput will decrease by 0.2% in FY2019 and by 1.9% in FY2020 on a fall in fuel oil sales, posting a four-year consecutive decline. In FY2020, it will slip below 3 million barrels per day for the first time since FY1987 to a far lower level than the current atmospheric distillation capacity at 3.52 million bpd.

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	167.7	165.8	161.7	-4.1%	-1.1%	-2.5%
Gasoline	58.2	52.5	51.8	50.6	49.5	48.2	-2.3%	-2.3%	-2.6%
Naphtha	46.7	44.8	45.1	43.9	44.3	43.1	-2.6%	1.0%	-2.7%
Jet fuel	5.2	5.3	5.0	5.0	5.0	5.0	-1.2%	0.4%	0.3%
Kerosene	20.4	16.3	16.6	14.5	15.1	15.0	-12.9%	4.1%	-0.5%
Diesel oil	32.9	33.3	33.8	33.8	33.9	34.0	-0.1%	0.3%	0.2%
Heavy fuel oil A	15.4	12.0	11.5	11.1	10.5	10.1	-4.0%	-4.9%	-4.5%
Heavy fuel oils B and C	17.3	12.8	10.8	8.8	7.5	6.3	-18.5%	-14.7%	-16.4%
For electric utilities	7.7	7.9	6.0	4.0	3.5	2.6	-34.3%	-12.8%	-25.0%
For other users	9.7	4.8	4.8	4.9	4.1	3.7	1.3%	-16.2%	-9.1%
LPG sales (Mt)	16.5	14.4	14.8	14.2	14.3	14.1	-4.1%	0.7%	-1.3%
Crude oil throughput (GL)	208.9	190.6	184.2	176.7	176.3	173.0	-4.1%	-0.2%	-1.9%

Renewable power generation (FIT power source)

Renewable power generation capacity will reach 83 GW, while the FIT scheme begins to expire.

Renewable power generation capacity approved under the FIT scheme reached 105 GW in March 2017. As a deadline was set for making approved capacity operational for grid connection contracts, however, approval for some capacity including non-residential solar PV facilities (such as mega-solar plants) was cancelled, leading the approved capacity to fall to 89 GW (including 71.8 GW for solar PV, 7.3 GW for wind and 8.6 GW for biomass) in June 2019.

If all the approved capacity of 89 GW, including already operational and transferred facilities [2], is operational, the cumulative burden on consumers will reach an estimated JPY60 trillion [3].The estimated burden amounts to an electricity rate hike of JPY3,400/MWh, or 15% for residential users and 21% for industrial users. However, the estimated burden represents a substantial fall from JPY70 trillion for the peak approved capacity including a cancelled portion, indicating that the revised FIT Act for such cancellation can be assessed as having made some achievement. If about 2 GW in approved biomass capacity expected to be cancelled due to barriers to long-term stable fuel supply is excluded, however, the estimated burden may be lowered to JPY46 trillion.

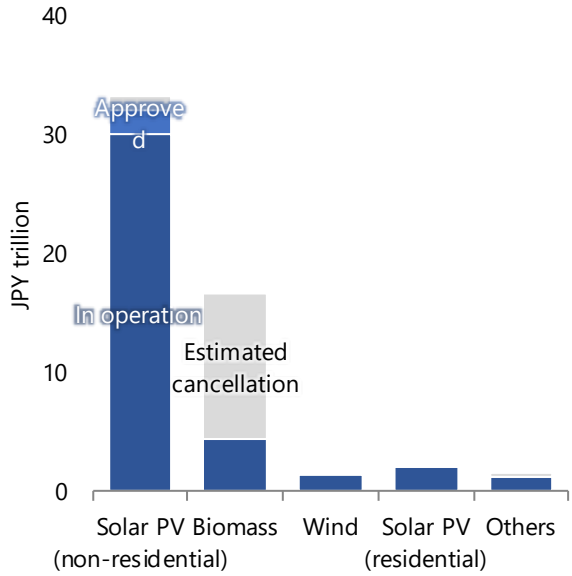
Installed renewable power generation capacity (including capacity for which the FIT scheme has expired) will reach 82.7 GW at the end of FY2020. Massive renewable energy power plants approved under the FIT scheme launch operation before the deadlines of March 2020 for those with capacity at less than 2 MW and September 2020 for larger ones because the FIT guarantee period is planned to be shortened for those failing to meet the deadlines. After decelerating growth in recent years, non-residential solar PV capacity will accelerate expansion and reach 50.9 GW in FY2020. As a long time is required for launching wind power generation after approval because of environment assessment and other procedures, wind generation capacity will be limited to 4.4 GW. Renewable energy-based power generation in FY2020 will total 152.3 TWh (including 76.2 TWh for solar PV, 39.6 TWh for small and medium-sized hydroelectric plants, 30.2 TWh for biomass and 8.2 TWh for wind), accounting for 15% of Japan's total power generation.

Business services for third parties' purchases of surplus electricity from residential solar PV panels and for the promotion of panel owners' consumption of such electricity started in FY2019 when the FIT guarantee began to expire and are expected to continuously spread. A government advisory panel on the fundamental revision of the FIT Act by the end of FY2020 is considering integrating large solar PV and wind power plants into the electricity market based on the FIP(feed-in premium). It will be important to make renewable energy competitive and a major power source that would remain stable over a long time.

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

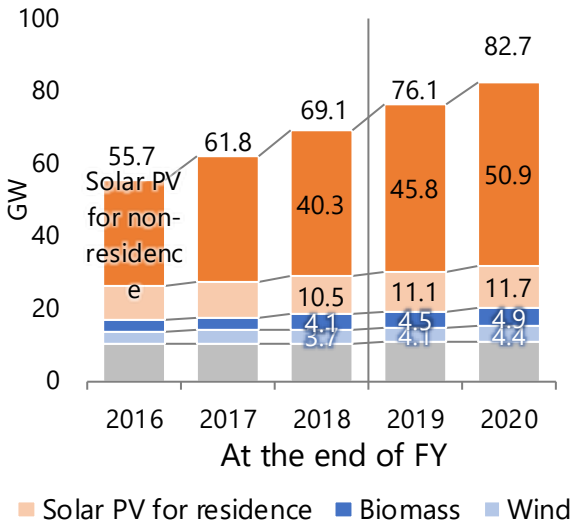
[3] The remaining FIT periods for transferred facilities are taken into consideration. The avoidable cost has been estimated by the IEEJ, based on various documents. The capacity factor is assumed at 20% for wind, 12% for solar PV, 70% for geothermal energy, 45% for hydro and 70% for biomass.

Figure3 | Cumulative burden of FIT scheme over purchasing period (capacity approved or in operation at the end of June 2019)



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

Figure 4 | Installed FIT power generation capacity (based on operation)



Note: Including capacity subject to FIT contract expiration

Topic [1] Residential energy consumption by use

Residential energy consumption will increase in FY2019 for the first time in two years as space and water heating demand rises due to colder winter. In FY2020, it will fall slightly due to the spread of energy-efficient appliances and an energy-saving mindset.

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Since the Great East Japan Earthquake, the spread of energy-efficient appliances and an energy-saving mindset has outdone the effect of an increase in the number of households on residential energy consumption. Over a short term, however, it is sensitive to temperature changes.

Residential energy consumption has continued a downtrend since the Great East Japan Earthquake as an energy intensity decline through the spread of energy-efficient appliances and an energy-saving mindset has outdone the effect of an increase in the number of households. In FY 2019, however, such energy consumption will increase by 2.0% from the previous year due to colder winter, indicating its short-term sensitivity to temperature changes. In FY2020, residential energy consumption will decline by 0.2% from the previous year due to progress in energy conservation, posting an average annual decrease of 1.3% from FY2010 before the earthquake greatly affected the energy situation in Japan.

Consumption for cooling will decrease due to lower summer temperatures in FY2019 and FY2020.

While air conditioner efficiency has been improving at an annual rate of 0.1%, air conditioner ownership ratio has been rising. Over a short term, energy consumption for cooling is influenced by summer temperature changes. In FY2018, cooling energy consumption shot up 42.4% from the previous year on record summer temperatures. Cooler summer will lead cooling energy consumption to decline by 9.3% in FY2019 and by 11.3% in FY2020.

Consumption for space and water heating will increase on lower winter temperatures in FY2019 and FY2020.

Space heating accounts for 30% of residential energy consumption and concentrates in cold regions. Space heating energy consumption is greatly influenced by colder winter over a short term and is expected to increase by 7.7% in FY2019 and by 1.5% in FY2020 due to warmer winter. For space heating, consumers have been switching from oil heaters to air conditioners with heating options. Kerosene's share of energy consumption for space heating will slip below 50% in FY2020 from more than 60% in FY2010. Electricity's share will rise to more than 30% in FY2020 from 22% in FY2010, indicating that space heating will record the fastest electrification among residential energy consumption components.

While city gas and LPG account for two-thirds of residential energy consumption for water heating, the diffusion of electrical water heaters and EcoCute heat pumps represents progress in the electrification of water heating energy consumption. Residential water heating energy consumption is influenced by temperature changes particularly in winter or changes in the number of heating degree days. It will rise by 2.3% in FY2019 and by 0.5% in FY2020.

Consumption for cooking per household will fall for the 10th straight year due to lifestyle changes.

Residential energy consumption for cooking will almost level off with a 0.1% loss in FY2019 and with a 0.1% gain in FY2020 as the spread of eating-out practices and home-meal replacements and the improvement of cooking efficiency offset the effect of an increase in the number of households on such consumption. Cooking energy consumption per household will decrease in FY2020 for the 10th straight year. The spread of induction heating cookers will lead cooking electricity consumption to increase at an annual rate of 2.8% from FY2010 to FY2020, with electricity's share of cooking energy consumption rising from 21% to 29%. In contrast, cooking LPG consumption will fall at an annual rate of 2.4%, with LPG's share of cooking energy consumption declining from 43% to 35%.

Consumption for power, etc. will decrease on the spread of energy-efficient appliances.

Residential energy consumption for power, etc. has followed a downtrend due to the spread of an energy-saving mindset as well as energy efficiency improvements through switching from fluorescent and incandescent lamps to more energy-efficient light-emitting diode lamps. Power, etc. energy consumption will decrease by 1.2% in FY2019 and FY2020, posting an average annual decline of 1.7% from FY2010 to FY2020. On a per household basis, power, etc. energy consumption, as well as cooking energy consumption, will drop in FY2020 for the 10th straight year.

Table 8 | Residential energy consumption by use

	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Residential(Mtoe)	53.96	47.88	49.85	46.61	47.52	47.45	-6.5%	2.0%	-0.2%
Space cooling	1.53	1.11	1.05	1.49	1.35	1.20	42.4%	-9.3%	-11.3%
Space heating	15.11	13.11	15.06	12.45	13.40	13.61	-17.4%	7.7%	1.5%
Water heating	14.91	13.51	13.43	12.98	13.26	13.32	-3.4%	2.2%	0.4%
Cooking	4.41	4.20	4.22	4.20	4.19	4.20	-0.6%	-0.1%	0.1%
Power, etc	18.00	15.96	16.09	15.50	15.31	15.13	-3.7%	-1.2%	-1.2%
Number of households (Million)	53.78	57.48	58.01	58.93	59.52	60.12	1.6%	1.0%	1.0%

Topic [2] Impacts of ship fuel sulphur content regulation

From January 2020, 30% of heavy fuel oil C will be substituted by fuel adapted to the IMO regulation. In FY2020, SO_x emissions from domestic Japanese vessels will be cut by 79 Mt at a cost of JPY140-380/MtSO_2.

The International Maritime Organization (IMO) will implement a tougher ship fuel SO_x content regulation in January 2020. The maximum allowable sulphur content in fuel for all ocean-going and domestic vessels including existing ones in all regions will be cut from 3.5% to 0.5%. As the sulphur content in heavy fuel oil C used for domestic Japanese vessels ranges from 1.0% to 3.0%, Japan is required to make responses to the tougher IMO regulation.

There are the following three options responding to the tougher IMO regulation for vessels:

① Switching to very low-sulphur heavy fuel oil C with sulphur content of up to 0.5% (hereinafter referred to VLSFO)

② Installing scrubbers to make high-sulphur heavy fuel oil C available for vessels

③ Switching to LNG-powered vessels

In Japan, the first option of switching to VLSFO may be selected mainly for domestic (small) vessels and the second option of installing scrubbers for ocean-going (large) vessels from the viewpoint of economic efficiency. The third option of building LNG-powered vessels will be difficult to select because of high costs and fuel supply infrastructure constraints over a short term.

Stable adapted fuel supply is promising. Supply for domestic vessels is projected at 2.15 GL for FY2020.

While various advisory panels have considered responses to the tougher regulation based on knowledge gained from tests through public and private sector efforts, petroleum products wholesalers have introduced or expanded desulphurisation and heavy crude oil cracking systems at their refineries to produce and sell VLSFO. Shipping companies test-operated domestic vessels with VLSFO and confirmed that there would be no problem with fuel switching and safe operation for all vessels. In the absence of major troubles in the present transition to the tougher regulation, Japan has been prepared to supply VLSFO stably and secure safe operation before the tougher IMO regulation is implemented.

VLSFO will account for 0.71 GL of 3.17 GL in fuel oil sales for domestic vessels (cargo and passenger vessels) in FY2019 and for 2.15 GL of 3.09 GL in FY2020. VLSFO will thus capture 30% of total domestic heavy fuel oil B and C sales and more than 50% of those excluding sales for power generation in FY2020. The abovementioned test operation confirmed that there would be no safety problems with mixing high-sulphur fuel oil with VLSFO in vessels' fuel tanks. A plan to switch to heavy fuel oil A in the event of concern about safety did not have to be adopted. All heavy fuel oil C for domestic vessels will thus be substituted by VLSFO.

Table 9| The sales for VLSFO in the vessel (freight and passenger)

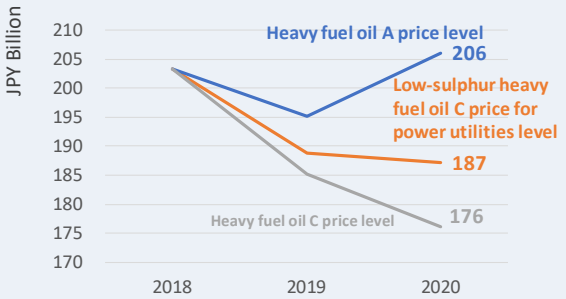
	Historical				Projection		Year-over-year		
	FY2010	FY2016	FY2017	FY2018	FY2019	FY2020	FY2018	FY2019	FY2020
Freight (billion ton-km)	179.7	180.2	180.7	178.8	174.9	175.5	-1.1%	-2.2%	0.4%
Passenger (billion passenger-km)	3.0	3.3	3.2	3.1	3.0	3.0	-2.5%	-2.4%	-2.4%
Fuel oil consumption（10ML)	348.6	336.9	329.8	327.6	316.7	308.7	-0.7%	-3.3%	-2.5%
Heavy fuel oil C + VLSFO	248.2	236.1	230.3	230.2	220.8	214.9	0.0%	-4.1%	-2.7%
Heavy fuel oil C (HSC fuel oil)	248.2	236.1	230.3	230.2	149.4	0.0	0.0%	-35.1%	-100.0%
VLSFO (LSC fuel oil)	-	-	-	-	71.4	214.9	..	..	201.0%
Heavy fuel oil A	100.4	100.7	99.5	97.4	95.9	93.8	-2.1%	-1.5%	-2.2%

Note Although VLSFO contents lower sulphur and viscosity, it will be categorized in heavy fuel oil C.
In parts of fuel oil sales, VLSFO is included in heavy fuel oils B and C for other users, it is separately shown from heavy fuel oil C.

Fuel costs in FY2020 will rise by 6.3-17.1%, with SO_x reduction costs being at JPY140-380/$MtSO_2$

The price of VLSFO sales from wholesalers to domestic vessel operators may be set at the low-sulphur heavy fuel oil C price for power utilities plus the middle distillate value, a shipping facility expansion cost and some other costs. (1) If the VLSFO price is equivalent to the low-sulphur heavy fuel oil C price for power utilities, fuel costs for domestic vessels will increase by JPY3.6/L or JPY11.1 billion (6.3%). (2) If the VLSFO price rises to the heavy fuel oil A price level due to a tighter supply-demand balance, the fuel costs will soar by JPY9.8/L or JPY30.1 billion (17.1%).

Figure 5| Fuel costs of vessels

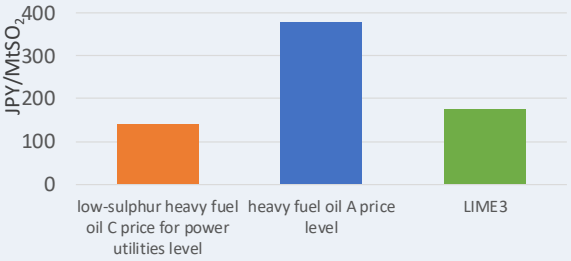


Sulphur contents in high-sulphur heavy fuel oil C differ by company or region. If the present average sulphur content is a refinery's representative level of 2.2%, with the sulphur content standing at 0.3% for VLSFO, the SO_x emission reduction rate will come to 86%, with the SO_x emission cut for domestic vessels standing at 79 Mt in terms of SO_2.

If the VLSFO price is within a range between cases (1) and (2) above, SO_x emission reduction costs are estimated at (1) JPY140/$MtSO_2$ for the VLSFO price equivalent to the low-sulphur heavy fuel oil C price for power utilities and at (2) JPY380/$MtSO_2$ for the VLSFO price equivalent to the low-sulphur heavy fuel oil A price. In Japan, a fuel cost increase arising from SO_x emission cuts will be added to fares and passed on to shippers or passengers. Finally, the cost hike will be shouldered by society or consumers.

According to the Life cycle Impact assessment Method based on Endpoint modelling 3 (LIME3)[4], for example, external cost for avoiding health damage by air pollution with SO_2 stands at \$1,581/tSO_2[5]. If a fuel cost increase for domestic vessels is held down to JPY13.8 billion (7.9%) or less, social benefits will be achieved.

Figure 6| SO_x reduction costs of vessels in FY2020



Keep paying attention to future fuel oil market and ship transportation trends

As VLSFO demand has increased globally due to the tougher IMO regulation, VLSFO prices have risen close to diesel oil price levels in some countries. VLSFO production and diesel oil exports for overseas demand will thus be promoted, leading middle distillates for domestic demand to be redirected for overseas demand. A tighter supply-demand balance for diesel oil and kerosene in Japan could exert upward pressure on ground transportation costs and heating oil prices.

A decline in the market value of high-sulphur heavy fuel oil C could lead to surplus heavy fractions and their price falls, widening price gaps between VLSFO and high-sulphur fuel oil C. While initial investment in scrubbers is recovered over a short term, the option of switching to VLSFO could become unfavourable for competition.

Since switching to VLSFO does not contribute to cutting other gas emissions like CO_2, separate investment in CO_2 emission cuts may be required. Shipping companies may thus have to promote software measures such as more efficient operation and allocation of ships, hardware measures including the introduction of more energy-efficient equipment and the replacement of outdated ships and switch to LNG as fuel. It is important to closely pay attention to IMO-related changes in the ship fuel market and take timely, adequate measures.

[4] N. Itsubo and A. Inaba (2018) "LIME3 – Environmental Impact Assessment Approach to Realize Global-scale Life Cycle Assessment": This approach was developed by the Research Centre for Life Cycle Assessment at the National Institute of Advanced Industrial Science and Technology under a national LCA project. It determines global warming, air pollution and other environmental damage for each of the endpoints such as human health to integrate environmental impacts.

[5] It should be noted that although the estimation target here is limited to domestic vessels, SO_2 emission reduction costs for the whole of Japan are used.

Topic [3] Effects of counterterrorism facility completion and nuclear plant restart delays

Nuclear energy contributes greatly to 3Es

This chapter assesses the impacts on the so-called 3Es (energy security, environmental friendliness and economic efficiency) of nuclear power generation changes.

In the Reference Scenario, the number of operational nuclear power plants will increase from nine at present to 10 at the end of FY2020 as four more plants are restarted, with three operational ones shut down due to a delay in the completion of their counterterrorism facilities by their respective deadlines. In addition to the Reference Scenario, we have developed the High Case in which the three operational ones will avoid the shutdown with their counterterrorism facilities completed by the deadlines and the "Low Case" in which the four plants planned to restart in FY2020 will fail to do so. Based on the target power generation mix for 2030 in the Long-term Energy Supply and Demand Outlook by the Ministry of Economy, Trade and Industry, we have also developed the theoretical "Best Mix Case," setting the power generation mix share at 21% for nuclear, 23% for renewable energy and 56% for fossil fuels for FY2020.

Table 10 | 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	6	10	13	..	-4	+3	..
	Power generation (TWh)	48.7	63.5	71.4	225.6	-14.8	+7.9	+162.1
	Share in generation and purchases	4%	6%	7%	21%	-1p	+1p	+15p
Economy	Electricity unit cost[1] (JPY/kWh)	7.1	7.0	7.0	6.6	+0.1	-0.0	-0.4
	Fuel cost	4.2	4.1	4.0	3.2	+0.1	-0.0	-0.8
	FIT purchasing cost	2.9	2.9	2.9	3.3	0.0	0.0	+0.4
	Total fossil fuel imports (JPY trillion)	16.0	15.9	15.8	14.7	+0.1	-0.1	-1.1
	Oil	9.9	9.9	9.9	9.8	+0.0	-0.0	-0.1
	LNG	3.9	3.8	3.8	3.0	+0.1	-0.0	-0.9
	Trade balances (JPY trillion)	0.3	0.4	0.4	1.3	-0.1	+0.0	+0.9
	Real GDP (JPY2011 trillion)	540.0	540.1	540.2	541.5	-0.1	+0.1	+1.4
Energy and environment	Primary energy supply							
	Oil (GL)	186.5	186.0	185.7	183.2	+0.6	-0.3	-2.7
	Natural gas (Mt of LNG eq.)	80.8	79.1	78.2	62.0	+1.6	-0.9	-17.1
	Self-sufficiency rate	9.5%	10.4%	10.9%	20.2%	-0.9p	+0.5p	+9.9p
	Energy-related CO_2 (Mt)	1,054	1,048	1,045	960	+6	-3	-88
	Changes from FY2013	-14.7%	-15.2%	-15.4%	-22.3%	+0.5p	-0.3p	-7.1p

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

Regarding economic efficiency, the fossil fuel imports in the High Case are JPY0.06 trillion less than in the Reference Scenario and the value in the Best Mix Case is JPY1.13 trillion less. If crude oil and LNG prices rise due to international situation changes or any other factor, such import decline through the reduction of dependence on fossil fuels would be greater. As disposable income increases through the drop in payments for fossil fuel imports, real GDP in the High Case is JPY0.7 trillion more than in the Reference Scenario. Real GDP in the Best Mix Case is JPY1.36 trillion more.

The unit electricity cost is JPY50/MWh less in the High Case and JPY430/MWh less in the Best Mix Case. The gap for the Best Mix Case is limited as the higher FIT cost for the Best Mix Case reduces the effect of the smaller fuel cost.

As geopolitical risks are growing in the Middle East at present, interest has increased in energy security. The energy self-sufficiency rate, one of the representative energy security indicators, is 0.5 percentage points higher in the High Case and 9.9 points higher in the Best Mix Case.

CO_2 emissions indicating environmental friendliness are 3 Mt less in the High Case and 88 Mt less in the Best Mix Case. From FY2013 or the base year for Japan's emission reduction target[6] for the Paris

[6] Japan's target calls for cutting GHG emissions in FY2030 by 26% and energy-related CO_2 emissions by 25% from

Agreement, emissions in the High Case fall by 15.4% and those in the Best Mix Case decline by 22.3%.

Given that the deadlines for completing counterterrorism facilities will expire for more nuclear power plants in and after FY2020, the facilitation of nuclear plant restarts through functional examinations[7] is significant for Japan's 3Es.

FY2013 by mobilising the low-carbonisation of power generation discussed here as well as energy efficiency improvements and the low-carbonisation of final energy consumption.

[7] Functional examinations are implemented according to the different conditions of individual plants.

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