IEE JAPAN THE INSTITUTE OF ENERGY ECONOMICS, JAPAN

Economic and Energy Outlook of Japan through FY2019

Decelerating growth and growing disquiets

YANAGISAWA Akira, M. Aoshima, H. Arimoto, Y. Yorita, D.M. Kim, T. Ohira, Y. Shibata, S. Suehiro and K. Ito

Summary of economic and energy outlook [Reference Scenario]

Macro economy and production activity | Japanese economic expansion is slowing down, and FY2019 will end four years of growth exceeding 1.0%

In FY2018, the Japanese economy will slow down its expansion of domestic and foreign demand and grow by only 1.1%. The increase in energy prices will work as a downward force. In the absence of drivers to accelerate development in both domestic and foreign demand, the GDP growth will further decelerate to 0.9% in FY2019. Although the index of industrial production will experience its highest level since the Lehman shock, its year over year expansion will diminish to about 1%. The trade balance will fall to a deficit of JPY1.2 trillion due to a rise in energy prices in FY2018.

Energy supply and demand | Total primary energy supply declines from the FY2017, and CO_2 emissions continue their decrease since FY2014

Total primary energy supply in FY2018 will decrease (-0.8%) due to a slowdown from the previous year's high economic growth and severe winter. Although FY2019 will not react to the previous year's winter weather, its supply will decline by 0.2%, due to a slight slowdown of the economic/production activities combined with continued energy conservation. Natural gas supply reaches its lowest level since the Great East Japan Earthquake, and for the first time declines for three consecutive years. The shift from oil and natural gas to nuclear and renewable energy continues.

The final energy consumption of FY2018 will turn to a decrease of 1.1%, updating the lowest level since the peak in FY2000, and the overall decline in consumption for FY2019 will be 0.4%. Consumption in all sectors for both years will decrease. The energy-related CO_2 emissions will drop to 1,074 Mt in FY2019, or 13.1% less than in FY2013. The three main contributors to the reduction are a decrease in energy consumption (-5.9%) and increases in renewable energy (-3.2%) as well as nuclear (-2.5%).

Energy sales | Electricity remains unchanged, city gas turns to a decrease, and the decrease in fuel oil sales further expands in FY2018

Following the previous year's electricity consumption growth, the sales for FY2018 remain unchanged. Sales for lighting services will decrease due to the previous year's severe winter, the penetration of solar photovoltaic power generation and the increase in energy efficient appliances for lighting and in household electric appliances. Although space cooling demand will increase, sales for power services will expand at a slower pace because of the moderate growth of production in machinery industries. Electricity sales for FY2019 also remain unchanged in total from the previous year. Sales for lighting services will decrease slightly in a reaction to the heat wave of the previous summer, while sales for power services increase in response to the moderate expansion of production activities.

Total city gas sales in FY2018 will turn to a decrease (-0.3%) for the first time in three years. Sales to industry will increase because of a moderate growth in production and economic activities and because of fuel switching of industrial furnaces and boilers. On the other hand, sales to households decline in reaction to the

previous year's severe winter. Led by growing sales to industry, total sales for FY2019 will turn to an increase (1.0%) and will update the record high. This increment will largely come from sales to electric utilities.

In FY2018, total fuel oil sales decrease by 3.1% due to a significant reduction in sales of heavy fuel oil C (mainly to oil-fired power generation), a decrease in sales of gasoline (due to the penetration of fuel-efficient vehicles) and a decrease in sales of naphtha (due to the periodic maintenance of more ethylene plants than the previous year). Although FY2019 will experience increased sales of naphtha with less ethylene plants conducting periodic maintenance and a steady increase of diesel oil, total fuel oil sales will decrease (-1.3%) for the seventh consecutive year. This is caused by a continuous larger decrease in sales for gasoline and heavy fuel oil C (for power generation).

Table 1 | Summary of Reference Scenario

		Historical			Projection		Year-to-year changes		
		FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Energy	Primary energy supply (Mtoe)[1]	515.9	467.2	463.5	465.3	461.6	460.8	0.4%	-0.8%	-0.2%
	Oil[2] (GL)	232.2	211.6	205.1	202.6	196.3	193.6	-1.2%	-3.1%	-1.4%
	Natural gas[2] (Mt of LNG equiv.)	73.3	86.0	88.1	85.6	81.8	81.2	-2.8%	-4.4%	-0.7%
	Coal[2] (Mt)	184.7	190.1	188.0	190.7	189.8	190.1	1.4%	-0.4%	0.1%
	Nuclear (TWh)	288.2	9.4	17.3	31.3	62.5	65.4	80.8%	99.8%	4.6%
	Renewable electricity[3] (TWh)	111.1	149.0	149.5	165.0	171.8	179.9	10.4%	4.1%	4.7%
	FIT generation (TWh)	63.9	99.2	108.7	118.3	127.0	135.1	8.9%	7.3%	6.4%
	Final energy consumption[4] (Mtoe)	338.2	310.1	310.1	312.1	308.7	307.5	0.7%	-1.1%	-0.4%
	Industry[5]	158.7	146.9	146.4	147.5	145.9	145.7	0.8%	-1.1%	-0.1%
	Buildings	97.1	86.4	87.8	89.2	87.8	87.4	1.5%	-1.5%	-0.5%
	Transport	82.4	76.8	75.8	75.3	74.9	74.3	-0.7%	-0.6%	-0.8%
	Petroleum products	176.0	157.9	156.2	156.3	153.0	151.7	0.1%	-2.1%	-0.8%
	Natural gas and city gas	34.0	32.8	33.6	34.7	34.5	34.5	3.3%	-0.6%	0.1%
	Electricity	88.2	82.1	83.4	84.1	84.0	84.0	0.8%	-0.1%	0.0%
	Electricity sales[6] (TWh)	(926.6)	(837.5)	850.5	863.2	862.9	862.8	1.5%	0.0%	0.0%
	City gas sales[7] (Billion m³)	39.28	39.91	41.53	42.48	42.37	42.79	2.3%	-0.3%	1.0%
	Fuel oil sales (GL)	196.0	180.5	176.9	174.7	169.3	167.2	-1.2%	-3.1%	-1.3%
	Energy-related CO_2 emissions[4] (Mt)	1,135	1,147	1,128	1,112	1,083	1,074	-1.4%	-2.6%	-0.8%
	(FY2013=100)	91.9	92.9	91.3	90.0	87.7	86.9	..	..	..
Prices	Crude oil, import, CIF ($/bbl)	84	49	48	57	72	69	19.6%	26.1%	-4.0%
	LNG, import, CIF ($/MBtu)	11.3	8.7	7.0	8.5	11.0	10.7	20.5%	29.9%	-2.7%
	Steam coal, import, CIF ($/t)	114	76	81	102	111	95	26.4%	8.1%	-14.4%
	Coking coal, import, CIF ($/t)	175	88	111	146	146	122	31.8%	-0.1%	-16.9%
Economy	Real GDP (JPY2011 trillion)	492.9	518.3	524.4	533.0	538.8	543.9	1.6%	1.1%	0.9%
	Industrial production (CY2010=100)	99.4	97.5	98.5	102.5	103.7	104.8	4.1%	1.1%	1.0%
	Exchange rate (JPY/$)	86.1	120.4	108.4	111.1	111.5	114.8	2.4%	0.4%	2.9%
	Cooling degree days	560	322	431	397	453	380	-7.7%	14.1%	-16.2%
	Heating degree days	1,077	875	966	1,072	997	1,019	11.0%	-7.0%	2.2%

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. Estimated historical values for FY2017. 5. Industry includes non-energy use.

6. Figures in parentheses are old statistical figures. 7. Conversion factor: 1 m³ = 10,000 kcal

Renewable power generation | The FIT power generation capacity reaches 74 GW at the end of FY2019

The revised FIT Act came into force in April 2017. As the act now seeks for promotion with more economic rationality, the amount of approved capacity in FIT system is not expected to increase substantially. However, the facilities under construction and expected to start operation by the end of FY2019 will reach 73.9 GW combined with existing ones, including 43.6 GW of non-residential solar PV. The power generation will expand to 135.1 TWh in FY2019, equivalent to 13% of Japan's total generation. The consumer burden expands in exchange for promoting renewable energy generation. Out of the total approved of 105 GW, 25 GW are assumed as expired capacities or capacities which are unlikely to start operation, leaving a maximum of 80 GW to become operational. The cumulative amount of consumer burden for the entire purchase period will reach JPY50 trillion, equivalent to a rise in electricity prices of JPY2,900/MWh – 12% for the residential and 17% for the industry sector.

Topic | The uncertainty factors

1/ Nuclear power generation | Nuclear contributes significantly to achieving the 3Es

We analyse the impact of the nuclear power generation using the 3Es approach – economy, energy (stable supply) and environment. In the Reference Scenario, we assume a total of eleven nuclear power plants to restart by the end of FY2019 and in the High Case we assume additional five nuclear power plants. Between the High Case and the Reference Scenario, total spending on fossil fuel imports decreases by about JPY0.3 trillion, the self-sufficiency rate improves by 2.1% point, and the energy-related CO_2 emissions decline by as much as 13 Mt. Thus, the degree of utilisation of nuclear power generation has a significant impact of the improvement of the 3Es.

Figure 1 | Effect of the nuclear power generation [FY2019, compared with the Reference Scenario]
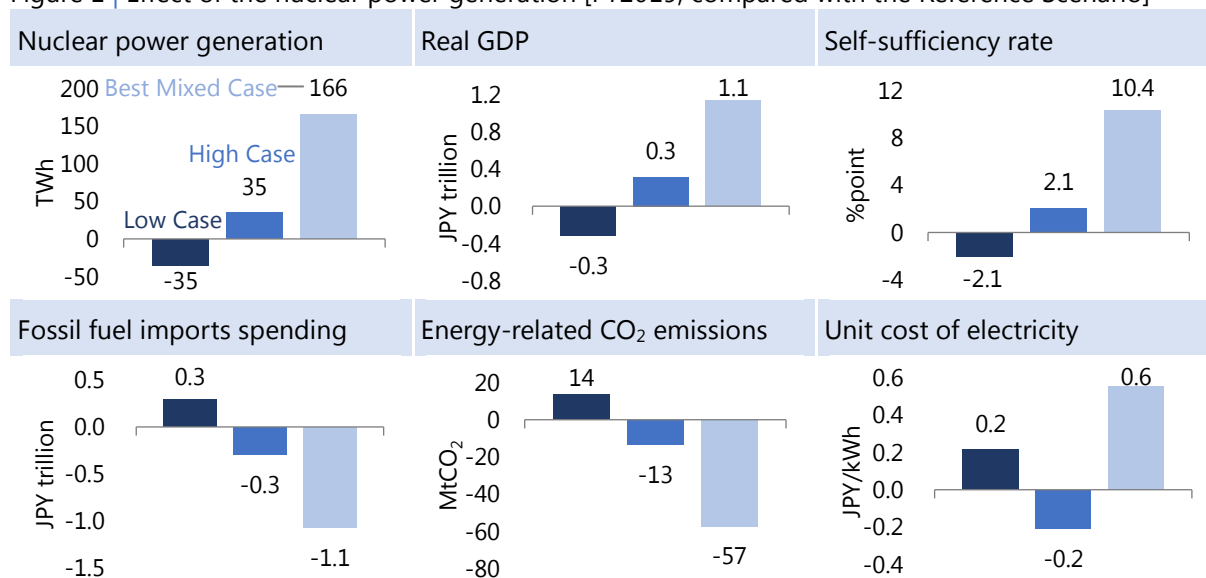
2/ Oil Prices | A rise in oil prices is a headwind to the Japanese economy

If oil prices increase by $10/bbl from the Reference Scenario and LNG prices increase accordingly, the growth of the Japanese economy would be held back by 0.2%. The additional payments for oil and natural gas imports could potentially amount to JPY2.7 trillion, which is larger than the tax revenue from a 1% VAT. Out of this amount, households would bear JPY600 billion, equivalent to an increased annual payment for each household of about JPY10,000; electricity (JPY5,000) and gasoline (JPY2,500).

Oil price increases cause economic slowdowns. A $10/bbl rise in oil prices would decrease each sales of electricity, city gas, and fuel oils and total primary energy supply by 0.3% to 0.4%.

3/ U.S. Trade Policy | Japan is more concerned over the imposition of tariffs on imported cars than over a U.S.-China trade war

If the U.S. imposes a 45% tariff on imports from China, as in President Trump's statement during the presidential election, and if China imposes the same rate in retaliatory duties, this would drop the U.S. economy and the Chinese economy by 2.1% and 2.9% respectively. The U.S. and Chinese oil consumption would decrease by 0.2 Mb/d and 0.3 Mb/d, and natural gas would fall by 13 Bcm and 6 Bcm respectively. Although such actions would push down the global economy by 0.6%, they would induce an incremental growth of 0.4% to the Japanese economy. This is because Japan plays the role of a substitute for both the U.S. and China in international trade. Japanese overall energy demand would increase a little due to the economic expansion, but coal consumption would decline slightly due to lower steel production for the less exports to Asia.

On the other hand, if Washington imposes a 20% tariff on imported cars, the production of automobiles and parts in the U.S. would benefit, but the U.S. economy would shrink by 0.4%. This would negatively affect the global economy and the Japanese economy by 0.2% and 0.1% respectively. The drop also works as a decreasing pressure on the Japanese energy demand with electricity sales decreasing the most, because the automobile manufacturing would be the starting point for the negative shock. By region, the impact on Middle and West Japan could be the worse because of the importance of the automobile manufacturing and steel industry (which supplies the automobile manufacturing) in those regions.

Introduction

The Japanese economy shrank in the first quarter of 2018, temporarily endangering its longest growth in 28 years. However, the overseas economy has continued robust growth. The global economy in 2017 posted a growth rate of 3.8%, the highest since 2011.

The international crude oil market has been recovering a supply-demand equilibrium as rebalancing has made progress under a coordinated production cut by OPEC and non-OPEC oil-producing countries. The recovery has been combined with growing geopolitical risks in the Middle East to push up oil prices.

By July 2018, Japan restarted nine nuclear power plants out of 25 plants for which applications were filed for examinations on their conformity with regulatory standards. Five plants have cleared the examinations while having yet to be restarted. In addition, the Tokai Daini Power Station is expected to clear the examinations in the near future.

Regarding renewable energy, Japan is set to face a 2019 problem on the expiration of 10-year contracts under which households have sold surplus electricity generated by their solar photovoltaics panels since 2009.

Key assumptions behind Reference Scenario

Global economy

We expect the global economy to continue high growth, assuming a global economic growth rate at 3.9% each for 2018 and 2019. In the U.S. economy, corporate earnings performance has been robust as indicated by brisk production and non-residential investment under large tax cuts. The employment environment has been improving thanks to increasing employment, although wage hikes have remained moderate. In the European economy, private consumption has remained firm. However, business confidence has slightly deteriorated in manufacturing and services industries that have driven economic growth, leading some European people to feel a pause in economic expansion. The Asian economy sees firm domestic demand in addition to a sustained pickup in foreign demand. Economic growth will accelerate in India and some other Asian countries while decelerating in China.

Crude oil/LNG/coal import CIF prices

We assume oil and LNG prices to weaken through FY2019 due to a small crude oil oversupply as an increase in Saudi Arabian and U.S. production offsets a decline in Iranian and Venezuelan production. Crude oil import CIF prices are assumed to average $72/bbl in FY2018 and $69/bbl in FY2019. LNG import CIF prices

are assumed to average $11.0/MBtu in FY2018 and $10.7/MBtu in FY2019. We assume coal prices to rise in FY2018 as China, the largest coal consumer in the world, continues to import coal in line with moves to restrict surplus domestic production capacity. Through FY2019, coal prices may fall again on slack global coal demand mainly in Europe. Steam coal import CIF prices are assumed to average $111/t in FY2018 and $95/t in FY2019. Coking coal import CIF prices are assumed to average $146/t in FY2018 and $122/t in FY2019 (Sources: Morikawa "Outlook for International Oil Market," Kobayashi "Outlook for International Gas Market" and Sagawa "Outlook for International Coal Market").

Exchange rate

We assume the average exchange rate to be JPY112/$ in FY2018 and JPY115/$ in FY2019.

Nuclear power generation

In addition to nine nuclear power plants that have been restarted in Japan, five more have cleared regulatory standards conformity examinations. However, no more plants are likely to be restarted within FY2018 as construction and other procedures take more time. In FY2018, the nine restarted plants will operate for an average nine months and generate 62.5 TWh (accounting for 6% of total

power generation and purchases by electric utilities. As two plants are restarted in FY2019, a total of 11 reactors will be operational at the end of FY2019. In the year, they will operate for an average eight months and generate 65.4 TWh (accounting for 6%).

Tax

We assume Japan will raise the standard VAT 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 FY2018 will be warmer than normal before air temperatures return to normal levels. This means that summer in FY2018 will be warmer (+0.4°C) than in the previous year and that winter will be warmer (+0.5°C) than in the previous year. In FY2019, summer will be cooler (-0.7°C) than in the previous year and winter will be as cold as in the previous year.

Macro economy

Japanese economic growth in FY2018 will decelerate to 1.1% despite continuous expansion. In FY2019, growth will slip below 1.0% for the first time in five years, although the planned VAT hike will fall short of affecting growth for the year so seriously.

Private consumption in FY2018 will increase for the fourth straight year, but energy price hikes will exert downward pressure on consumption. Non-residential investment will slightly slow down its growth due to raw material price increases and personnel cost hikes, although business corporations will remain willing to expand investment, with Olympics-related demand contributing to investment expansion. Residential investment will continue to decline on the disappearance of upward pressure from inheritance tax measures. Private demand will contribute 0.8 percentage points to the GDP growth as private consumption, and non-residential and residential investment decelerate growth. Public demand will contribute 0.1 percentage points as public investment declines due to a decline in spending under a supplementary budget for FY2017. Exports will remain firm on overseas economic growth and robust demand for goods related to information technology, while reducing their contribution to

Japanese economic growth. Foreign demand will contribute 0.2 points to the GDP growth.

Fossil fuel imports will increase close to JPY20 trillion for the first time in four years due to price hikes, leading Japan to plunge into a trade deficit. Energy price hikes will help the consumer price index to accelerate its rise to 0.9%.

In FY2019, consumer prices will increase due to the VAT hike as well as non-energy price rises. However, the tax hike will have less impact on consumption than the previous one. The reduced VAT rate for selected goods such as food products and the introduction of free schooling for infants will mitigate private consumption deceleration. Non-residential investment will remain brisk, accelerating growth. Private demand will contribute 0.7 percentage points to the total GDP growth rate assumed at 0.9%. Public demand will contribute 0.2 points through public investment expansion. Foreign demand will contribute 0.1 points.

Table 2 | Macroeconomic indicators

	Historical				Projection		Year-over-year		
	FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Real GDP (JPY2011 trillion)	492.9	518.3	524.4	533.0	538.8	543.9	1.6%	1.1%	0.9%
Private demand	369.0	392.6	395.3	401.2	405.6	409.5	(1.0%)	(0.8%)	(0.7%)
Private consumption	286.5	296.3	297.1	299.6	301.4	303.0	0.9%	0.6%	0.5%
Private residential investment	13.9	15.2	16.1	16.1	15.9	15.9	-0.3%	-1.5%	0.3%
Private non-residential investment	67.6	81.6	82.6	85.2	87.5	90.0	3.2%	2.6%	2.9%
Public demand	122.6	130.9	131.6	132.8	133.3	134.3	(0.2%)	(0.1%)	(0.2%)
Government consumption	98.1	105.2	105.7	106.5	107.2	108.0	0.7%	0.7%	0.7%
Public investment	24.7	25.7	25.9	26.3	26.1	26.3	1.4%	-0.7%	0.8%
Net exports of goods and services	1.3	-7.0	-3.2	-1.5	-0.6	-0.3	(0.4%)	(0.2%)	(0.1%)
Exports of goods and services	74.7	82.9	85.9	91.2	94.4	96.8	6.2%	3.5%	2.5%
Imports of goods and services	73.4	89.9	89.1	92.7	95.0	97.1	4.0%	2.4%	2.3%
Nominal GDP (JPY trillion)	499.3	533.9	539.4	548.7	558.0	569.0	1.7%	1.7%	2.0%
Balance of trade (JPY trillion)	5.3	-1.1	4.0	2.5	-1.2	-1.4	-38.4%	-148%	16.2%
Exports	67.8	74.1	71.5	79.2	80.4	81.8	10.8%	1.5%	1.7%
Imports	62.5	75.2	67.5	76.8	81.6	83.1	13.7%	6.2%	1.9%
Fossil fuels	18.1	16.1	13.1	16.2	19.4	18.8	23.6%	19.6%	-3.4%
Oil	12.3	9.6	7.8	9.6	11.7	11.3	22.1%	22.1%	-2.9%
LNG	3.5	4.5	3.3	4.1	5.0	5.0	22.1%	24.0%	-1.1%
Current account (JPY trillion)	18.3	18.3	21.0	21.3	20.8	22.2	1.4%	-2.5%	6.7%
Domestic corporate goods price index (2015=100)	97.6	99.1	96.7	99.3	101.7	102.3	2.7%	2.4%	0.6%
Consumer price index (2015=100)	96.4	100.0	100.0	100.7	101.6	103.2	0.7%	0.9%	1.5%
GDP deflator (2011=100)	101.3	103.0	102.8	102.9	103.5	104.6	0.1%	0.6%	1.0%
Unemployment rate (%)	5.0	3.3	3.0	2.7	2.5	2.5	[-0.3%]	[-0.2%]	[-0.0%]

Note: GDP components may not add up to the total GDP due to stock changes and minor data deviations. ( ) contributions. [ ] difference from the previous year.

Production activities

The industrial production index will rewrite its post-Lehman shock high in FY2018 and FY2019, though decelerating growth substantially from FY2017.

The industrial production index in FY2018 will increase by 1.1% from the previous year thanks to growing exports amid overseas economic expansion and to rising domestic demand related to the 2020 Summer Olympics in Tokyo. Particularly, production will expand for machinery for labour-saving investment and chemicals. In FY2019, the industrial production index will increase by 1.0% on growth in both exports and domestic demand.

Crude steel production will continuously increase in the coming two years due to urban redevelopment and infrastructure construction related to the Tokyo Olympics.

In FY2018, crude steel production will increase by 1.1% from the previous year due to the expansion of domestic demand for urban redevelopment and infrastructure construction for the Tokyo Olympics, as well as export growth backed by the robust global economy. In FY2019, crude steel production will decelerate growth to 0.7% as domestic demand growth slows down on the end of demand related to the Tokyo Olympics, with export growth weakening.

Ethylene production will decrease on increased regular plant repairs in FY2018 and post a limited rally due to U.S. shale-based ethylene production in FY2019.

Ethylene production in FY2018 will decrease by 4.3% from the previous year due to increased regular plant repairs. The production fall will be covered by a cut in exports. In FY2019, ethylene production will increase on fewer regular plant repairs. However, the increase will be limited due to falling domestic demand amid population decline and products made from U.S. shale gas-based ethylene flowing into the international market that may worsen the export environment for Japan's ethylene production.

Cement production will increase by 1% or more for the third straight year thanks to construction projects related to the Tokyo Olympics and urban redevelopment.

Cement production in FY2018 will increase by 1.1% from the previous year to 61 Mt due to growth in construction related to the Tokyo Olympics and urban redevelopment. In FY2019, cement production will expand by 1.0% thanks to continued demand related to the Tokyo Olympics, posting an annual rise of 1.0% or more for the third straight year. Cement production will grow for the fourth consecutive year.

Paper and paperboard production will decrease due to structural factors in FY2018 and FY2019.

While paper demand will decline on a population fall and a switch to electronic media in FY2018 and FY2019, paperboard production will expand due to growth in exports amid increasing sales via the Internet in China. As the paperboard production rise fails to cover the paper production fall, however, total paper and paperboard production will decrease by 0.2% in FY2018 and by 0.4% in FY2019.

Automobile production will top 9.7 million units in both FY2018 and FY2019, though decelerating growth.

In FY2018, automobile production will increase by 0.3% from the previous year to 9.71 million units as exports to emerging and other countries expand to more than offset a domestic shipment fall attributable to a population drop. In FY2019, production growth will be limited to 0.1% as exports decelerate growth on a fall in replacement demand in the U.S. market, with domestic shipments falling as in the previous year.

Table 3 | Production activities

		Historical				Projection		Year-over-year		
		FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Production	Crude steel (Mt)	110.8	104.2	105.2	104.8	105.9	106.7	-0.3%	1.1%	0.7%
	Ethylene (Mt)	7.00	6.78	6.29	6.46	6.18	6.24	2.7%	-4.3%	0.9%
	Cement (Mt)	56.1	59.2	59.3	60.4	61.0	61.6	1.8%	1.1%	1.0%
	Paper and paperboard (Mt)	27.3	26.2	26.3	26.4	26.4	26.2	0.2%	-0.2%	-0.4%
	Automobiles (Million units)	8.99	9.19	9.36	9.68	9.71	9.72	3.4%	0.3%	0.1%
Production indices	Mining and manufacturing (2010=100)	99.4	97.5	98.5	102.5	103.7	104.8	4.1%	1.1%	1.0%
	Food	98.2	96.9	96.8	96.7	96.3	95.7	-0.2%	-0.4%	-0.6%
	Chemicals	99.7	98.0	100.8	106.1	108.3	110.1	5.3%	2.1%	1.6%
	Non-ferrous metals	98.9	96.5	98.9	101.5	103.1	104.6	2.6%	1.6%	1.4%
	Machinery	99.3	98.4	99.4	104.9	106.4	107.8	5.6%	1.5%	1.3%
Tertiary industry activity index (2010=100)		99.9	103.5	103.9	105.0	105.4	106.1	1.0%	0.4%	0.6%

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

Primary energy supply in Japan will decline in FY2018 and FY2019. The restart of nuclear power plants and progress in renewable energy penetration will lead fossil fuel consumption to greatly decline. LNG imports will post a decrease of more than 10% from the peak.

Primary energy supply in Japan in FY2018 will decline by 0.8% from the previous year on slight economic deceleration and temperature changes. Energy consumption in all sectors including the power generation sector will decrease from the previous year. The restart of nuclear power plants and the expansion of renewable energy will lead Japan's energy self-sufficiency ratio to increase by 2.3 percentage points to 12.3% (compared with 20.2% in FY2010).

Oil, which accounts for about40% of Japan's primary energy supply, will decrease by 3.1% in FY2018 for the sixth straight annual fall, slipping below 200 billion litres of crude oil equivalent for the first time almost in a half century since 1969 before the first oil crisis. Fuel efficiency improvements in the final consumption, fuel switching and a decline in the capacity factor for oil-fired power plants accompanying the restart of nuclear power plants will accelerate an oil consumption fall. Nuclear will increase by 31.2 TWh (6.5 Mtoe) as the number of operating nuclear power plants has risen to nine.

Natural gas in FY2018 will fall by 4.4% for the second straight annual drop, posting the largest percentage decrease among fuels. Consumption for city gas will decline for the first time in three years. Natural gas for power generation will decrease due to the restart of nuclear power plants, although operation started at Unit 7-2 of the Nishi-Nagoya thermal power station at the end of FY2017 and is planned to start at the first LNG plant of the Toyama Shinko thermal power station in November 2018 and at the first LNG plant of the Ishikari-wan Shinko LNG thermal power station in February 2019. LNG imports in

FY2018 will fall by 11% from the peak in FY2014. Coal will decrease by 0.4% as a decline in consumption for power generation more than offsets a slight increase in final consumption.

New energy, etc. including solar photovoltaics, wind and biomass will post a large increase of 1.8 Mtoe on the strength of the Feed-in Tariff scheme, accounting for nearly 5% of Japan's primary energy supply.

Japan's energy-related CO_2 emissions in FY2018 will decline by 2.6% to 1,083 Mt for the fifth straight annual drop. From FY2013, the base year for the emission reduction target under the Paris Agreement, FY2018 emissions will post a decline of 12.3% including 5.7 percentage points resulting from energy consumption cuts covering energy conservation effects, 2.4 points from a nuclear power generation increase and 2.4 points from renewable energy expansion.

In FY2019, Japan's primary energy supply will decrease by 0.2% for the second straight annual decline. Progress in energy conservation will be more responsible for the decrease than the slight deceleration of economic and production activities. Oil will decline by 1.4% due to falls in supply for final consumption and power generation, lowering its share of primary energy supply to 38%. Natural gas will drop by 0.7% in its first ever three-year losing streak. Coal will increase by 0.1% on rises for both power generation and final consumption. Nuclear and new energy, etc. will post respective increases of 4.6% and 7.3%, indicating a continuous uptrend for non-fossil energy sources. As a result, the energy self-sufficiency ratio will rise by 0.5 points, with CO_2 emissions being cut by 0.8%.

14

Table 4 | Primary energy supply

	Historical				Projection		Year-over-year		
	FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Primary energy supply (Mtoe)	515.9	467.2	463.5	465.3	461.6	460.8	0.4%	-0.8%	-0.2%
Coal	119.1	123.7	121.9	123.5	123.0	123.1	1.3%	-0.4%	0.1%
Oil	211.9	193.5	187.6	185.3	179.5	177.0	-1.2%	-3.1%	-1.4%
Natural gas	95.7	111.9	114.7	111.4	106.5	105.7	-2.8%	-4.4%	-0.7%
LNG imports (Mt)	70.6	83.6	84.7	83.9	79.4	78.9	-1.0%	-5.3%	-0.7%
Hydro	17.7	18.1	16.3	17.6	17.2	17.2	7.6%	-2.2%	0.0%
Nuclear	60.7	2.0	3.7	6.5	13.0	13.6	73.3%	99.8%	4.6%
New energy, etc.	10.7	17.9	19.3	20.7	22.5	24.1	6.8%	8.8%	7.3%
Self-sufficiency rate	20.2%	7.4%	8.3%	10.0%	12.3%	12.8%	1.7p	2.3p	0.5p
Energy intensity (FY2011=100)	105.1	90.6	88.8	87.7	86.1	85.1	-1.2%	-1.9%	-1.1%
Energy-related CO_2 emissions (MtCO_2)	1,135	1,147	1,128	1,112	1,083	1,074	-1.4%	-2.6%	-0.8%
(FY2013=100)	91.9	92.9	91.3	90.0	87.7	86.9	..	..	..

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

Self-sufficiency rate is based on IEA standard.

Final energy consumption

Japan's final energy consumption will decline in FY2018 again to the lowest level since the peak in FY2000 and decrease in FY2019 for the second straight year.
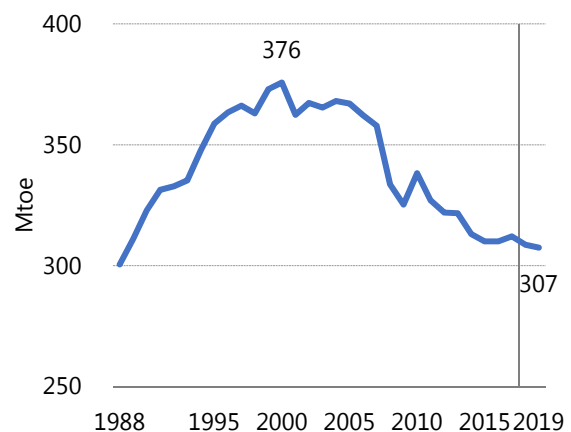
Final energy consumption in FY2018 will decrease from the previous year again after increasing in FY2017 for the first time in seven years since the Great East Japan Earthquake. As all industrial, residential, commercial and transport sectors reduce consumption, the decrease will be 1.1%, more than offsetting the FY2017 decrease to bring consumption to the lowest level since the peak in FY2000.

The industrial sector will reduce energy consumption by 1.1% in FY2018 due to energy conservation efforts coupled with the deceleration of production growth. Particularly, a petrochemical feedstock consumption decline accompanying an ethylene production decrease will make a great contribution to the reduction. The buildings sector (covering residential and commercial sectors) will see a 1.5% consumption drop after a two-year consecutive increase. Space heating demand will decrease after a severely cold winter in the previous year. The transport sector will cut energy consumption by 0.6% for the third straight annual reduction. Automobile fuel consumption accounting for 90% of transport sector consumption will continue to decrease on fuel efficiency improvements for passenger cars, despite brisk fuel consumption for trucks.

Oil will decrease in all sectors due primarily to fuel switching from oil to city gas or electricity in industrial and buildings sectors, as well as vehicle fuel efficiency improvements. Oil's share of total final energy consumption will slip below 50% for the first time in 56 years. City gas and natural gas will decrease for the first time in three years. Gas will be robust in the industrial

sector but decline substantially due to temperature changes in the residential sector. Electricity will slightly decrease on temperature changes. Coal will increase by 0.2% as crude steel and cement production grows.

Figure 2 | Final energy consumption

In FY2019, energy consumption will decline by 0.4% for the second straight year of fall as consumption decreases in all sectors. Consumption volume will drop to the lowest level in about 30 years. While industrial production will retain growth, the industrial sector will reduce energy consumption for the second straight year. The buildings sector will continue a downtrend despite temperature changes. The transport sector will continue to see a fuel efficiency improvement trend, cutting energy consumption for the fourth straight year. Oil will retain a downtrend. Electricity and city gas will score limited growth. No continuous or large growth can be expected in the future.

Table 5 | Final energy consumption

	Historical				Projection		Year-over-year		
	FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Final energy consumption (Mtoe)	338.2	310.1	310.1	312.1	308.7	307.5	0.7%	-1.1%	-0.4%
Industry	158.7	146.9	146.4	147.5	145.9	145.7	0.8%	-1.1%	-0.1%
Buildings	97.1	86.4	87.8	89.2	87.8	87.4	1.5%	-1.5%	-0.5%
Residential	54.0	47.1	47.9	49.6	48.6	48.5	3.5%	-2.0%	-0.2%
Commercial	43.1	39.2	39.9	39.6	39.2	38.9	-0.8%	-1.0%	-0.8%
Transport	82.4	76.8	75.8	75.3	74.9	74.3	-0.7%	-0.6%	-0.8%
Coal and coal products	36.6	34.2	33.9	34.0	34.1	34.2	0.5%	0.2%	0.1%
Petroleum products	176.0	157.9	156.2	156.3	153.0	151.7	0.1%	-2.1%	-0.8%
City and natural gases	34.0	32.8	33.6	34.7	34.5	34.5	3.3%	-0.6%	0.1%
Electricity	88.2	82.1	83.4	84.1	84.0	84.0	0.8%	-0.1%	0.0%
Others	3.4	3.1	3.0	3.0	3.1	3.0	0.2%	1.2%	-1.1%

Note: FY2017 is estimated value. The industry sector's energy consumption includes non-energy use.

Electricity sales and power generation mix (electric utilities)

Electricity sales, and power generation and purchases will level off on the deceleration of production growth. Zero-emission electricity sources' share of the power generation mix will top 20%, with fossil fuel-fired power plants' share shrinking.

In FY2018, electricity sales to lighting service users will decrease by 1.3% due to a colder winter in the previous year and the penetration of residential solar PV systems, and of energy-efficient lamps and electrical appliances, although cooling demand will increase in a hotter summer, with progress seen in the electrification of water heaters and cooking equipment. Sales to power service users will slightly decelerate growth to 0.6% on slower machinery production growth amid an export slowdown, despite an increase in space cooling demand. Total electricity sales in FY2018 will level off from the previous year.

In FY2019, sales to lighting service users will decrease by 0.4% due to a cooler summer than in the previous year while the electrification will continue along with the penetration of residential solar PV systems and energy-efficient equipment. The year will see the expiration of first 10-year contracts for residential users to sell surplus electricity generated with solar PV to electric utilities under the FIT scheme. However, the expiration will have little impact on electricity sales to lighting service users in the year. Sales to power service users will increase by 0.2% for the third straight year of growth on moderate expansion in production, despite a reactionary fall in space cooling demand after a hotter summer in the previous year. Total electricity sales in FY2019 will level off for the second straight year.

Due to the full liberalisation of retail electricity sales, power producer and supplier companies' (new entrants') share of electricity sales rose from 5.3% in April 2016 to 12.7% in April, indicating users' growing switching from traditional electric utilities to PPS companies. The share has topped 20% for high-voltage users and is increasing for lighting service users.

In FY2018, nuclear's share of total power generation and purchases will rise by 3.0 percentage points to 6% as more nuclear power plants are in operation. Renewable energy sources (excluding hydro) will increase their share of the power generation mix by 0.8 points to 9%. As a result, the combined share of zero-emission power sources – hydro, nuclear and renewables (other than hydro) – will top 20% for the first time since the Great East Japan Earthquake. In response, fossil fuel-fired power generation's share will fall by 3.8 points to 72%, the lowest since the Great East Japan Earthquake. Of fossil fuel-fired power generation, LNG will narrow their share by 2.7 points. Oil's share will decrease by 1.0 points as Units 3 and 4 (each with capacity at 1 GW) of the Hirono thermal power station and Units 1 and 2 (each with capacity at 0.5 GW) of the Buzen power station enter a long-term shutdown or are decommissioned. However, share of fossil fuel-fired in the power generation mix will still be some 10 points higher than in FY2010 before Japan's power generation mix changed dramatically on the Great East Japan Earthquake.

In FY2019, nuclear's share of the power generation mix will level off at 6% as the restart of additional nuclear power plants coincides with regular checks at operating ones. As renewables (excluding hydro) expand their share by 0.8 points, share of fossil fuel-fired will fall by 1.0 points to 71%.

Table 6 | Electricity sales and power generation/purchase mix (electric utility use)

	Historical				Projection		Year-over-year/changes		
	FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Electricity sales(TWh)	(926.6)	(837.5)	850.5	863.2	862.9	862.8	1.5%	0.0%	0.0%
Lighting service	304.2	266.9	272.9	281.3	277.7	276.6	3.1%	-1.3%	-0.4%
Electric Power	(622.4)	(570.7)	577.6	581.9	585.2	586.2	0.7%	0.6%	0.2%
Extra-high voltage	(246.1)	(229.3)	231.5	233.8	235.3	235.8	1.0%	0.6%	0.2%
High voltage	(330.3)	(303.7)	308.3	309.6	311.3	311.8	0.4%	0.5%	0.1%
Low voltage	(45.9)	(37.7)	37.8	38.4	38.6	38.6	1.6%	0.5%	0.1%
Electricity generated and purchased (TWh)	(1,028)	(920)	984	1,027	1,027	1,026	4.4%	0.0%	0.0%
Hydro	(9%)	(9%)	8%	9%	8%	8%	+0.2p	-0.2p	+0.0p
Fossil fuels	(62%)	(83%)	81%	75%	72%	71%	-5.5p	-3.8p	-1.0p
Coal	(25%)	(31%)	28%	28%	28%	28%	-0.8p	+0.0p	+0.0p
LNG	(29%)	(45%)	45%	41%	38%	38%	-3.5p	-2.7p	-0.5p
Oil, etc.	(8%)	(8%)	8%	7%	6%	5%	-1.2p	-1.0p	-0.6p
Nuclear	(29%)	(1%)	2%	3%	6%	6%	+1.3p	+3.0p	+0.3p
Renewables (excluding hydro), etc.	(1%)	(4%)	7%	8%	9%	9%	+1.1p	+0.8p	+0.8p
Others	(1%)	(2%)	2%	5%	5%	5%	+2.9p	+0.0p	+0.0p

Note: 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 will decline mainly for the residential sector in FY2018 after a colder winter in the previous year. In FY2019, city gas sales will hit a record high, driven by those for industrial use, though with a small gain.

City gas sales in FY2018 will decrease from the previous year to 42.4 billion m^3 in the absence of the effect of a colder winter seen in the previous year, although those for industrial use will increase thanks to a moderate expansion in production and economic activities and fuel switching for industrial furnaces and boilers. In FY2019, city gas sales will hit a record high of 42.8 billion m^3, up 1.0%, as those for industrial use expand on an increase in sales to electric utilities.

Residential gas sales will post a large decline of 3.7% in FY2018 in the absence of the effect of a colder winter seen in the previous year. In FY2019, residential sales will rise by 0.2% on the expansion of city gas service areas and gas utilities' continuous customer exploration efforts, although energy efficient equipment including efficient water heaters will penetrate.

Business gas sales (commercial and other sales) in FY2018 will decrease (-0.5% for commercial sales and -0.5% for others) in the absence of the effect of a colder winter seen in the previous year, while demand will get a boost from the exploration of demand for cogeneration systems for large users and gas heat pumps, robust commercial and services activities and a space cooling demand rise in a hotter summer. In FY2019, business sales will decline (-1.2% for commercial sales and −0.9% for others) due to energy conservation and a space cooling demand fall in a cooler summer, while fuel switching to city gas will make progress.

Industrial gas sales in FY2018 will increase by 1.2% on industrial production expansion, fuel switching from oil to city gas for industrial furnaces and boilers, and the exploration of new demand, although the increase will decelerate

from the previous year. In FY2019, they will expand by 2.0%, driven by sales to electric utilities on the launch of the first city gas-fired power plant (with capacity at 0.62 MW) at the Mooka thermal power station in the second half of the year.

Residential sales' share of total city gas sales will shrink to 22% in FY2019 from 50% in FY1990, while industrial sales' share will expand to 59% from 26%. However, support for industrial sales is declining on the stagnation of demand from large users and weak production in the food manufacturing industry, one of the key customers for gas utilities.

Figure 3 | Industrial production and industrial city gas sales
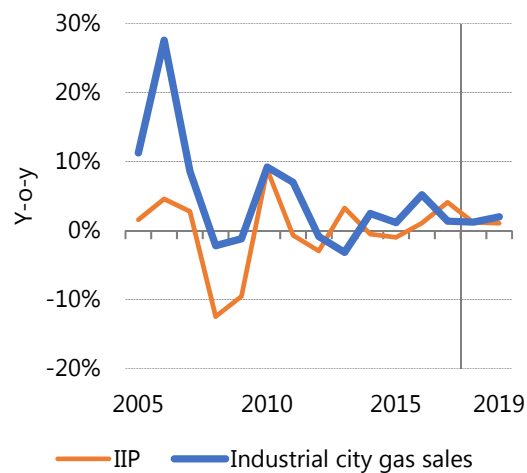
Since the full liberalisation of city gas retail sales in April 2017, the number of applications for switching from traditional suppliers reached 1.12 million by the end of June 2018. Regional numbers differ widely, with the Kinki region posting the largest number, accounting for a half of the total.

Table 7 | City gas sales (gas utilities)

	Historical				Projection		Year-over-year		
	FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Total (Billion m^3)	39.28	39.91	41.53	42.48	42.37	42.79	2.3%	-0.3%	1.0%
Residential	9.79	9.24	9.41	9.88	9.51	9.53	5.0%	-3.7%	0.2%
Commercial	4.75	4.26	4.32	4.37	4.35	4.30	1.2%	-0.5%	-1.2%
Industrial	21.61	23.01	24.20	24.52	24.82	25.31	1.3%	1.2%	2.0%
Manufacturing	(20.18)	(20.16)	19.30	19.97	20.27	20.44	3.5%	1.5%	0.8%
Electric utilities	(1.43)	(2.85)	4.90	4.55	4.55	4.88	-7.1%	0.0%	7.1%
Others	3.13	3.41	3.61	3.71	3.69	3.66	2.8%	-0.5%	-0.9%

Note: 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 will continue to decline on a sharp fall in heavy fuel oil C for power generation and a gasoline drop amid fuel efficiency improvements. Particularly, FY2018 will see the largest decline in four years as naphtha sales decrease on an increase in regular ethylene plant repairs.

Fuel oil sales in FY2018 will decline by 3.1% due to a substantial fall in heavy fuel oil C for power generation amid a decrease in operating oil-fired power plants, a gasoline fall on the penetration of more fuel-efficient automobiles and a naphtha decrease on an increase in regular ethylene plant repairs. In FY2019, total fuel oil sales will decline by 1.3% for the seventh straight annual fall as decreases in heavy fuel oil C for power generation and gasoline outdo increases in naphtha supported by fewer regular ethylene plant repairs and diesel oil backed by steady demand.

Gasoline will decrease by 1.6% in FY2018 and by 1.8% in FY2019 due to the further penetration of fuel efficient vehicles including hybrid and mini vehicles. FY2019 sales will hit a quarter century low close to 50 billion litres, plunging by 20% from the peak of 62 GL in FY2004.

Naphtha will decrease by 4.2% in FY2018 in response to an increase in regular ethylene plant repairs. In FY2019, sales growth will be limited 0.6% as ethylene production fails to rise back to the FY2017 level despite a decrease in regular ethylene plant repairs.

Kerosene will decrease by 2.5% in FY2018 on continuous fuel switching to city gas or electricity and normal winter temperatures after far lower winter temperatures in the previous year. In FY2019, sales will fall by 1.0% on continuous fuel switching.

Diesel oil will increase by 0.9% in FY2018 and by 0.6% in FY2019 despite further improvements in freight transport and fuel efficiency as freight traffic expands on growing industrial production and online sales amid an economic pickup. They will post a three-year consecutive rise for the first time in a quarter century.

Heavy fuel oil A will drop by 3.5% in FY2018 as space heating demand in the commercial sector declines in the absence of the effect of a colder winter seen in the previous year, with fuel switching to city gas making progress in industrial and commercial sectors. In FY2019, sales will decrease by 2.5% on continuous fuel switching.

Heavy fuel oil B and C for industrial use will decrease due to fuel switching and energy conservation. Sales for power generation will decline on the restart of additional nuclear reactors, the expansion of renewable energy-based power generation and the operation of new LNG-fired power plants. Total heavy fuel oil B and C sales will fall by 20.0% in FY2018 and by 14.2% in FY2019, posting a double-digit decline for the seventh straight year.

LPG will fall by 1.0% in FY2018 due to a warmer winter. In FY2019, sales will decrease by 0.4% on progress in fuel switching to electricity or city gas.

Crude oil throughput will decrease for the third straight year. As throughput in FY2017 was limited to a low level in response to the second notification under the Act on Sophisticated Methods of Energy Supply Structure, however, the FY2018 fall of 2.5% will be slower than the fuel oil sales drop.

Table 8 | Fuel oil/LPG sales and crude oil throughput

	Historical			Projection		Year-over-year		
	FY2010	FY2015	FY2016	FY2017	FY2018	FY2019	FY2017	FY2018	FY2019
Fuel oil sales (GL)	196.0	180.5	176.9	174.7	169.3	167.2	-1.2%	-3.1%	-1.3%
Gasoline	58.2	53.1	52.5	51.8	51.0	50.1	-1.3%	-1.6%	-1.8%
Naphtha	46.7	46.2	44.8	45.1	43.2	43.5	0.7%	-4.2%	0.6%
Jet fuel	5.2	5.5	5.3	5.0	5.0	5.0	-5.2%	-0.3%	-0.3%
Kerosene	20.4	15.9	16.3	16.6	16.2	16.1	2.4%	-2.5%	-1.0%
Diesel oil	32.9	33.6	33.3	33.8	34.1	34.3	1.5%	0.9%	0.6%
Heavy fuel oil A	15.4	11.9	12.0	11.5	11.1	10.8	-4.0%	-3.5%	-2.5%
Heavy fuel oils B and C	17.3	14.2	12.8	10.8	8.7	7.4	-15.1%	-20.0%	-14.2%
For electric utilities	7.7	8.2	7.9	6.0	4.5	3.7	-23.8%	-24.7%	-18.2%
For other users	9.7	6.1	4.8	4.8	4.1	3.7	-0.9%	-14.1%	-9.8%
LPG sales (Mt)	16.5	14.7	14.4	14.8	14.7	14.6	2.9%	-1.0%	-0.4%
Crude oil throughput (GL)	208.9	189.0	190.6	184.2	179.6	176.6	-3.3%	-2.5%	-1.7%

Renewable power generation (**FIT power source**)

The cumulative capacity of renewable energy-based power generation facilities approved under the FIT scheme is approaching 74 GW. However, the cancellation of FIT approval for some facilities will greatly hold down growth in the burdens on citizens.

Renewable energy-based power generation capacity approved under the Feed-in Tariff scheme reached 105 GW (including 84.5 GW for solar PV, 7.0 GW for wind and 12.4 GW for biomass) in March 2017 as applications for FIT approval increased before the revised FIT Act took effect in April to reduce feed-in tariffs. As the revised FIT Act sets a deadline for making approved FIT capacity operational, however, 16 GW out of the approved FIT capacity may be cancelled, centring on non-residential solar PV capacity (such as mega-solar plants). Given difficulties in procuring fuels for biomass-fired power generation facilities, only 20% of approved non-operational biomass-fired power generation capacity is expected by analysts to become operational.

If FIT capacity totalling 80 GW, excluding capacity cancelled under the deadline and biomass capacity expected to be cancelled from 105 GW[1] in approved FIT capacity at the end of March 2017, is operational, the cumulative burden on consumers will come to JPY50 trillion[2] including a component for transferred facilities[3]. The estimated burden amounts to an electricity rate hike of JPY2,900/MWh or 12% for residential users and 17% for industrial users. 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.

While no substantial increase can be expected in approved FIT capacity, facilities under construction are expected to become operational. Although constraints exist on the connection of renewable energy-based power generation facilities with local power grids, initiatives to mitigate such constraints are planned to be implemented from the current fiscal year. No major barriers to making approved FIT capacity operational can be expected. Installed FIT capacity will reach 73.9 GW at the end of FY2019. Particularly, installed non-residential solar PV capacity will expand to 43.6 GW, accounting for a majority of the total installed FIT capacity. Given that five years are required for launching wind power generation after approval, installed wind generation capacity will be limited to 4.4 GW at the end of FY2019. Renewable energy-based power generation in FY2019 will total 135.1 TWh (including 57.4 TWh for solar PV, 7.7 TWh for wind and 39.0 TWh for small and medium-sized hydroelectric plants), accounting for 13% of Japan's total power generation (excluding pumped-storage power generation).

[1] While the latest available information puts approved FIT capacity at 93 GW as of September 2017, we here use the data for March 2017 as the standard month for setting the deadline for cancellation.
[2] The remaining FIT periods for transferred facilities are taken into consideration. The marginal avoidance

cost is estimated based on various renewable 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.
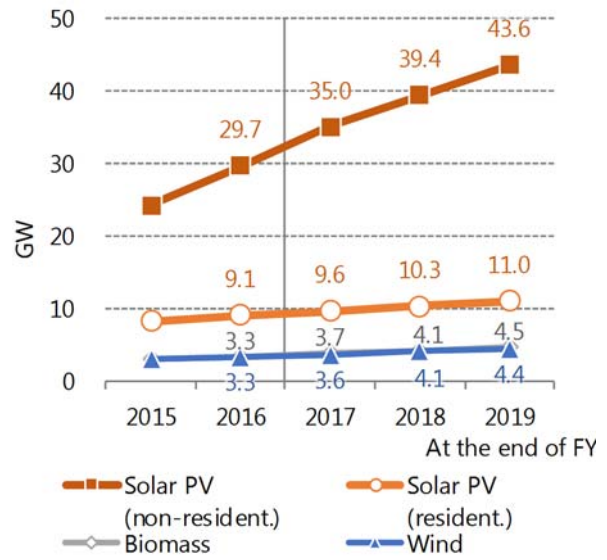[3] Transferred facilities are those that were installed before the introduction of the FIT scheme and later subjected to the scheme.

Figure 4 | Cumulative burden of FIT scheme over purchasing period

Figure 5 | Installed FIT power generation capacity (based on operation)
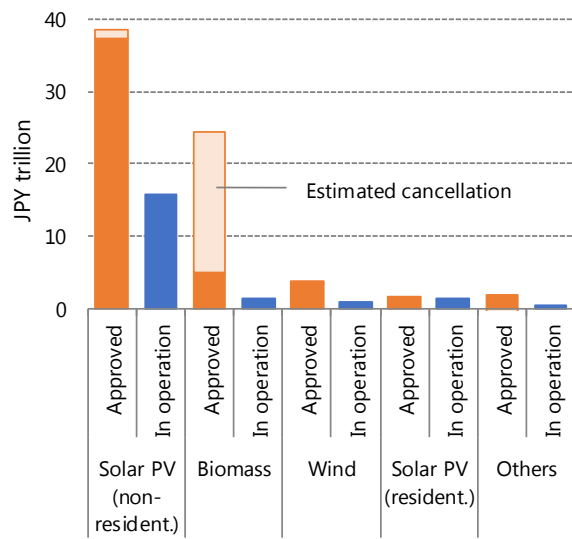
(Note) Capacity approved and in operation at the end of September 2017

Effects of uncertain factors [1] Nuclear power generation

Nuclear power generation greatly contributes to 3E's

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

In addition to the Reference Scenario where the cumulative number of restarted nuclear power plants would increase from nine at present to 11 by the end of FY2019, we have projected the "High Case" where the number would be five more and the "Low Case" where the number would be five less[4] for a sensibility analysis. For the hypothetical "Best Mixed Case," we referred to a 2030 power generation 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.

Nuclear's contributions to 3E's

As for economy efficiency, fossil fuel imports in the High Case would be JPY300 billion less than in the Reference Scenario. Those in the Best Mixed Case would be JPY1.1 trillion less. The electricity unit cost in the High Case would be JPY200/MWh less than in the Reference Scenario. The cost in the Best Mixed Case would be JPY600/MWh more. This is because FIT costs for renewable energy promotion would increase despite fuel cost savings. Due to less fossil fuel imports, real GDP would be JPY300 billion more in the High Case and JPY1.1 trillion more in the Best Mixed Case.

The energy self-sufficiency rate as an energy security indicator would be 2.1 points higher in the High Case and 10.4 points higher in the Best Mixed Case.

CO_2 emissions as an environment indicator would be 13 Mt less in the High Case and 57 Mt less in the Best Mixed Case. From FY2013, the base year for Japan's emission reduction target[5] for the Paris Agreement, emissions would decline by 14.1% in the High Case and by 17.7% in the Best Mixed Case.

---

[4] Each of the five plants for the addition or the reduction is assumed to have generation capacity at 1 GW and operate at 80% of its capacity.

[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%.

Table 9 | Effects of differing nuclear power generation [FY2019]

		Low Case	Reference Scenario	High Case	Best Mixed Case	Changes from Reference		
						Low	High	Best Mixed
Nuclear assumptions	Restarted nuclear reactors	6	11	16	..	-5	+5	..
	Power generation (TWh)	30.4	65.4	100.4	231.4	-35.0	+35.0	+166.0
	Share in generation and purchases	3%	6%	9%	21%	-3p	+3p	+15p
Economy	Electricity unit cost[1] (JPY/kWh)	6.6	6.4	6.2	6.9	+0.2	-0.2	+0.6
	Fuel cost	4.7	4.5	4.3	3.8	+0.2	-0.2	-0.8
	FIT purchasing cost	1.9	1.9	1.9	3.2	0.0	0.0	+1.3
	Total fossil fuel imports (JPY trillion)	19.1	18.8	18.5	17.7	+0.3	-0.3	-1.1
	Oil	11.4	11.3	11.3	11.2	+0.1	-0.0	-0.2
	LNG	5.2	5.0	4.8	4.1	+0.2	-0.2	-0.9
	Trade balances (JPY trillion)	-1.6	-1.4	-1.1	-0.5	-0.3	+0.3	+0.9
	Real GDP (JPY2011 trillion)	543.6	543.9	544.2	545.1	-0.3	+0.3	+1.1
Energy and environment	Primary energy supply							
	Oil (GL)	190.4	189.1	188.1	185.2	+1.3	-1.1	-3.9
	Natural gas (Mt of LNG eq.)	85.6	81.9	78.1	67.8	+3.7	-3.8	-14.2
	Self-sufficiency rate	10.8%	12.8%	14.9%	23.2%	-2.1p	+2.1p	+10.4p
	Energy-related CO_2 (Mt)	1,088	1,074	1,061	1,017	+14	-13	-57
	Changes from FY2013	-12.0%	-13.1%	-14.1%	-17.7%	..	..	..

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

Effects of uncertain factors [2] Oil prices

Oil price hikes affecting adversely Japanese economy

While it is always difficult to predict future oil prices, the difficulty has increased further on rapid oil price hikes since this spring. Crude oil import CIF prices are assumed to average $72/bbl in FY2018 and $69/bbl in FY2019 in the Reference Scenario. Differing from the market situation where lower-for-longer oil price had been dominantly expected, the present situation features a rising number of market participants bullish about oil prices. We developed and assessed a "Higher Oil Price Case" where the average oil price would be $10/bbl higher than in the Reference Scenario, with LNG prices being higher in line with oil prices.

$10/bbl hike to push economy down by 0.2%

An oil price hike of $10/bbl would push the Japanese economy down by 0.2% (compared with the Reference Scenario in FY2019). This is because overseas income outflow and cost-push inflation would affect domestic demand including non-residential investment. Global economic slowdown would spill over to exports. This would push machinery and other production, leading industrial production to decline by 0.4%. Some people welcome resources price hikes as pushing up net profit for some industries[6]. From the viewpoint based on the national economy and cash flow, oil price hikes are unwelcoming for Japan that depends on imports for almost all oil supply.

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

| | | Historical | Reference Scenario | | Higher Oil Price Case | | | |
| | | | | | | | Changes from Reference | |
		FY2017	FY2018	FY2019	FY2018	FY2019	FY2018	FY2019
Prices	Crude oil import CIF ($/bbl)	57	72	69	79	79	(7)	(10)
	LNG import CIF ($/MBtu)	8.5	11.0	10.7	12.4	13.1	(1.4)	(2.4)
Economy	Real GDP (JPY2011 trillion)	533.0	538.8	543.9	538.4	542.9	-0.1%	-0.2%
	Fossil fuel imports (JPY trillion)	16.2	19.4	18.8	21.2	21.4	(1.7)	(2.7)
	Trade balances (JPY trillion)	2.5	-1.2	-1.4	-2.5	-3.1	(-1.3)	(-1.7)
	Industrial production (2010=100)	102.5	103.7	104.8	103.6	104.4	-0.1%	-0.4%
	Domestic corporate goods price (2015=100)	99.3	101.7	102.3	102.4	103.7	0.7%	1.3%
	Consumer prices (2015=100)	100.7	101.6	103.2	101.8	103.7	0.2%	0.5%
Energy	Primary energy supply (Mtoe[1])	465.3	461.6	460.8	461.1	459.3	-0.1%	-0.3%
	Oil[2] (GL)	202.6	196.3	193.6	196.0	192.9	-0.2%	-0.3%
	Natural gas[2] (Mt of LNG eq.)	85.6	81.8	81.2	81.7	80.7	-0.2%	-0.6%
	Coal[2] (Mt)	190.7	189.8	190.1	189.7	189.8	0.0%	-0.2%
	Electricity sales (TWh)	863.2	862.9	862.8	862.2	859.2	-0.1%	-0.4%
	City gas sales[3] (Billion m³)	42.48	42.37	42.79	42.32	42.66	-0.1%	-0.3%
	Fuel oil sales (GL)	174.7	169.3	167.2	169.0	166.6	-0.2%	-0.4%
	Energy-related CO_2 emissions (Mt)	1,112	1,083	1,074	1,081	1,070	-0.1%	-0.4%

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.
3. Conversion factor: 1 m³ = 10,000 kcal

---

[6] Particularly, inventory valuation profit increases in the oil refining industry. For most Japanese trading companies that booked massive losses in FY2016 when crude oil and other resources prices declined, the recent oil price hikes would be used to reverse past losses and book profit under the International Financial Reporting Standards they have adopted.

Energy sales would fall by 0.3-0.4%, affected not only by the direct effect of oil price hikes but also economic deceleration. The percentage change is smaller by a degree of magnitude than recent annual changes in fuel oil sales. In primary energy supply in Japan, the total and oil would decrease by 0.3%. Natural gas would drop by 0.6% as consumption for both city gas and power generation plunge. CO_2 emissions would post a 0.4% fall, faster than the primary energy supply fall.

Who would pay additional JPY2.3 trillion?

Potential additional payments for oil and natural gas imports through oil price hikes would total JPY2.7 trillion. A 0.3-0.6% oil consumption cut could reduce the additional payments by $0.1 trillion. Households and companies would have to shoulder most of the remainder.

**Figure 6 | Share of additional spending [FY2019]**
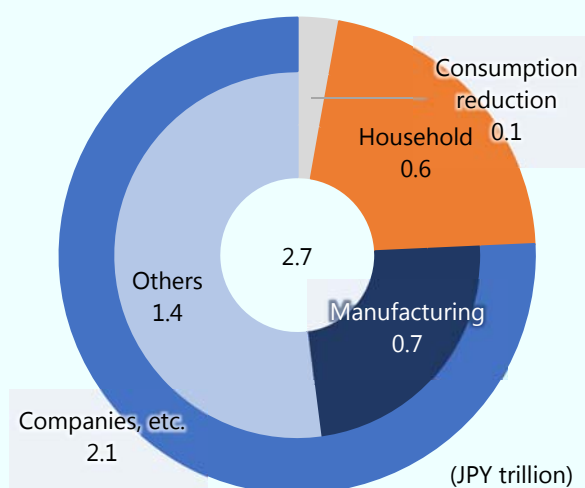
(JPY trillion)

Note: Manufacturing excludes oil and coal products producers.

Of the additional payments, households would shoulder JPY0.6 trillion. Energy cost increases would amount to JPY10,000 per year for each household. The sum includes JPY5,000 in electricity cost and JPY2,500 in gasoline cost. Burdens on households would increase further in rural regions depending on automobiles and cold regions featuring more heating demand.

**Figure 7 | Household energy cost increase [FY2019]**
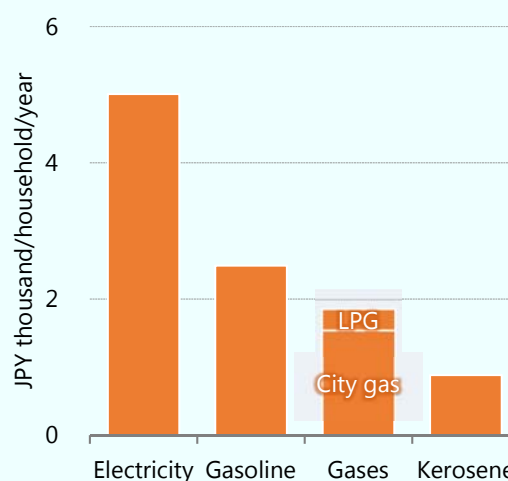
Companies can substantially mitigate the direct adverse effect of oil price hikes by raising prices of their products. Actually, however, they shoulder oil cost hikes while refraining from raising their products prices. Their oil cost hikes would total JPY2.1 trillion accounting for four-fifths of the additional payments.

Manufacturers other than oil and coal products producers would shoulder JPY0.7 trillion of companies' additional payments, deteriorating their operating balance[7] over a short term. Particularly, oil price hikes would remarkably affect earnings of the chemical industry, the largest oil consumer. They would cut earnings of industries for which energy accounts for a high share of total costs. Machinery manufacturers would have difficulties in reflecting raw material cost fluctuations in their products prices and take much time in doing so, being vulnerable to materials cost hikes. However, energy's share of their total costs is limited, making the adverse effect of oil price hikes on their earnings relatively smaller.

---

[7] Operating profit for manufacturers other than oil and coal products producers totalled about

JPY22 trillion in FY2017 (Financial Statements Statistics of Corporations by Industry).

Figure 8 | Contributions to cutting operating profit [FY2019]
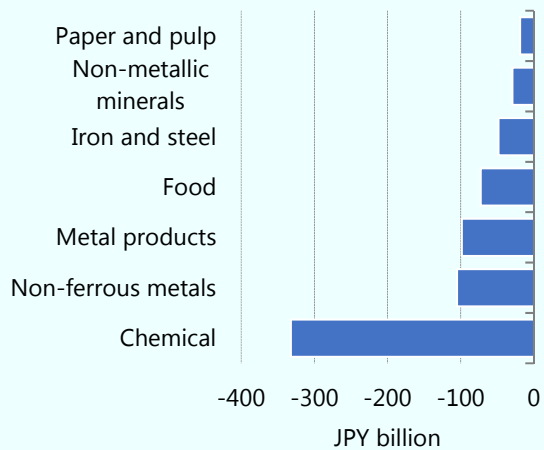
The remaining JPY1.4 trillion of the additional payments would be shouldered by nonmanufacturers, energy companies[8], the government, etc. Nonmanufacturers consume less energy on production and shoulder energy cost hikes more widely and thinly. Even among nonmanufacturers, transporters consuming massive oil would see their earnings affected seriously by oil price hikes.

---

[8] Within the feedstock and fuel cost adjustment system, oil price hikes would be fully reflected in prices of city gas and electricity.

Effects of uncertain factors [3] U.S. trade policy

A U.S. tariff on imported cars would be more serious than U.S.-China trade war for Japan's economy.

Ahead of this autumn's midterm congressional election in the United States, President Donal Trump's "America First" foreign policy is feared to grow dominant in U.S. trade policy. Even beyond the election, the tendency is expected by some analysts to continue. We have developed two hypothetical cases to assess U.S. trade policy's impacts on Japan's economy and energy demand[9].

If the United States and China impose a 45% tariff on imports from each other…

President Trump has implemented or is likely to implement what were taken as wild commitments he made during the presidential election campaigns in 2016. Among them are not only the withdrawal from the Trans-Pacific Partnership free trade agreement, the Paris Agreement and the Iran nuclear deal, the renegotiation of the North American Free Trade Agreement and the recognition of Jerusalem as the capital of Israel, but also the designation of China as a currency manipulator and a 45% tariff on imports from China with which the United States has the largest trade deficit. The incredibly high tariff has grown likelier amid a mixture of tension and relaxation.

Table 11 | U.S. and Chinese moves regarding trade

|	
3 April	The Office of the U.S. Trade Representative publishes a draft plan to impose an additional 25% tariff on $50 billion in Chinese imports across 1,300 categories of products for China's intellectual property rights violation.
4 April	The Chinese government announces a plan to levy a retaliatory tariff on $50 billion in U.S. imports across 106 categories of products.
5 April	President Trump calls for considering increasing the tariff target import value by $100 billion.
3-4 May	At a bilateral trade consultation, the United States asks China to reduce the U.S. trade deficit with China by $200 billion instead of $100 billion as earlier requested.
18 June	President Trump calls for considering a 10% tariff on $200 billion in Chinese imports and raising the sum by $200 billion if China levies a retaliatory tariff.
6 July	The United States and China begin to import an additional 25% tariff on $34 billion in imports from each other.

We assume that the United States and China would levy a 45% tariff on all imports from each other (High U.S. and Chinese Tariff Case). Such a U.S.-China trade war would push real GDP down by 2.1% in the United States and by 2.9% in China. As a result, oil consumption would decrease by 0.2 million barrels per day in the United States and 0.3 Mb/d in China. Natural gas consumption would decline by 13 billion cubic metres and by 6 Bcm in the United States and in China, respectively. While the trade war would push the global economy down by 0.6%, countries that could serve as substitution for the United States or China would benefit from the trade war. In Japan, one of such countries, real GDP would be pushed up by 0.4%. While Japan's exports to China would decline on China's economic growth deceleration, its exports to the United States would increase, being by electrical machinery. This could risk leading the United States to enhance its demand for Japan to cut a U.S. trade deficit with Japan.

---

[9] Although the impacts may take much time to emerge, we for the sake of convenience assume the impacts to emerge in FY2019 and compare the differing degrees of impacts with the Reference Scenario.

Figure 9 | Mutual tariff imposition's impacts on real GDP
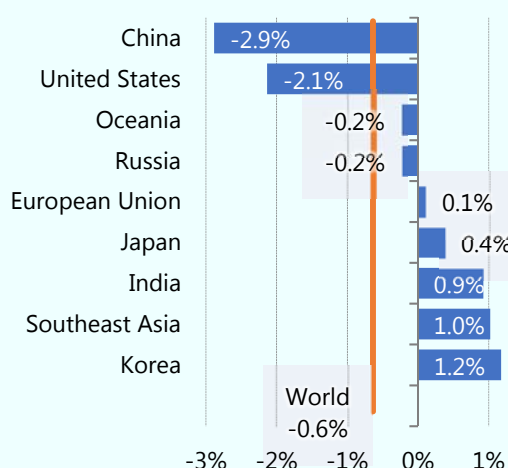
In Japan, energy consumption would increase slightly on economic expansion. However, coal consumption would decline a little on a fall in steel production due to less exports to Asia. Any adverse effect of the U.S.-China trade war could not be as great as expected generally.

Table 12 | Impacts of U.S.-China reciprocal tariff war on Japan

		High U.S. and Chinese Tariff
Economy	Real GDP	0.4%
	GNI per capita	1.1%
	Industrial production	0.2%
Energy	Primary energy supply	0.1%
	Oil	0.1%
	Natural gas	0.2%
	Coal	-0.1%
	Electricity sales	0.1%
	City gas sales	0.1%
	Fuel oil sales	0.1%
	Energy-related CO_2 emissions	0.1%

(Note) assume the impacts to emerge in FY2019 and compare the differing degrees of impacts with the Reference Scenario

If the United States levies a 20% tariff on imported vehicles...

In May, it was reported that the U.S. administration was considering increasing a tariff on vehicle imports to up to 25% for national security purposes in addition to tariffs on steel and aluminium imports. Given massive U.S. vehicle imports and the auto industry's business relations with a wide range of other

industries, such U.S. tariff's potential adverse impacts have become a matter of concern. Over such U.S. approach, severe confrontation between the United States and six other countries grew clearer at the Group of Seven Charlevoix summit in June and a meeting of G7 finance ministers and central bank governors, which was not designed for discussions trade policy.

(Source) Prime Minister's Office Instagram

Given that President Trump mentioned a 20% tariff on 1 July, we assume that the United States would levy a 20% tariff on imported vehicles and auto parts (U.S. Imported Vehicle Tariff Case). The impacts of the high tariff would be great, expanding U.S. vehicle and auto parts production by 8.4%. However, the U.S. economy would be pushed down by 0.4% and the global economy by 0.2%.

Figure 10 | U.S. vehicle import tariff's impacts on real GDP
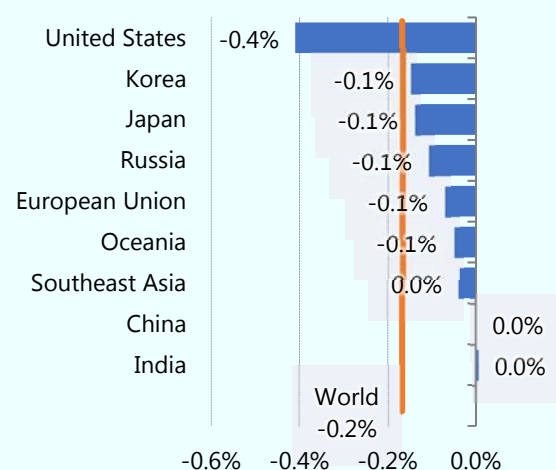
The Japanese economy would be pushed down by 0.1%, with vehicle production dropping by 3.6%. Given that the automotive industry has higher added values than other industries and has close relations with a wide range of other industries, industrial production would fall more remarkably than GDP. Among regions, Chubu where the transport machinery sector

plays a far greater role than in other regions would be seriously affected. Given that steel and other industries providing materials to the automotive industry would be exposed to adverse impacts, western Japan including the Chugoku and Kinki regions would be affected more seriously than indicated by a national average.

Figure 11 | Transport machinery industry's and steel industry's shares of gross regional product [2014]
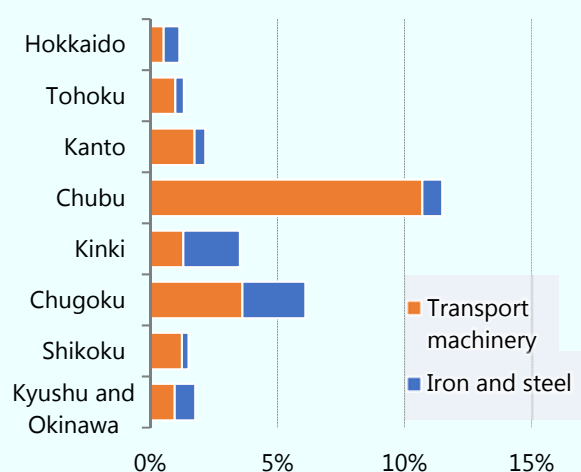
(Note) Automobile and its parts manufacturing industry accounts for about 80% of GDP by transport machinery industry.
(Source) Cabinet Office "Regional Accounts", "National Accounts"

Energy demand would also come under downward pressure. As the automotive industry is first affected by the tariff, electricity would post the largest sales decline. City gas would log the second largest drop close to the largest one. In Chubu, Hokuriku, Chugoku and Shikoku where industrial users' share of city gas sales is higher than in other regions, with the share being lower for residential users that are not so sensitive to economic conditions, city gas sales falls as well as the abovementioned industrial production drops could be more remarkable than in other regions. Among fuel oils, heavy fuel oil C would post a remarkable sales decrease of 0.3%. This is because heavy fuel oil C is used more heavily than other fuel oils for manufacturing plants, maritime freight transportation and power generation.

Table 13 | U.S. vehicle import tariff's impacts on Japan

		U.S. Imported Vehicle Tariff
Economy	Real GDP	-0.1%
	GNI per capita	-0.4%
	Industrial production	-0.4%
Energy	Primary energy supply	-0.1%
	Oil	0.0%
	Natural gas	-0.2%
	Coal	0.0%
	Electricity sales	-0.1%
	City gas sales	-0.1%
	Fuel oil sales	0.0%
	Energy-related CO_2 emissions	-0.1%

(Note) assume the impacts to emerge in FY2019 and compare the differing degrees of impacts with the Reference Scenario