ISSN 1880-9286

IEEJ Energy Journal

Vol.16, No.1 2021

Economic and Energy Outlook of Japan for FY2021

IEEJ Outlook 2021
- Energy transition in the post corona world

Smart City Development Trends Centered on the Transportation and Traffic Sector in ASEAN Countries
- Japan's Strengths and China's Rise in Smart City Exports to ASEAN Countries

The Institute of Energy Economics, Japan

Contents

Economic and Energy Outlook of Japan for FY2021

On the way back to a normal energy situation while ending the COVID-19 pandemic◆

Ryo Eto*

Introduction

The Japanese economy in the third quarter of 2020 posted a growth rate of 5.3% in gross domestic product, the first positive growth in four quarters, in response to economic reopening following the lifting of a state of emergency declaration. Domestic demand contributed 2.6 percentage points to the growth and external demand 2.7 points. The Japanese economy and the world economy are moderately recovering from a plunge triggered by COVID-19 and are expected to recover further amid efforts to promote economic activities while preventing COVID-19 from spreading.

The average crude oil import price for Japan fell to $25 per barrel in June due to a global oil demand decline. It rallied later as COVID-19 constraints on economic activities decreased gradually despite a damper from concern about the resurgence of COVID-19. Currently, it is staying above $40/bbl.

Applications have been filed for examinations of 27 nuclear power plants for conformity to new regulatory standards in Japan. Of them, 16 have cleared the examinations, including nine that have restarted. However, five of the nine restarted plants have suspended operation because of judicial problems or a delay in the completion of counterterrorism facilities.

As the feed-in tariff (FIT) scheme for solar photovoltaics power generation at households began to expire in November 2019, 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

● COVID-19

While knowledge about COVID-19 treatments and countermeasures has deepened, 95% effective COVID-19 vaccines have been made available in Europe and the United States. We assume that new COVID-19 infections will gradually decrease from January 2021, with the number of seriously ill patients being held down to avoid healthcare collapse, a state of emergency declaration, or social unrest growth. In FY2021, we assume that the situation will improve due to the promotion of COVID-19 vaccination and treatments, while social distancing and other COVID-19 countermeasures are retained, with time taken for confirming vaccination effects and developing vaccination arrangements.

● Global economy

Global economic growth is assumed at -4.4% for 2020, the lowest since the end of World War II, and at 5.2% for 2021. In 2020, the global economy contracted substantially due to social distancing practices and lockdowns under the COVID-19 pandemic. In 2021, consumption and investment are assumed to gradually recover, though with global GDP managing to grow by 0.6% from 2019 before the COVID-19 outbreak.

◆ This report is based on the information as of December 24, 2020.

* Senior Economist, Energy and Economic Analysis Group (EEA), Energy Data and Modelling Center (EDMC), The Institute of Energy Economics, Japan

- **Crude oil/LNG/coal import CIF prices**

Crude oil import prices for Japan are assumed to average $43/bbl in FY2020 ($36/bbl in the first half and $50/bbl in the second) and $52/bbl in FY2021, based on the international crude oil price outlook below, rising from the second half of FY2020. The average LNG import price for Japan is assumed to rise from $6.8/MBtu in FY2020 to $7.3/MBtu in FY2021, reflecting earlier crude oil price rises. Steam coal import prices are projected to gradually rise from the second half of FY2020 to FY2021. Coking coal import prices are also assumed to increase as steel demand grows due to China's economic recovery. Steam coal import prices are assumed to average $81/t in FY2020 and $93/bbl in FY2021. Coking coal import prices are projected to average $102/t in FY2020 and $115/t in FY2021. (IEEJ Hashizume "Outlook and Challenges for Oil Market," Hashimoto "Outlook and Challenges for Gas Market," Ito "Outlook and Challenges for International Coal Market.")

- **Exchange rate**

We assume the dollar's average exchange rate with the yen to stand at JPY105.8/USD in FY2020 and at JPY105.0/USD in FY2021.

- **Air temperature**

According to the Japan Meteorological Agency's three-month weather forecast, we assume that winter in FY2020 will be slightly warmer than normal before temperatures restore normal levels in FY2021. FY2020 summer was as warm as the previous summer (+0.0 °C). FY2020 winter will be colder (-1.2 °C) than the previous winter that was far warmer than normal. Summer in FY2021 will be cooler (-0.5°C) than the previous summer. Winter in FY2021 will be slightly colder (-0.2°C).

- **Nuclear power generation**

Given progress in regulatory standards conformity examinations for nuclear power plants, more plants are assumed to restart. Two nuclear power plants were to restart within FY2020, bringing the cumulative number of restarted plants to 11 at the end of the fiscal year. As five restarted plants have been suspended due to judicial problems or a delay in the completion of counterterrorism facilities, the 11 plants in FY2020 will operate for an average five months and generate 44.2 TWh, down 27.5% from the previous year. Two nuclear power plants will restart in FY2021, bringing the cumulative number of restarted plants to 13 at the end of the fiscal year. However, four restarted plants will be suspended due to judicial problems or a delay in the completion of counterterrorism facilities. In FY2021, the 13 restarted plants will operate for an average eight months and generate 79.7 TWh, up 80.0% from the previous year.

Macro economy

- **GDP will score a real growth rate of 3.4% in FY2021 but remain below the FY2019 level before the COVID-19 pandemic due to a steep contraction in FY2020**

Japan's gross domestic product in FY2020 will post the largest post-war contraction of 5.5%, despite a rebound in the second half. Private consumption will decline by 5.8% as voluntary restrictions remain in the second half. Private non-residential investment will decrease by 7.2% due to deterioration in earnings and uncertainties. Private demand will thus contribute -5.2 points to the contraction. Public demand will contribute 0.7 points due to economic stimulus measures such as a special fixed-sum cash handout. External demand will make a contribution of -1.0 points to the contraction as manufacturers' exports drop due to stagnant European and American economies.

In FY2021, Japan's GDP will score a 3.4% increase covering a little more than half of the contraction in the

previous year. Private consumption will rise by 3.4% as consumer sentiment improves under the easing impacts of the COVID-19 pandemic. Given continuous efforts to prevent COVID-19 infections, as well as income and employment environment deterioration, any recovery in spending on eating-out, travelling, and leisure will be limited. Private non-residential investment will grow by 2.4% as a decline in uncertainties and a rebound in business earnings encourage companies to implement investment carried over from the previous year in equipment to enhance business efficiency and cope with labour shortages, as well as in information facilities for telework and other infection prevention measures. Private demand's contribution to the growth will be limited to 2.1 points, less than in FY2012 after the Great East Japan Earthquake. Public demand will contribute 0.4 points to the growth and hit a record high due mainly to an increase in public investment related to the National Resilience Plan and healthcare expenditure growth. External demand's contribution to the GDP growth will be limited to 0.9 points as export growth amid a moderate global economic recovery is countered by import growth.

Japan's fossil fuel imports will plunge by 38.4% in FY2020 due to a demand fall and drops in all fossil fuel prices. In FY2021, they will increase by 15.4% due to a demand recovery and price hikes but be limited to the lowest level in 17 years excluding FY2020.

Table 2 Macroeconomic indicators

	Historical				Projection		Year-over-year		
	FY2010	FY2017	FY2018	FY2019	FY2020	FY2021	FY2019	FY2020	FY2021
Real GDP (JPY2015 trillion)	512.1	553.1	554.8	552.9	522.4	540.4	-0.3%	-5.5%	3.4%
Private demand	383.7	415.2	416.1	412.9	384.1	395.0	(-0.6%)	(-5.2%)	(2.1%)
Private consumption	290.5	302.2	302.7	299.8	282.5	292.0	-0.9%	-5.8%	3.4%
Private residential investment	18.2	20.9	19.9	20.4	19.0	19.2	2.5%	-6.9%	1.1%
Private non-residential investment	73.7	90.2	91.1	90.5	84.0	86.0	-0.6%	-7.2%	2.4%
Public demand	124.2	135.0	136.2	138.9	143.1	145.1	(0.5%)	(0.7%)	(0.4%)
Government consumption	98.1	107.5	108.7	110.9	113.9	115.3	2.0%	2.8%	1.2%
Public investment	26.2	27.4	27.6	28.0	29.1	29.8	1.5%	3.9%	2.3%
Net exports of goods and services	4.7	3.3	2.7	1.2	-5.1	-0.1	(-0.2%)	(-1.0%)	(0.9%)
Exports of goods and services	83.8	103.0	105.1	102.4	89.5	98.4	-2.6%	-12.6%	10.0%
Imports of goods and services	79.2	99.7	102.5	101.2	94.6	98.5	-1.2%	-6.5%	4.2%
Nominal GDP (JPY trillion)	504.9	555.7	556.8	559.7	532.5	551.4	0.5%	-4.9%	3.5%
Balance of trade (JPY trillion)	5.3	2.4	-1.6	-1.3	2.7	10.6	-19.8%	-311.0%	289.6%
Exports	67.8	79.2	80.7	75.9	65.5	72.7	-6.0%	-13.7%	11.0%
Imports	62.5	76.8	82.3	77.2	62.8	62.1	-6.3%	-18.7%	-1.1%
Fossil fuels	18.1	16.3	19.1	16.6	10.2	11.8	-13.2%	-38.4%	15.4%
Oil	12.3	9.6	11.3	10.1	5.7	6.9	-11.0%	-43.1%	20.2%
LNG	3.5	4.1	4.9	4.1	2.7	2.9	-15.8%	-33.0%	3.9%
Current account (JPY trillion)	18.3	22.4	19.6	20.1	21.1	31.1	2.8%	5.0%	47.0%
Domestic corporate goods price index (2015=100)	97.6	99.3	101.5	101.6	99.8	100.6	0.1%	-1.7%	0.7%
Consumer price index (2015=100)	96.4	100.7	101.4	102.0	101.5	101.7	0.5%	-0.5%	0.2%
Unemployment rate (%)	5.0	2.7	2.4	2.3	3.1	3.3	[-0.1%]	[0.8%]	[0.1%]

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

Production activities

- **Industrial production mainly heavy electrical machinery and automobiles will increase in FY2021 against the backdrop of global and Japanese economic recovery but be limited to a level just above the FY2009 result after the global financial crisis.**

In FY2020, the industrial production index will plunge by 9.9% from the previous year due to global and domestic economic stagnation, although demand for home electrical appliances and information equipment

such as personal computers will increase because of stay-home and telework practices for avoiding COVID-19 infections. The index will slip to 90.1 below 91.6 for FY1987. As a wide range of industries mainly heavy electric machinery and automobile sectors expand production on the calming-down of the COVID-19 pandemic in FY2021, the index will rise by 7.5%, managing to surpass 93.0 for FY2009 after the global financial crisis.

Crude steel production in FY2020 will post a substantial decline of 15.6% as both domestic and overseas demand decreases on a steep global fall in machinery production and construction under the COVID-19 pandemic, slipping below 90 million tons for the first time since FY1971. In FY2021, crude steel production will score a sharp increase of 6.9% thanks to a recovery in domestic demand for machinery and building materials and in exports to ASEAN but remain below 90 million tons for the second straight year.

Ethylene production in FY2020 will decline by 7.5% from the previous year due to a fall in exports amid frequent regular ethylene plant repairs and a plunge in synthetic resin demand amid a decline in automobile and other domestic production, slipping below 6 million tons for the first time since FY1993. In FY2020, ethylene production will rise by 4.9% thanks to an overall industrial production recovery and an export increase amid a decrease in regular ethylene plant repairs, managing to surpass 6 million tons.

Cement production in FY2020 will decrease by 2.9% to 56.5 million tons due to the postponement of construction for avoiding COVID-19 infections, although exports will rise thanks to supply shortages under environmental regulations in China. The production level is close to 56.1 million tons in FY2010, the lowest since FY1970. In FY2021, exports will increase as demand in Southeast Asia and Oceania recovers after a decline under the COVID-19 pandemic. Domestic demand will also grow as construction of disaster prevention and reduction facilities under the National Resilience Plan is normalised. Cement production in FY2021 will thus rise by 1.2% to 57.1 million tons, still the third lowest level since FY1970.

Paper and paperboard production in FY2020 will nose-dive by 8.5% from the previous year as rapid computerisation is coupled with a drop in printing paper demand through increasing telework, a fall in advertisement paper demand through decreasing events, and a decrease in paperboard demand through falling souvenir demand amid sluggish industrial activities and tourism demand, although electronic commerce expansion will work to boost paperboard production. In FY2021, paper and paperboard production will rise by 5.5% as electronic commerce expansion coincides with a recovery in industrial activities and tourism demand. However, a long-term downtrend will be sustained.

Automobile production in FY2020 will post a steep decline of 19.8% and slip below 80 million units for the first time since FY1976 as car purchase opportunities decrease due to income drops and stay-home campaigns in the world. In FY2021, automobile production will increase by 16.4% in line with a global economic recovery. As export growth is limited due to a slow recovery in overseas markets, the production will be lower than 88.65 million units in FY2009 after the global financial crisis.

Table 3 Production activities

		Historical				Projection		Year-over-year		
		FY2010	FY2017	FY2018	FY2019	FY2020	FY2021	FY2019	FY2020	FY2021
Production	Crude steel (Mt)	110.8	104.8	102.9	98.4	83.0	88.8	-4.3%	-15.6%	6.9%
	Ethylene (Mt)	7.00	6.46	6.19	6.28	5.81	6.09	1.5%	-7.5%	4.9%
	Cement (Mt)	56.1	60.4	60.2	58.1	56.5	57.1	-3.5%	-2.9%	1.2%
	Paper and paperboard (Mt)	27.3	26.4	26.0	25.0	22.9	24.1	-3.8%	-8.5%	5.5%
	Automobiles (Million units)	8.99	9.68	9.75	9.49	7.61	8.85	-2.7%	-19.8%	16.4%
Production indices	Mining and manufacturing (2015=100)	101.2	103.5	103.8	99.9	90.1	96.8	-3.7%	-9.9%	7.5%
	Food and tobacco	100.7	100.2	99.6	100.5	97.1	99.7	0.9%	-3.4%	2.6%
	Chemicals	99.6	105.4	107.5	104.5	98.8	103.0	-2.8%	-5.4%	4.3%
	Non-ferrous metals	100.0	103.5	104.3	99.2	88.4	94.7	-4.8%	-10.9%	7.2%
	Machinery	99.4	105.0	105.6	100.3	87.9	97.2	-5.1%	-12.3%	10.5%
Tertiary industry activity index (2015=100)		97.6	101.9	103.0	102.3	95.4	99.6	-0.7%	-6.8%	4.5%

Notes: Chemicals include chemical fibers.
Machinery includes general machinery, electrical machinery, information and telecommunications equipment, electronic parts and devices, precision machinery and metal products.

Primary energy supply

- **As energy consumption increases substantially in FY2021, nuclear energy supply will rise, with LNG Imports falling to the FY2010 level before the Great East Japan Earthquake impact. CO2 emission cuts will achieve more than 90% of the Paris Agreement target for the second straight year.**

In FY2020, primary energy supply in Japan will plunge by 5.5% from the previous year due to production cuts by machinery and other manufacturers and a transportation volume decline under the COVID-19 pandemic, despite a reactionary energy supply rise after the previous year's warmer winter. In FY2021, energy supply will increase by 2.6% thanks to a recovery in industrial activities and transportation volume but still be the second lowest since FY1987. Energy consumption per GDP will improve by less than 1% for the second straight year, indicating a far slower improvement than in earlier years.

New energy supply including solar, wind and biomass energies will decelerate growth to 2.2% due to the pandemic in FY2020. In FY2021, growth will accelerate to 3.8% as more new capacity including non-residential solar PV plants will be launched.

Nuclear power generation in FY2020 will decline by 26.5% from the previous year as the suspension of restarted plants is prolonged, despite the restart of two more plants. In FY2021, two more plants will be restarted, but four restarted plants will halt operation due to judicial problems and a delay in the completion of counterterrorism facilities. Nuclear power generation growth will be limited to 75.6%.

Oil supply will post an 8.2% plunge from the previous year, the largest fall since FY1980, due to sharp drops in production activities, transportation volume, and petroleum products exports including jet fuel. In FY2021, oil supply will increase by 3.1% thanks to a recovery in production activities and transportation volume as well as a rise in ethylene production. Note that a rise in oil's share of Japan's total primary energy supply will be limited to 0.2 percentage points due to energy efficiency improvement and fuel switching.

Coal supply will decline by 5.4% in FY2020 due to sharp falls in crude oil and cement production, although coal for power generation will increase on the launch of new capacity. In FY2021, coal supply will rise by 3.4% as coal for both power generation and industrial production expands on the launch of new power generation capacity and a recovery in industrial materials production.

Natural gas supply will decrease for both power generation and city gas production in FY2020, posting a decline of 1.1% from the previous year. In FY2021, natural gas supply will fall by 5.6% for the fifth straight

year of decline despite an increase in supply for city gas production as supply for power generation decreases in line with an increase in nuclear power generation. LNG imports will decline to the FY2010 level for the first time since the Great East Japan Earthquake.

Japan's energy self-sufficiency rate in FY2020 will increase by 0.1 percentage points due to a drop in fossil fuel demand, despite the nuclear power generation fall. In FY2021, the rate will rise by 2.2 points to 14.4% for the seventh straight year of increase, covering 60% of the target of 24.3% for FY2030.

Japan's energy-related CO_2 emissions in FY2020 will decrease by 8.8% to 939 Mt, down 24.0% from the standard year of FY2013 for the Paris Agreement. Japan will thus almost accomplish the target cut of 25.0% from FY2013 for FY2030. In FY2021, emissions will increase by 1.6% to 955 Mt on an increase in fossil fuel demand under an economic recovery. The emissions represent a 22.7% decline from FY2013, covering more than 90% of the target. However, the low emission levels are attributable primarily to an energy demand decline under a temporary economic slowdown. A future challenge for Japan will be how to secure progress toward the achievement of the target.

Table 4 Primary energy supply

	Historical				Projection		Year-over-year		
	FY2010	FY2017	FY2018	FY2019	FY2020	FY2021	FY2019	FY2020	FY2021
Primary energy supply (Mtoe)	515.9	465.1	455.4	444.4	420.0	431.0	-2.4%	-5.5%	2.6%
Coal	119.1	123.7	121.5	120.4	113.9	117.8	-0.9%	-5.4%	3.4%
Oil	212.0	185.5	176.2	170.1	156.1	160.8	-3.5%	-8.2%	3.1%
Natural gas	95.7	111.4	106.7	102.4	101.2	95.6	-4.0%	-1.1%	-5.6%
LNG imports (Mt)	70.6	83.9	80.6	76.5	74.9	71.3	-5.0%	-2.1%	-4.8%
Hydro	17.7	17.5	16.7	16.5	16.7	16.6	-1.1%	1.2%	-0.6%
Nuclear	60.7	6.8	13.3	13.0	9.6	16.8	-1.8%	-26.5%	75.6%
New energy, etc.	10.7	20.2	21.1	22.1	22.5	23.4	4.4%	2.2%	3.8%
Self-sufficiency rate	20.2%	9.4%	11.7%	12.1%	12.2%	14.4%	0.5p	0.1p	2.2p
Energy intensity (FY2013=100)	104.9	87.8	85.8	84.0	83.9	83.3	-2.1%	-0.1%	-0.8%
Energy-related CO_2 emissions ($MtCO_2$)	1,137	1,110	1,065	1,029	939	955	-3.4%	-8.8%	1.6%
Change from FY2013	-8.0%	-10.1%	-13.8%	-16.7%	-24.0%	-22.7%	-2.9p	-7.3p	1.3p

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 FY2021 will increase as industrial sales rise on a manufacturing production recovery, with residential sales remaining high after a sharp expansion in the previous year. Fossil electricity sources' share of the power generation mix will slip below 70% for the first time since FY2011, though with the coal share increasing.**

In FY2020, electricity sales will fall by 1.5%. Sales to power service users will decline by 4.3% due to sluggish production in steel and machinery industries, although space and water heating demand will increase in reaction to warmer winter weather in the previous year. Sales to lighting service users will increase by 4.3% due to a colder winter than in the previous year as well as spreading telework and stay-home campaigns.

In FY2021, electricity sales will increase by 1.2% from FY2020 but fall by 0.4% from FY2019 before the COVID-19 pandemic. Sales to power service users will rise by 1.8% on a production recovery in steel and machinery industries. From FY2019, however, they will decrease by 2.5%. Sales to lighting service users will fall by 0.1% due to the stay-home rate's decline in reaction to stay-home campaigns in the previous year and the diffusion of light-emitting diode lamps and other energy-efficient equipment and solar PV power generation, although the electrification of water heating and cooking equipment will make progress on an increase in all-

electric homes.

The electricity retail deregulation led power producer/supplier companies' share of total electricity sales to rise from 5.1% in April 2016 to 19.7% in August 2020. Such share rose to 21.5% for lighting service users and 17.3% for low voltage users, indicating a steady uptrend. It also increased for high and extra-high voltage users despite an overall electricity demand decline in FY2020. PPS companies' share expanded from 10.5% in April 2016 to 26.2% in August 2020 for high-voltage users and from 5.3% to 8.5% for extra-high voltage users. High voltage users have switched to PPS companies as much as low voltage users.

Nuclear energy's share of total power generation will fall by 1.8 points due to prolonged regular plant checks in FY2020 but increase by 3.8 points thanks to the restart of more nuclear plants and fewer regular checks in FY2021. The share for non-hydro renewables will rise by 1.2 points due to a fall in electricity demand, although less new capacity is launched. In FY2021, the share will increase by 1.0 points as more new non-residential solar PV capacity is launched. Although hydro's share will shrink by 0.1 points due to the retirement of the 20,000 kW Kamiiwamatsu Unit-1 plant in July 2021, non-fossil electricity sources' share will rise to 30.6%, topping 30% for the first time since the Great East Japan Earthquake. However, the share will still be 7.6 points lower than 38.2% in FY2010, being required to rise further.

New coal-fired power plants went on stream one after another in the first half of FY2020 and will do so in and after the second half. Three plants (Kushiro, Hitachinaka Kyodo Unit 1, and Kaita) with capacity at 0.87 GW will launch commercial operation in the second half of 2020 and three more (Hirono IGCC, Taketoyo, and Kobe) with capacity at 2.26 GW in FY2021. Coal's share of total power generation will thus rise by 1.4 points in FY2020 and by 0.7 points in FY2021, reaching 30.8%. The share for power plants fired by fuel oil C and crude oil will drop by 0.6 points in FY2021. The LNG share will decline by 4.7 points to 32.5% in FY2021, still 3.2 points higher than 29.3% for FY2010 before the Great East Japan Earthquake affected nuclear power generation and led to a sharp rise in LNG-fired power generation.

Table 5 Electricity sales and power generation mix (electric utilities)

	Historical				Projection		Year-over-year		
	FY2010	FY2017	FY2018	FY2019	FY2020	FY2021	FY2019	FY2020	FY2021
Electricity sales (TWh)	(926.6)	863.2	852.6	836.0	823.1	832.7	-1.9%	-1.5%	1.2%
Lighting service	304.2	279.3	270.3	266.7	278.1	277.7	-1.4%	4.3%	-0.1%
Power sercice	(622.4)	583.9	582.2	569.4	545.0	555.0	-2.2%	-4.3%	1.8%
Extra-high and High voltage	(576.5)	544.9	544.6	533.2	508.7	518.6	-2.1%	-4.6%	1.9%
Low voltage	(45.9)	39.0	37.6	36.2	36.3	36.4	-3.7%	0.1%	0.2%
Electricity generated and purchased (TWh)	(1,028)	966.4	949.0	923.5	909.3	919.5	-2.7%	-1.5%	1.1%
Hydro	(8.5%)	9.3%	9.2%	9.4%	9.7%	9.5%	0.2p	0.3p	-0.1p
Fossil fuels	(61.7%)	79.5%	75.2%	73.8%	74.1%	69.4%	-1.4p	0.3p	-4.7p
Coal	(25.0%)	29.5%	28.7%	28.7%	30.1%	30.8%	-0.0p	1.4p	0.7p
LNG	(29.3%)	41.1%	39.6%	38.4%	37.2%	32.5%	-1.2p	-1.2p	-4.7p
Oil, etc.	(7.5%)	8.9%	6.9%	6.7%	6.8%	6.1%	-0.2p	0.1p	-0.6p
Nuclear	(28.6%)	3.2%	6.5%	6.6%	4.9%	8.7%	0.1p	-1.8p	3.8p
Renewables (excluding hydro), etc.	(1.1%)	7.9%	9.0%	10.2%	11.4%	12.4%	1.2p	1.2p	1.0p

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 in FY2021 will rise from FY2019 but those to industrial and commercial users will fall short of covering a plunge in FY2020 due to temperature changes**

City gas sales[1] in FY2020 will decline by 3.3% from the previous year and slip below 40 billion m^3 for the first time in five years due to drops in those to industrial and commercial users, despite increases in those to residential users, power utilities, and others. In FY2021, city gas sales will expand by 3.8% to 40.6 billion m^3, topping the FY2019 level. However, the rise from FY2019 will reflect a sharp increase in sales to power utilities in FY2020, as well as sluggish gas demand in FY2019's winter that was the warmest since FY1897 when the temperature survey started. Sales to industrial and commercials users in FY2021 will slip below the 2019 levels.

Of residential sales, those for cooking had continued to structurally decrease due to the spread of induction heating cookers. Those for water and space heating had also structurally declined on the diffusion of more energy efficient water heaters and all-electric homes. In FY2020, however, residential sales increased by 4.7% thanks to a rise in those for water and space heating after the previous year's warm winter, as well as a higher stay-home rate caused by voluntary restrictions on outing and growing telework. In FY2021, residential sales will decline by 1.4% due to the year's slightly warmer winter and a stay-home rate fall in reaction to the voluntary restrictions on outing in the previous year.

Regarding business sales (commercial and other sales) in FY2020, water and space heating demand will increase due to a colder winter, despite continued energy efficiency improvement that works to cut gas sales. However, commercial sales will plunge by 10.0% and slip below 4 billion m^3 for the first time in 21 years as providers of accommodation, food, living-related and personal, and amusement services are hard hit by voluntary restrictions on outing and social distancing campaigns to avoid COVID-19 infections. The other sales, though being affected by school closure and online classes, will increase by 4.2% due to the winter temperature change. In FY2021, accommodation, food, living-related and personal, and amusement services will recover, but social distancing campaigns will continue in a manner to force these services to remain less brisk than in FY2019 before the COVID-19 pandemic. Furthermore, cooler summer weather will work to cut air-conditioning demand. Commercial sales, though rising by 6.5% from FY2020, will fall short of reaching 4 billion m^3 and post a 4.2% decrease from FY2019 including a warmer winter. The other sales will expand by 3.5% on the normalisation of schools and healthcare providers, despite the diffusion of remote medical care and online classes and a decline in air-conditioning demand.

Industrial sales in FY2020 will decrease by 6.2%. Those to manufacturing users will plunge by 9.2% on the stagnation of automobile and other machinery production. As the Mooka thermal power station's Unit 1 and 2 (each with capacity at 620 MW) started operation in September 2019 and March 2020, respectively, those to power utilities will expand by 8.2%. In FY2021, industrial sales will expand by 5.6%. Those to manufacturing users will rise by 7.1% on a production recovery. Those to power utilities will remain almost unchanged in the absence of major thermal power plants launching operation.

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 15.9% in August 2020. Their share came to 11.6% for residential sales in three years and a half after the full deregulation and to 5.1% for commercial sales. The share for residential sales has been firmly rising. New gas suppliers' share for industrial sales levelled off before starting an uptrend in the second half of FY2019. It rose from 12.6% in April 2017 to 20.1%, rising more rapidly than for the share for commercial sales.

[1] Sales by gas utilities excluding former community gas utilities

Table 6 City gas sales (gas utilities)

	Historical				Projection		Year-over-year		
	FY2010	FY2017	FY2018	FY2019	FY2020	FY2021	FY2019	FY2020	FY2021
Total (Billion m^3)	39.28	42.43	41.58	40.40	39.07	40.55	-2.8%	-3.3%	3.8%
Residential	9.79	9.87	9.24	9.38	9.81	9.67	1.4%	4.7%	-1.4%
Commercial	4.75	4.36	4.26	4.16	3.74	3.99	-2.3%	-10.0%	6.5%
Industrial	21.61	24.49	25.03	23.82	22.34	23.60	-4.8%	-6.2%	5.6%
Manufacturing	(20.28)	20.19	20.51	19.66	17.85	19.11	-4.1%	-9.2%	7.1%
Electric utilities	(1.34)	4.29	4.52	4.15	4.49	4.49	-8.0%	8.2%	0.0%
Others	3.13	3.71	3.05	3.05	3.18	3.29	0.2%	4.2%	3.5%

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

Fuel oil/LPG sales and crude oil throughput

- **Fuel oil sales including those for transportation in FY2021 will increase from the previous year for the first time in nine years but retain a long-term downtrend.**

Fuel oil sales in FY2020 will post a substantial decline of 6.5% from the previous year as those for transportation and industrial use decrease sharply due to COVID-19 countermeasures despite a colder winter. The decline will be the largest since FY2008. In FY2021, fuel oil sales will increase by 3.1% from FY2020 for the first rise in nine years as those for transportation and industrial use recover. From FY2019, however, they will show a 3.6% decrease, prolonging a long-term downtrend.

Gasoline sales in FY2020 will record the largest post-war annual decline of 4.8 million kL or 9.8% as passenger car transportation volume plunges on COVID-19 countermeasures. In FY2021, gasoline sales will increase by 4.8% for the first rise in six years as transportation volume recovers. From FY2019, however, they will fall by 5.4%, indicating a long-term downtrend.

Naphtha sales in FY2020 will decrease by 5.9% due to frequent regular checks on ethylene plants, hitting the lowest level since FY1993 along with ethylene production. In FY2021, they will increase by 4.1% thanks to longer ethylene plant operation.

Kerosene sales in FY2020 will increase by 12.8% due to a rise in the stay-home rate and a colder winter. In FY2021, they will drop by 1.7% due to fuel switching, despite an increase in space heating demand. Among fuel oil products, however, kerosene alone will score a sales increase from FY2019.

Diesel oil sales in FY2020 will drop by 6.1% from the previous year and slip below 32 million kl for the first time in 33 years. In FY2021, they will increase by 3.5% on a recovery in transportation demand but stand at the second lowest level since FY2009.

Heavy fuel oil A sales in FY2020 will drop by 1.8% on a plunge in industrial production and slip below 10 million kl for the first time in 51 years, although space and water heating demand in buildings, hospitals and schools will increase because of a colder winter. In FY2021, they will decline by 1.3% due to energy efficiency improvement and fuel switching, despite an industrial production recovery and a rise in space and water heating demand.

Heavy fuel oil B/C sales for industrial use will increase by 0.4% in FY2021 on a production recovery, despite fuel switching and energy efficiency improvement. Those for power generation will decline as oil-fired power plants' operation factor declines on the shutdown of such power plants in Tokyo and Chubu regions from FY2020. Total heavy fuel oil B/C sales will plunge by 13.1% in FY2020 and by 10.0% in FY2021, reaching 20% of the FY2012 level, the highest since the Great East Japan Earthquake.

In FY2020, LPG sales in the buildings sector will rise for space heating but decrease for cooking due to the reduced operations of restaurants. Those in the industry sector will decline on a production slowdown and the

reduced operations of ethylene plants. Those for commercial passenger transportation will also decrease. Total LPG sales in FY2020 will decline by 6.2%. In FY2021, they will increase by 4.3% on a rebound in restaurant operations, industrial production, and commercial passenger transportation.

Crude oil throughput will post a substantial decrease of 16.3% due to a steep fall in transportation fuel exports including jet fuel, declining faster than fuel oil sales. In FY2021, crude oil throughput will score a 2.8% increase, rising slower than fuel oil sales in the absence of any recovery in transportation fuel exports.

Table 7 Fuel oil/LPG sales and crude oil throughput

	Historical				Projection		Year-over-year		
	FY2010	FY2017	FY2018	FY2019	FY2020	FY2021	FY2019	FY2020	FY2021
Fuel oil sales (GL)	196.0	174.7	167.7	161.6	151.2	155.9	-3.6%	-6.5%	3.1%
Gasoline	58.2	51.8	50.6	49.1	44.3	46.4	-3.0%	-9.8%	4.8%
Naphtha	46.7	45.1	43.9	42.5	40.0	41.7	-3.1%	-5.9%	4.1%
Jet fuel	5.2	5.0	5.0	5.1	3.5	4.3	3.5%	-32.9%	25.3%
Kerosene	20.3	16.6	14.5	13.6	15.4	15.1	-6.3%	12.8%	-1.7%
Diesel oil	32.9	33.8	33.8	33.7	31.6	32.7	-0.4%	-6.1%	3.5%
Heavy fuel oil A	15.4	11.5	11.1	10.2	10.0	9.8	-8.2%	-1.8%	-1.3%
Heavy fuel oils B and C	17.3	10.8	8.8	7.4	6.4	5.8	-16.3%	-13.1%	-10.0%
For electric utilities	7.7	6.0	4.0	2.6	2.2	1.6	-33.3%	-15.9%	-29.7%
For other users	9.7	4.8	4.9	4.7	4.2	4.2	-2.5%	-11.5%	0.4%
LPG sales (Mt)	16.5	14.8	14.2	14.1	13.3	13.8	-0.5%	-6.2%	4.3%
Crude oil throughput (GL)	208.9	184.2	176.7	174.0	145.6	149.6	-1.5%	-16.3%	2.8%

Renewable power generation (FIT power source)

- **Installed renewable power generation capacity will expand to 87 GW, though with growth decelerating on COVID-19.**

Renewable power generation capacity approved under the FIT scheme reached 105 GW in March 2017. As approval for some capacity before installation was cancelled, however, the capacity subject to existing approval now remains around 90 GW. At the end of June 2020, approved renewable power generation capacity stood at 93.1 GW (including 74.3 GW for solar PV, 9.0 GW for wind and 8.3 GW for biomass).

If all the approved capacity of 93.1 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 has 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 86.8 GW at the end of FY2021. Non-residential solar PV capacity will expand to 53.0 GW by the end of FY2021, although the COVID-19 spread delays installation by restricting solar PV plant builders' communications with residents near plant sites and making it difficult to secure construction workers. As a long

[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 24.8% for wind, 13.7% for solar PV, 70% for geothermal energy, 45% for hydro and 70% for biomass.

time is required for launching wind power generation after approval because of environment assessment and other procedures, wind generation capacity will be limited to 5.3 GW. Renewable power generation in FY2021 will total 166.2 TWh (including 79.8 TWh for solar PV, 39.9 TWh for small and medium-sized hydroelectric plants, 32.7 TWh for biomass and 10.1 TWh for wind), accounting for 17% of Japan's total power generation.

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 feed-in premium (FIP). The connect and manage system to overcome constraints on renewable energy facilities' connection to the grid will be enhanced under the revised act. It will be important to make renewable energy competitive and a major power source that would remain stable over a long time.

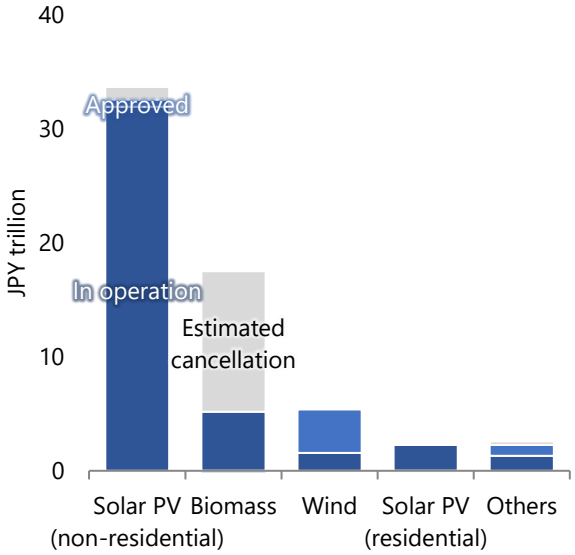


Fig. 1
Cumulative burden of FIT scheme over purchasing period (capacity approved or in operation at the end of June 2020)

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

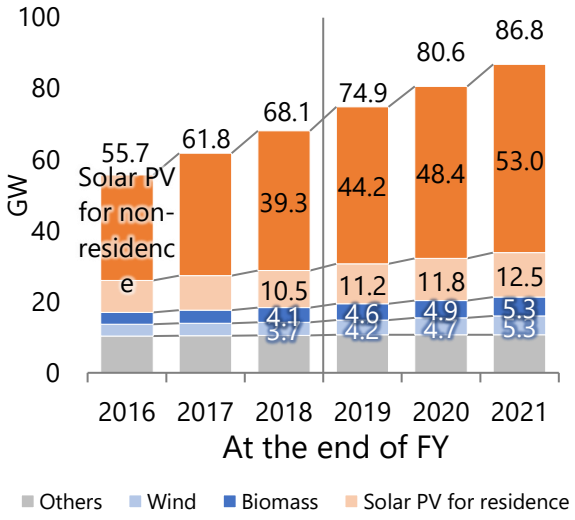


Fig. 2
Installed FIT power generation capacity (based on operation)

Note: Including capacity subject to FIT contract expiration

Topic [1] Transportation energy demand by mode

- **Transportation energy demand will substantially decline as transportation demand plunges for all modes due to COVID-19. In FY2021, the sector's energy demand will increase moderately and fall short of reaching 70 Mtoe**

The transportation energy demand in the 2010s followed a downtrend as downside pressure from energy intensity declines through vehicle fuel efficiency improvement and switching to energy-efficient aircraft, ships, and railroad outdid upside pressure from transport volume growth. Affected by a steep decline in passenger transport volume through growing telework and a fall in non-essential outings and a drop in cargo transport volume through a plunge in demand from manufacturing and services industries under the COVID-19 pandemic, the transportation energy demand in the FY2020 will post a 10.2% drop from the previous year, the largest since FY1953 when comparable data began to be compiled, slipping below 70 Mtoe for the first time in 32 years. In FY2021, transport sector energy demand will increase by 5.5% from FY2020 on a transport volume recovery but post a 5.2% decrease from FY2019, remaining below 70 Mtoe for the second straight year.

Passenger vehicles account for more than a half of the transport sector's energy demand. Despite private

passenger car ownership and travel distance growth in recent years, their energy demand has continued a downtrend due to fuel efficiency improvement and the diffusion of hybrid and other next-generation cars. In FY2020, their energy demand will decrease by 10.5% due to voluntary restrictions on non-essential outings. This will be the first double-digit fall since FY1965 when comparable data began to be compiled. In FY2021, passenger vehicles' energy demand will rise by 5.4% from FY2020 but stand at the lowest level in 32 years excluding FY2020.

Freight vehicles account for 30% of the transport sector's energy demand and are more vulnerable to economic fluctuations than passenger vehicles. In recent years, their energy demand has levelled off as growth in cargo transport demand through online shopping has offset the effects of transport and fuel efficiency improvement. In FY2020, their energy demand declined by 5.2% as a rise in cargo transport demand through growing online shopping under stay-home campaigns was much more than offset by a plunge in demand from manufacturing and services industries. In FY2021, freight vehicles' energy demand will rise by 2.8% on a transport volume rebound amid an economic recovery but stand at the lowest level in 33 years excluding FY2020.

Domestic aviation demand, of which passenger transport accounts for nearly 90%, has increased in recent years as travel demand growth through a rise in personal income and an increase in foreign visitors to Japan combined with an aviation capacity expansion and cost cuts. Domestic aviation energy consumption has levelled off as aviation demand growth has been countered by switching to fuel efficient aircraft. In FY2020, domestic aviation energy consumption will post a sharp decline of 32.9% from the previous year due to flight reductions, topping an 18.5% decline in FY2011, which was the largest fall since comparative data began to be compiled in FY1965. In FY2021, it will increase by 25.3% from the previous year on a passenger transport demand recovery but be limited to the lowest level in 32 years excluding FY2020.

As for internal navigation, transport volume, of which freight accounts for 70%, has followed a downtrend along with energy consumption. As freight centres on production and construction goods, transport volume is vulnerable to their production fluctuations. In FY2020, energy consumption for internal navigation will decline by 2.9% as transport volume decreases on sluggish industrial production. As navigation is less affected by human travel restrictions, the energy consumption fall will be less than for other transport modes. In FY2021, energy consumption for internal navigation will rise by 0.4% on an industrial production recovery, the first increase in five years, but retain a long-term downtrend.

Railway transport volume, of which passengers account for more than 90%, has followed an uptrend thanks to travel demand growth in recent years. Energy consumption has remained almost unchanged in line with energy intensity improvement through the introduction of energy efficient railroad, switching to more efficient equipment, and energy-saving efforts. In FY2020, energy consumption for railway transport will record a 20.4% plunge from the previous year, the largest drop since FY1965 when comparable data began to be compiled. In FY2021, it will increase by 17.2% on a transport demand recovery but be limited to the lowest level in 33 years excluding FY2020.

Table 8 Transport sector energy demand by mode

	Historical				Projection		Year-over-Year		
	FY2010	FY2017	FY2018	FY2019	FY2020	FY2021	FY2019	FY2020	FY2021
Transportation (Mtoe)	82.43	75.43	74.33	73.07	65.64	69.26	-1.7%	-10.2%	5.5%
Passenger Vehicle	48.69	42.03	41.15	39.99	35.78	37.71	-2.8%	-10.5%	5.4%
Freight Vehicle	24.42	24.78	24.63	24.37	23.10	23.74	-1.1%	-5.2%	2.8%
Domestic Aviation	4.52	4.35	4.31	4.46	3.00	3.75	3.5%	-32.9%	25.3%
Internal Navigation	2.70	2.15	2.12	2.13	2.06	2.07	0.3%	-2.9%	0.4%
Railway	2.11	2.12	2.12	2.12	1.69	1.98	0.1%	-20.4%	17.2%

Topic [2] Impacts of fading out inefficient coal-fired power plants

- **The fade-out of inefficient coal-fired power plants will reduce CO2 emissions by 7.1% from FY2013 but boost fuel costs by JPY0.21/kWh. Construction costs will emerge for manufacturers that use coal-fired power plants for heat supply and other non-power generation purposes.**

Coal-fired power plants, which are designed in the Long-term Energy Supply and Demand Outlook to account for about 26% of the power generation mix in FY2030, captured 31.9% of the mix in FY2019. Electric utilities' installed coal-fired power generation capacity is expected to increase by 3.14 GW by the end of FY2021 from 49.44 GW in August 2020 and by 5.05 GW later. Coal-fired power plants feature relatively lower operation costs and new capacity is expected to operate at the present factor. Coal-fired power plants' share of the power generation mix is thus expected to rise further.

While planned new coal-fired power plants are expected to go on stream, the Strategic Energy Plan decided on by the cabinet in July 2018 calls for promoting more efficient next-generation plants and fading out supercritical or less efficient ones. At present, the total capacity of supercritical or less efficient coal-fired power plants stands at 30.03 GW4.

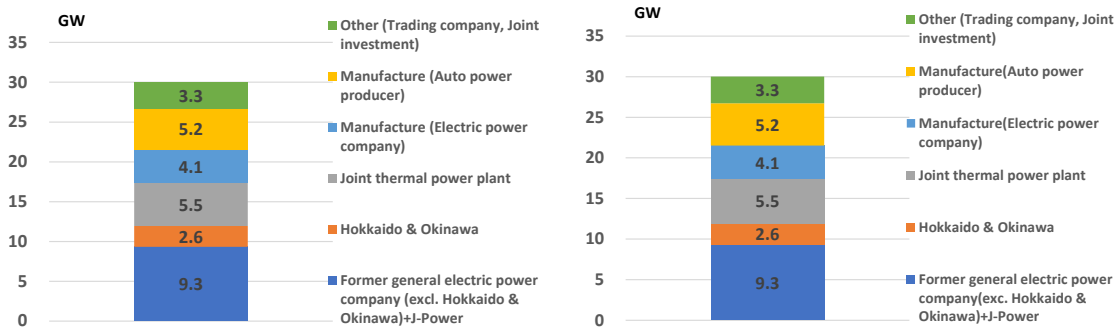


Fig. 3 Installed capacity of supercritical or less efficient coal-fired power plants

Inefficient coal-fired power plants are owned not only by former general electric utilities and Electric Power Development Co. but also by manufacturers and other business operators that do not need any larger plants. This paper virtually analyses the impacts of fading out all inefficient (supercritical or less efficient) coal-fired

[4] Data for electric utilities are from a document at the first meeting of a working group on coal-fired power generation under the Advisory Committee for Natural Resources and Energy. Data for manufacturers are from Documents 7 and 8 at the second meeting and Documents 7 and 8 at the third meeting.

power plants by FY2030, based on the FY2021 picture of the economy, and energy supply and demand.

Given that coal-fired power plants owned by joint ventures or manufacturers are required to provide heat as well as electricity, we here assume that all inefficient coal-fired power plants will be replaced with LNG-fired plants. We also assume that any decline in coal-fired power generation capacity will be covered by an increase in LNG-fired capacity without exerting any effects on the diffusion of renewable power generation capacity or the restart of nuclear power plants and that the retirement of inefficient coal-fired power plants will work to raise the efficiency of Japan's overall coal-fired power generation capacity by 1.2%5.

If all supercritical or less efficient coal-fired power plants are closed, coal-fired power generation will decrease by 165.0 TWh and the decrease will be covered by an increase of 164.7 TWh in LNG-fired power generation.

- **CO2 emissions will fall by 87 Mt, 7.1% from FY2013**

As coal-fired power generation declines, CO_2 emissions will fall by 87 Mt. amounting to 7.1% of energy-related CO_2 emissions in FY2013. Given the target of cutting emissions by 25% in 17 years, all inefficient coal-fired power plants' closure will cover about five years' emission cuts. Coal consumption will decrease by 64 Mt or 33.8%, while LNG consumption rises by 22 Mt or 30.0%. The decline in inefficient coal power generation will bring about a primary energy supply fall of 11.2 Mtoe or 3.0%.

- **Fuel costs will increase by JPY0.23/kWh and JPY1.8 trillion in construction costs will be added**

However, fuel costs will increase by JPY0.23/kWh due to switching from coal to higher-priced LNG. If the fuel cost hike is passed on to electricity prices, the unit electricity price will rise by 0.9% for residential and by 1.2% for industries. If LNG prices' deviation from coal prices expands further, fuel costs will rise further. In addition, construction of substitute LNG-fired power plants will cost manufacturers JPY1.8 trillion[6]. Furthermore, by-products that are mixed with coal for coal-fired power plants will have to be disposed separately, boosting manufacturers' overall production costs.

- **Based on conditions of each power plant, a macro approach should be taken for cutting CO_2 emissions**

The fade-out of inefficient coal-fired power plants is estimated to cut CO_2 emissions by 7.1% from FY2013. However, energy-intensive manufacturers own coal-fired power plants for meeting their heat demand, making effective use of by-products, and securing stable 24-hour plant operations. Thus, coal-fired power plants have non-power generation roles. Coal-fired power plants owned joint thermal power plants have the same functions as manufacturers' auto coal-fired power plants. Numerous business operators have recently launched coal-fired power plants and have yet to recover investment. Furthermore, there are geographical constraints on the fade-out of coal-fired power plants in Hokkaido and Okinawa. Given these points, the fade-out of inefficient coal-fired power plants should be promoted as one of various CO_2 emission reduction measures in line with the conditions of each plant. From the viewpoint of CO_2 emission cuts, benchmark indicators for coal-fired power plants should be developed with consideration given to the computation of power generation efficiency covering biomass and heat use and by-products. Furthermore, coal-fired power plant operators should be asked to develop plans to fade out their plants irrespective of the target year of FY2030. Progress in overall CO_2 emission cuts through renewable energy and energy efficiency promotion and the restart of nuclear power plants should be considered along with the impacts of the fade-out based on reported data and plans to ensure cost-effective CO_2 emission cuts.

---

[5] Computed based on theoretical efficiency.

[6] Estimated based on the unit cost of JPY121,000/kW for LNG-fired power plant construction given by the Power Generation Cost Verification Working Group of the Advisory Committee for Natural Resources and Energy.

Table 9 Impacts of fading out inefficient coal-fired power plants [FY2021]

		Reference	Fade-out of coal-fired	Changes from
Economy	Electricity unit cost1 (JPY/kWh)	3.34	3.57	+0.23
	Total fossil fuel imports (JPY trillion)	11.77	11.99	+0.22
Energy	Primary energy supply	374.2	363.0	-11.2
	Coal (Mt)	189.0	125.0	-64.0
	Oil (GL)	176.0	176.0	-0.03
	Natural gas (Mt of LNG eq.)	73.13	95.11	+22.0
Environment	Energy-related CO_2 (Mt)	954.5	867.1	-87
	FY2013比	-22.7%	-29.8%	-7.1p

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

- **Nuclear contributing to achieving 3Es**

This chapter assesses the impacts of changes in nuclear power generation on the so-called 3Es – economic efficiency, energy security, and environment.

In the Reference Scenario, four nuclear power plants will be restarted by the end of FY2021 in addition to the nine that have already been restarted, with four restarted plants being shut down due to delays in the completion of their counterterrorism facilities. As a result, nine will be in operation at the end of FY2021. In the High Case, the four restarted plants will avoid their shutdown with their counterterrorism facilities completed by their respective deadlines. In the Low Case, the four plants planned to be restarted in the Reference Scenario will fail to be restarted. Referring to the 2030 target power generation mix in the Long-term Energy Supply and Demand Outlook by the Ministry of Economy, Trade and Industry, we have also assumed the virtual Best Mix Case in which nuclear will account for 21% of Japan's total power generation, renewable energy for 23%, and fossil fuels for 56%.

Table 10 Impacts of changes in nuclear power generation [FY2021]

		Low Case	Reference Scenario	High Case	Best Mixed Case	Changes from Reference		
						Low	High	Best Mixed
Nuclear assumptions	Restarted nuclear reactors	5	9	13	..	-4	+4	..
	Power generation (TWh)	62.3	79.7	97.9	218.0	-17.4	+18.3	+138.4
	Share in generation and purchases	6.0%	7.7%	9.4%	21%	-1.7p	+1.8p	+13p
Economy	Electricity unit cost[1] (JPY/kWh)	6.56	6.49	6.42	6.41	+0.07	-0.07	-0.08
	Fuel cost	3.41	3.34	3.27	2.89	+0.07	-0.07	-0.46
	FIT purchasing cost	3.15	3.15	3.15	3.53	-	-	+0.38
	Total fossil fuel imports (JPY trillion)	11.86	11.77	11.68	11.08	+0.09	-0.10	-0.69
	Oil	6.90	6.90	6.89	6.87	+0.01	-0.01	-0.03
	LNG	2.94	2.85	2.76	2.41	+0.08	-0.09	-0.44
	Trade balances (JPY trillion)	10.54	10.61	10.69	11.20	-0.07	+0.08	+0.58
	Real GDP (JPY2015 trillion)	539.83	539.97	540.13	540.64	-0.14	+0.16	+0.67
Energy and environment	Primary energy supply							
	Oil (GL)	176.2	176.0	175.8	175.1	+0.2	-0.2	-0.9
	Natural gas (Mt of LNG eq.)	75.2	73.1	70.9	62.2	+2.1	-2.2	-10.9
	Self-sufficiency rate	13.4%	14.5%	15.7%	24.9%	-1.1p	+1.2p	+10.4p
	Energy-related CO_2 (Mt)	961	955	948	873	+6	-7	-81
	Changes from FY2013	-22.2%	-22.7%	-23.3%	-29.3%	+0.5p	-0.5p	-6.6p

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

Regarding economic efficiency, fossil fuel import value in the High Case will be reduced by JPY100 billion from the Reference Scenario and those in the Best Mix Case by JPY690 billion. If crude oil and LNG prices increase from assumed levels due to international situation changes, the import value fall or the effects of fossil fuel-fired power generation cuts will be greater. Disposable income will increase through the fall in payments for fossil fuel imports and real GDP will rise by JPY160 billion in the High Case and by JPY670 billion in the Best Mix Case from the Reference Scenario.

The unit power generation cost will decrease by JPY0.07/kWh in the High Case and by JPY0.08/kWh in the Best Mix Case. The decline in the Best Mix Case will be limited as an increase in costs for purchasing renewable electricity partially offsets the effects of fuel cost cuts.

Given growing geopolitical risks in the Middle East, energy security is attracting interests. Japan's energy self-sufficiency rate as a representative energy security indicator will improve by 1.2 points in the High Case and by 10.2 points in the Best Mix Case.

CO_2 emissions as an environment indicator will decline by 7 Mt in the High Case and by 81 Mt in the Best Mix Case. From FY2013 as the standard year for Japan's CO_2 emission reduction target under the Paris Agreement, emissions will decrease by 23.3% in the High Case and by 29.3% in the Best Mix Case[7].

Given that deadlines for completing counterterrorism facilities will expire for an increasing number of nuclear power plants after FY2021, it is important for Japan's 3Es to facilitate the restart of nuclear power plants through adequate examinations with consideration given to the conditions of each plant.

[7] The Japanese target calls for cutting GHG emissions in FY2030 by 26% from FY2013 and energy-related CO2 emissions by 25%. In addition to the low-carbonisation of power generation discussed here, energy efficiency improvement and the low-carbonisation of final energy consumption are planned to be mobilised to achieve the target.

Outlook and Challenges for Oil Market◆

Yoshihiro Hashizume※

Key Points of the Report

1. Although global oil demand in 2021 will grow to 97.9 million b/d, a 6.6 million b/d increase over 2020, owing to a slowdown in COVID-19 cases and to the growing economic recovery, it will not surpass the level in 2019 (which was 1.9 million b/d higher). Supply will also increase by 4.3 million b/d over 2020 to 99.5 million b/d. While 2021 should see a slight oversupply, continued demand growth should find the market gradually reach a supply-demand equilibrium.
2. International oil prices (Brent Crude) in 2021 will average $50/bbl, fluctuating in a $5 range. Uncertainties that could lead to lower prices include the lingering COVID-19 pandemic, global economic stagnation, a quick recovery of production in Iran (due to loosening of economic sanctions), loosening production decreases by OPEC Plus, and increased U.S. oil production (-5 USD compared to the base scenario). Conversely, factors that could boost prices include ending the pandemic quickly, an upturn in the global economy, demand led by China, and increased tensions in the Middle East (+5 USD compared to the base scenario).

The Global Oil Supply

3. Global oil demand decreased 7.8 million b/d (7.8%) year-over-year in 3Q 2020 to 93 million b/d. While this is a significant rise up from the 83.1 million b/d (down 16.2 million b/d year-over-year) of 2Q, when demand plummeted amid the outbreak of COVID-19, a second wave of COVID-19 cases is seeing this recovery falter, especially for jet fuel.
4. Global oil production decreased 9.2 million b/d (9.2%) year-over-year in 3Q 2020 to 91.1 million b/d, dropped below 92.1 b/d of 2Q 2020 due to strict observance of a policy to decrease production by OPEC Plus, as well as slow recoveries in the U.S., Canada, and elsewhere.

Trends Concerning OPEC and Major Countries

5. OPEC Plus's November 2020 production volume was 34.3 million b/d. With a production cut compliance rate of 101% that excludes three countries exempt from compliance, the coordinated production cut is being strictly upheld. At a joint ministerial meeting held on December 3, OPEC reached a decision to review its monthly production cut amounts going forward, agreeing to relax its current production cut by 0.5 million b/d (a decrease of 7.2 million b/d compared to base production) at the beginning of 2021. It is expected to decide on production levels based on the supply and demand situation.
6. Due to the impact of COVID-19, 2Q 2020 demand in the U.S. dropped 4.2 million b/d (20.8%) year-over-year to 16.1 million b/d. The rate of decrease by oil type was 75.9% for jet fuel and 25.0% for gasoline. By month, production hit bottom at 14.7 million b/d in April and recovered to 18.4 million b/d by August. 2Q 2020 production in the U.S. decreased 1.3 million b/d year-over-year (10.7%) to 10.8 million b/d as a result of declining oil prices. Likewise, the number of oil rigs in operation in U.S. also bottomed out at hundred and 80 rigs in July/August 2020, and has been rising since. Many will be watching to see if the oil policies

◆ This report is based on the information as of December 24, 2020.

※Secretary-General, The Oil Information Center, The Institute of Energy Economics, Japan

of the incoming administration (including prohibiting drilling on federal land or pipeline construction) will impact oil production.

7. 2Q 2020 demand in China increased 1.07 million b/d (12.0%) year-over-year to 15.6 million b/d, a rapid recovery from the 13.1 million b/d of 1Q, when the COVID-19 outbreak prompted demand to bottom out. Due to trade friction between the U.S. and China, there was no import record from the U.S. for December 2019 through May 2020.

Inventories and Finance Market

8. OECD commercial oil inventories remained at a high 3.129 billion barrels as of October 2020. Although OECD commercial oil inventories began surging in February 2020 due to a plunge in demand brought on by COVID-19, numbers have been declining slightly since May as a result of such factors as OPEC Plus' production decreases and a recovery in demand.
9. In the World Economic Outlook Report released in October, the IMF set the global economic growth rate at -4.4% for 2020 and 5.2% for 2021, an upward revision for the former and downward revision for the latter compared to the June forecast.
10. Although there was some degree of correlation between U.S. stock prices and oil prices when oil prices dropped due to COVID-19 and when they rose afterwards, a divergence was seen when oil prices stagnated amid the second wave of infections that began in August 2020. However, stock prices have once again synchronized with oil prices starting in November, when expectations towards a vaccine began driving stock prices up.

Japanese Market

11. Oil (fuel oil) demand for 3Q 2020 was 11.98 million kl (2.46 million b/d) per month on average, a 9.1% (1.2 million kl) year-over-year decrease and 9.2% increase over the 11.02 million kl (2.26 million b/d) in 2Q, when COVID-19 case numbers were at their worst. Due to a decline in structural demand, as well as lower demand prompted by the pandemic, topper utilization rate in refinery dropped to a low 64% in 2Q 2020, and 59% in May alone.
12. Amid strong oil price volatility, to date, the domestic petroleum products market has been tracking the procurement cost of crude oil (yen-denominated import price of oil), with a two-to-three-week lag.
13. Further decarbonization is expected in Japan. This will require oil industry players make parallel efforts to reinvent business models while maintaining a stable oil supply, including for depopulated areas, even during times of emergency, SS measures for depopulated areas and maintaining a stable oil supply, including during times of emergency.

Outlook and Challenges for Gas Market◆

Executive Summary

Hiroshi Hashimoto*

Prices, Demand and Supply of LNG in 2021

1. Japan's average LNG import price is forecast to go down to USD 7.0 - 7.3 per million Btu in 2021 from USD 7.8 in 2020. The assessed spot LNG price in Northeast Asia is forecast to be USD 8 in the first quarter, around USD 5 in the second and third quarters, and USD 6-7 in the fourth quarter.
2. The global LNG trades are forecast to expand by 5% to 380 million tonnes in 2021 from estimated 362 million tonnes in 2020, backed by lower prices and expected ample supply capacity, which is forecast to continue being larger than demand at around 400 million tonnes.

Regional Trends in the Global LNG and Natural Gas Markets

3. The global gas demand is expected to decline by 3% in the calendar year 2020, while some recovery trends were observed from the third quarter. Gas consumption significantly decreased in the first quarter in North America and in the first half in OECD Europe. Gas consumption did not grow much in the first quarter but grew markedly in the second quarter in China. On the other hand, gas consumption increased significantly in the first quarter then shrank markedly in the second quarter in India. Trends in demand show stark contrasts between major markets.
4. Global LNG trades continued its growth until the first quarter of 2020. Although the second quarter saw a year-on-year decrease, a 2% increase is estimated for the calendar year. The share of Japan in the global LNG trades declined from 22% in the year 2019 to 20% in the first half of 2020. China imported more LNG than Japan in November 2019, May, June, August, November and December 2020. Meanwhile, OECD Europe as a region has recently imported more LNG than Japan or China.
5. Recent major fluctuation of prices has been an intense wake-up call for the LNG industry to thoroughly review LNG contracts and pricing. The Japan's average LNG import price was below USD 6 in September. The gap between crude oil linked contract LNG prices and spot LNG prices was wider in the year.

Notable Trends in Gas and LNG Demand

6. While the growth rate of China's natural gas consumption slowed in the first quarter, consumption during the first ten months of 2020 was 6.6% larger than that of the same period in 2019. During the same period the country's LNG import increased by 11.9%, although the growth rate was smaller than those in the past few years. As some city-gas companies based in cities along the coast line have their own LNG receiving terminals, apart from terminals owned by the three major state companies, and third-party access is promoted at terminals - mainly those managed by the national pipeline company, new entrants' activities to increase LNG imports attract attention.
7. While India imported 19 million tonnes of LNG during the first nine months of 2020, 15% more than the same period in 2019, its gas consumption as a whole declined by 2%. The other South and Southeast Asian countries imported 3% more LNG during the first eleven months of 2020 than the same period one year earlier. Ample supply and relatively palatable prices are expected to stimulate demand there.

◆ This report is based on the information as of December 24, 2020.

* Senior Analyst, Head of Gas Group, Fossil Energies & International Cooperation Unit, The Institute of Energy Economics, Japan

8. Natural gas consumption declined by 4.6% and LNG import increased by 1.4% year-on-year during the first three quarters of 2020 in OECD Europe, while pipeline gas imports from other regions shrank by more than 20% during the same period. During the rise of LNG imports in the last several quarters, more LNG was imported from the United States and the Russian Arctic region. In October 2020, the European Commission announced its Methane Strategy, including initiatives to manage and regulate methane emissions from natural gas production and other activities. Its impacts on suppliers from other regions should be closely observed.

Notable Trends in Gas and LNG Supply

9. Monthly export of LNG from the United States declined by more than 50% from a January peak by July 2020. However, the U.S. Energy Information Administration (EIA) has estimated that monthly volumes again started registering record highs from November.
10. Many potential new LNG export projects in the United States and other regions postponed investment decisions due to uncertainties over future demand. Only one FID was announced in the world in the year, from a project on the Pacific Coast of Mexico in November.

Developments in LNG Bunkering and Small-Scale LNG

11. More and more initiatives have been underway to introduce LNG as a marine fuel around the world. In addition to business development in Japan, Japanese companies have participated in LNG bunkering projects in different countries. LNG has also been adopted as a land transportation fuel in different regions in the world.

City-Gas Liberalisation Developments in Japan

12. In the liberalised Japan's city-gas industry, 3.94 million retail customers (15.5% of the total customers) had switched their suppliers as of August 2020. More than 2 million customers (15.9% of the total) had switched their suppliers in the Kanto region at that time. While larger urban areas have observed many customer switchings, developments to promote competition in those areas where customer switchings have not happened should be also watched.

Remaining Challenges

13. While the LNG market continues expanding, it is essential to ensure investment in production projects to meet the expected demand after the middle of the 2020s. It is also important to enhance liquidity in the LNG market and improve trading conditions including appropriate pricing indexes, when the industry pursues development of emerging markets in Asia. New approach will be required to address CO2 and methane emissions.

Outlook and Challenges for International Coal Market◆

Executive Summary

Yoko Ito*

2021 Coal Price Outlook

1. The benchmark spot price of steam coal (the FOB price at New Castle Port in Australia) will move in a range between $70/ton and $80/ton in 2021 (while fluctuating due to seasonal factors). The spot price of coking coal (the FOB price for Australian premium hard coal) will rise back to a $130-150/ton range.
2. The spot steam coal price remained in a $65-70/ton range from the second half of 2019 to the first quarter of 2020 before dropping below $55/ton in May 2020 and to $47.53/ton (close to the latest bottom in January 2016) in late August. The price rebounded thanks to major suppliers' production adjustments and China's maintenance of demand from autumn 2020, rising above $60/ton in October and above $80/ton at present.
3. The benchmark spot coking coal price fell to around $140/ton in the second half of 2019, rose back above $155/ton in the first quarter of 2020, plunged from late April 2020, and slipped below $100/ton later. It rallied to $133/ton on an increase in Chinese crude steel production in October and now fluctuates around $100/ton, with steel production affected seriously by the COVID-19 pandemic in many countries.
4. The international environment for the coal market has become more uncertain due to the resurgence of the COVID-19 pandemic, the enhancement of climate change countermeasures in the world following the inauguration of a U.S. Democrat administration, and China's decarbonization policy and 14th five-year plan. Over the short term, however, supply and demand fundamentals in the Asian coal market are unlikely to dramatically change. Global coal consumption and imports are expected to increase if coal demand from power generators and steelmakers recovers in line with an economic rally. The increase will center on India and the Association of Southeast Asian Nations.

Demand Trends

5. Global coal demand turned down under the decarbonization trend in 2019 after continuing to increase in 2017 and 2018. The decline was remarkable in Western countries. In Asia, coal demand kept on expanding, leading global coal imports to hit a record high above 1.4 billion tons.
6. COVID-19 infection spreading, in the first 10 months of 2020, China increased steam coal imports by 0.4% year on year but reduced coking coal imports by 2.3%. The Chinese government has recently held down annual coal imports to less than 300 million tons under its import regulations to protect the domestic coal industry. Under a tight supply-demand balance, coal prices in China have remained high even since declines in international prices in May 2020. China is thus expected to maintain imports at recent levels. Pig iron production in China stagnated in early 2020 but scored a year-on-year increase of 8.4% in the January-October 2020 period.
7. As the COVID-19 spread grew serious, India reduced steam coal imports by 19.3% year on year and coking coal imports by 15% in the first nine months of 2020. Although the government has taken a policy of giving priority to domestic coal, India's coal imports had remained stable in earlier years. Economic improvements are expected to lead India's demand for coal imports to rebound.

◆ This report is based on the information as of December 24, 2020.

* Senior Researcher, Manager, Coal Group, Fossil Energies & International Cooperation Unit, The Institute of Energy Economic, Japan

8. Among ASEAN countries, Malaysia and Vietnam launched the operation of large coal-fired power plants in 2019. Their steam coal imports are likely to expand in line with the full-fledged operation of these plants and the operation of additional plants.

Supply Trends

9. On the supply side, Australia maintained its annual steal coal exports above 200 million tons from 2015 to 2019 before seeing a 3.7% year-on-year fall in the first 10 months of 2020. Indonesia expanded exports from 2016 to 2019 before recording a 10.8% year-on-year decrease in the first seven months of 2020. As for coking coal exports, Australia posted an 8.6% decline in the January-October 2020 period. Other exporters such as the United States, Canada, and Russia also reduced coking coal exports remarkably in 2020.
10. In response to international coal price falls from May 2020, major coal suppliers in Australia have adjusted production to cut supply. Russia's expansion of coal exports to the Asian market is limited due to challenges regarding coal transportation infrastructure expansion and cost cuts. In Colombia and South Africa, coal production has been destabilized by falling demand in Europe as their main market, the COVID-19 spread, and coalmine walkouts. Indonesia had indicated a policy of restricting coal production but is seen as ambitious to expand exports due to sluggish domestic demand under the COVID-19 pandemic.

Outlook and Challenges for Climate Change Policies◆

Takahiko Tagami*

Global situation

1. COP26, which was to be held in Glasgow, UK in 2020, was rescheduled to November 2021 due to the spread of Covid-19. The points of focus heading toward COP26 are the discussions on the guidance on cooperative approaches that involve the use of internationally transferred mitigation outcomes (ITMOs) referred to in Article 6, paragraph 2, of the Paris Agreement, and the rules, modalities and procedures for the mechanism for mitigation activities established by Article 6, paragraph 4, of the Agreement. The EU has updated its 2030 greenhouse gas (GHG) reduction target from 40% to 55%. China plans to update its target by the end of 2020, and the US aims to communicate its 2030 target in time for COP26. The details of these targets and the timing of their submission deserve attention.

Situation in each country

2. When inaugurated, the US Biden administration will set a target to achieve a 100% clean energy economy and net-zero emissions no later than 2050. How the Biden administration will change the US' environmental and energy policies and how this may impact the world must be watched. In particular, major challenges for the administration are whether it can introduce and enforce energy efficiency and clean electricity standards in the power sector and ambitious fuel standards in the auto sector, and deliver a $2 trillion clean energy investment. In the area of external policy, stopping China from subsidizing coal power exports is the focus. This policy is also a concern for the US in relation to its China strategy, and it could be a source of more pressure on Japan.
3. China has declared that it aims to achieve carbon neutrality by 2060. What kind of roadmap China will formulate to reach this target deserves attention. The first points of focus are what kinds of indicators will be set for its Fourteenth Five-Year Plan, particularly, whether limiting total energy-related CO_2 emissions to 10.5 billion tonnes will be set as an absolute target.
4. In the EU, a recovery plan for Europe and an increase of the 2030 target from 40% to 55% were agreed on. The EU is scheduled to present the draft amendments and enhancements to an emissions trading system, the Effort Sharing Regulation (which sets targets for each member for sectors not covered by the emissions trading system) and the CO_2 standards for automobiles to achieve the new target, and a legislative proposal for its carbon border adjustment mechanism, all by June 2021, which must be closely watched.
5. In India, in November 2020, Prime Minister Modi said that India's energy plan will have seven drivers including accelerating efforts to move forwards a gas-based economy. Whether the economy's shift to natural gas will be incorporated in the energy plan, and if so, how, deserve attention.

Japan's challenges for the future

6. In Japan, a review of global warming countermeasures has been launched, and in October 2020, Prime Minister Suga declared that Japan will aim for net-zero emissions by 2050. Challenges for achieving a carbon-neutral society by 2050 include setting specific and detailed measures for disruptive innovation and

◆ This report is based on the information as of December 25, 2020.

* Senior Coordinator, Manager, Climate Change Group, Climate Change and Energy Efficiency Unit, The Institute of Energy Economics, Japan

R&D, and what kind of policies to formulate for renewable energy, nuclear power, and fossil fuel power plants, and how to combine them.

Upstream emissions and carbon offset for oil and gas

7. Several energy companies have announced targets of achieving net-zero emissions and the sale of carbon-neutral fossil fuels has started. This has made it necessary to establish methodologies for accounting upstream emissions and enhance carbon offset markets. Methodologies of accounting upstream emissions are being proposed, while the Taskforce on Scaling Voluntary Carbon Markets (TSVCM) led by the private sector is discussing carbon offset. Developments in these proposals and discussions must be watched and considered.

Hydrogen and carbon recycling

8. Regarding hydrogen, the Japan-Saudi initiative on blue ammonia made progress in 2020. Furthermore, several European countries and the EU announced their hydrogen strategies, and Russia also showed an interest in producing and transporting hydrogen. Regarding carbon recycling, the Circular Carbon Economy (CCE) approach as an integrated approach to managing emissions, built on the four Rs (Reduce, Reuse, Recycle, and Remove), was proposed. Efforts for expanding hydrogen production and CO_2 utilization deserve attention.

Outlook and Challenges for Renewable Energy Market◆

Executive Summary

Yasushi Ninomiya*

Global renewable energy power generation, and its share of all energy, will continue rising in 2021

1. The drop in economic activity caused by COVID-19 pandemic saw 2020 global power decline over 2019. Although thermal power generation from sources such as coal has declined significantly throughout the year, renewable energy power generation is expected to grow at a pace of approximately 5% year-over-year. As a result, renewable energy as a proportion of global energy power generation, which was 26% in 2019 (including 16% hydropower), is expected to grow to about 28.0–28.5% in 2020 and 29% in 2021.
2. As power generation declines overall, the increase in renewable energy is for the reasons that include the start of operations in 2020 at renewable energy power generation plants that have continued to grow in capacity due to previous investment, many countries' adoption of incentives to spur greater renewable energy usage, including priority dispatch policies and mandates for purchasing power under FIT schemes, and the fact that marginal generation costs for renewable energy (other than biomass) are close to zero, making it competitive for the wholesale electricity markets in the U.S. and Europe, which buy and sell based on the merit order. Growth in renewable energy power generation capacity continues in 2020, putting increasing downward pressure on coal-fired thermal power in especially the U.S. and Europe. This is likely to see renewable energy as a proportion of total power generation continue to grow beyond 2021, when economies stage a recovery from COVID-19 pandemic.

Renewable energy power generation facility capacity will continue to increase in 2021

3. Supply chain disruptions and construction delays due to COVID-19 have caused the rise in renewable energy power generation facility capacity to stall in the first half of 2020, and there were some who forecast slowdowns throughout the year for facility capacity. Nevertheless, renewable energy facility construction increased significantly in particularly China, the U.S., and Europe beginning in the second half of 2020. Consequently, the 2020 annual renewable energy increase is expected to match or exceed the 2019 level (190 GW), the highest level recorded. The annual rate of increase will also remain at the high level of 8%/year that continued up through 2019.
4. 2020 will set a new record for annual renewable energy growth, which will then be outpaced in 2021. Due to renewable energy support programs, the U.S. and China are racing to build renewable energy facilities. Projects in the countries that had seen delays in 2020 will begin operations, which could see annual renewable energy growth over 200 GW and a new record. Over 80% of this increase will come from solar PV and wind, a market structure that will persist.
5. Global cumulative renewable energy power generation facility capacity (including hydropower) will reach about 3,100 GW (comprising 1,350 GW hydro and 1,750 GW non-hydro) by the end of 2021. Global power generation in 2019 was 7,030 TWh for renewables overall (comprising 4,220 TWh hydro and 2,810 TWh

◆ This report is based on the information as of December 25, 2020.

* Senior Researcher, New and Renewable Energy Group, Electric Power Industry & New and Renewable Energy Unit, The Institute of Energy Economic, Japan

non-hydro), which accounted for 26% of the total (comprising 15.6% hydro, 2.7% solar PV, 5.3% wind, and 2.4% biomass/geothermal).

Renewables market trends in Japan

6. Generation facility capacity for all renewable energy, excluding large hydrogen power facilities generating above 30 MW will grow at a rate of 6 GW/year for FY 2020–2021 as a result of a slowdown in residential and commercial solar PV deployment resulting from COVID-19 pandemic. The rate of growth will hold at about 8%/year for FY 2020–2021, a slower decrease than the IEEJ forecast in July 2020.
7. Total generation capacity will reach 87 GW by the end of FY 2021, bringing FY 2021 renewable energy power generation as defined above to 166 TWh. If large hydropower plants above 30 MW are included, renewable energy as a proportion of all energy power generation will reach 20.4% (8.0% hydro, 12.4% non-hydro) for FY 2021. The average annual increase of renewable energy power generation was 9% from FY 2008 to FY 2019, and will be 7% from FY 2020 to FY 2021. As renewable energy power generation capacity is also expected to continue rising beyond FY 2021, the current energy mix plan in 2030 (renewable energy becoming 22–24% of total generation) could actually be reached in the first half of 2020.
8. Solar PV generation is highly likely to hit 65 GW by the end of FY 2021, exceeding the 2030 energy mix plan of 64 GW. Wind and biomass will both continue increasing by 0.4–0.5 GW/year. As numerous projects approved for FIT are set to begin operations, onshore wind generation capacity will rise significantly after 2021 and large-scale bidding for offshore wind producers will begin, providing signs that markets will shift away from an “overconcentration” on solar PV. If the 93 GW of capacity that has received FIT approval as of June 30, 2020 goes into operation, consumers will have paid JPY 60 trillion to date; this is equivalent to about a JPY 3.40/kWh rise in electricity prices which is slightly higher than the current FIT surcharge of JPY 2.98/kWh for FY2020.

Policies for renewables other than electricity will be needed to achieve the 2050 carbon-neutral goal

9. Japan's renewable energy policy to date has focused only on electricity. However, achieving Japan's 2050 carbon-neutral target will require eliminating the majority of the country's current energy-originated CO_2 emissions. Policy interest is rising not only for electricity, which satisfies a mere 28% of final energy demand, but also for fossil fuels, which satisfy the remaining 72%, with a particular focus on heat utilization in industry sector and decarbonization in transportation sector. Along with the decarbonization of fossil fuels, further renewable energy usage is also expected to draw attention in these sectors.

Outlook and Challenges for Nuclear Power Generation◆
Executive Summary

Tomoko Murakami *

Japan

1. Since specialized safety facilities (SSFs) of nuclear power plants take time to construct, a grace period was set in 2015 allowing power plants to operate for five years after obtaining a construction permit for regular facilities even if their SSFs are not yet complete. In 2020, Sendai Units 1 and 2 shut down consecutively after their grace periods expired. Unit 1 went back online on November 19 after its SSFs were completed, and Unit 2 is scheduled to do so in late December.
2. Kansai Electric's Takahama Units 3 and 4 also shut down in 2020 after their grace periods expired. According to Kansai Electric's periodic outage schedule, Unit 3 is due to go back online on December 22 and Unit 4 in February 2021.
3. Meanwhile, in March 2021, the grace period will expire for Shikoku Electric's Ikata Unit 3, whose operation is suspended under an injunction by the Hiroshima High Court issued in January 2020. President Nagai of the company announced on October 29 that the SSFs will be completed around October 2021. Before the facilities are completed, the Hiroshima High Court, which issued the injunction, is scheduled to decide in March 2021 whether to allow the plant to operate in response to an appeal.
4. In 2021, the grace period will also expire for Kansai Electric's Mihama Unit 3 and Takahama Units 1 and 2. If the construction of the SSFs proceeds as scheduled, these plants may also be restarted in FY2021.
5. On November 6, 2020, Tokyo Electric submitted an application for a pre-service inspection of Kashiwazaki-Kariwa Unit 7 to the Nuclear Regulation Authority. According to the application, the inspection is scheduled to be completed around April 2021.
6. Based on the above, operation plans in FY2021 are expected to be as follows: four plants are projected to restart in FY2021, in addition to the nine plants already restarted. However, it is not clear whether the plants will actually restart, due to non-technological factors such as court decisions and approval by municipalities.
7. There were important moves concerning the siting of a high-level waste (HLW) disposal facility. On November 17, 2020, a literature survey, the first phase for selecting a site, began at Hokkaido's Suttsu Town, which had applied in October at its own initiative, and at Kamoenai Village, also in Hokkaido, which accepted the government's request. In starting the survey, the Nuclear Waste Management Organization of Japan (NUMO), the entity in charge of the geological disposal project, has said they will "start by collecting and organizing necessary literature and data, such as geological maps and academic journals, and explain to the local communities how the literature survey will be conducted." The efforts of NUMO, which considers the literature survey as "a forum for dialog" with local residents and is conducting ongoing information disclosure and dialogs, deserve attention.
8. On November 11, 2020, the Recycle-fuel Storage Center in Mutsu City, Aomori obtained approval from the Nuclear Regulation Authority for changes to its business concerning the safety assessment in accordance with the new regulation standards.

◆ This report is based on the information as of December 25, 2020.

* Senior Economist, Manager, Nuclear Energy Group, Strategy Research Unit, The Institute of Energy Economics, Japan

Overseas

9. Currently ranked third in the world in installed nuclear capacity, China actively continued to develop nuclear power in 2020. Tianwan Unit 5 went online in August 2020, followed by Fuqing Unit 5 in November. With the start of construction of Taipingling Unit 2 and Zhangzhou Unit 2 in 2020, there are now 14 plants (approx. 1.471 GW) under construction, of which three or four are scheduled to start operation in 2021.
10. In August 2020, Barakah Unit 1 went online in the UAE followed by Ostrovets Unit 1 in Belarus in November, both as the countries' first nuclear power plant. With this, the number of countries using nuclear power increased to 33, up two countries from 2019. Barakah Unit 2 and Ostrovets Unit 2 are expected to start operation in 2021. However, it is not clear whether the plants can continue to operate beyond 2021 since the three Baltic states, including Belarus' neighbor Lithuania, have decided not to buy electricity produced by Ostrovets.
11. NuScale Power Module (NPM), a small modular reactor (SMR) from US NuScale, obtained standard design approval (SDA) from the US Nuclear Regulatory Commission on September 30, 2020. Out of the NPM series, the one with an output of 50 MW was granted SDA; NuScale has not applied for SDA for its 77 MW reactor unveiled in November 2020. In the United States, Utah Associated Municipal Power Systems (UAMPS) already has plans to build an NPM in the DOE's Idaho National Laboratory. However, the start of operation of the first plant, initially scheduled for 2026, has been pushed back to 2030, and the project costs have also ballooned from $4.2 billion to $6.1 billion in the past two years. Due to the delay and the rise in costs, eight municipalities participating in UAMPS have decided to leave the project. Attention must be paid to any cost increase and delays in the future, as well as changes in the participation of municipalities in UAMPS.

Outlook and Challenges for Electric Utility Industry◆
Executive Summary

Junichi Ogasawara*

Competition in the Japanese Electricity Market

1. Day-ahead spot trading now accounts for 30% of total electricity sales in Japan, indicating that day-ahead spot prices have significant impacts on the profitability of power generation facilities and competition for retail sales. In central and western Japan, day-ahead spot prices have come closer to fuel costs for coal-fired power plants, affecting the maintenance of LNG-fired power plants. The monthly average day-ahead spot price for some months has slipped below the avoidable cost computed based on variable costs for all electricity sources that are published for feed-in-tariff adjustment, indicating that it has become difficult to recover fixed costs for electricity sources. Spot prices are likely to remain stagnant in 2021.
2. Power producer-supplier companies have taken advantage of retail sales based on such low day-ahead spot prices to expand their power market shares in many regions. Until delivery starts on the capacity market in which electricity retailers are required to make capacity contributions, PPS companies that procure and supply electricity in the low-price spot market may increase their competitiveness.
3. Successful bid price reached the ceiling in an auction for delivery in the capacity market in 2024, becoming a big topic. The average successful bid price, though higher than prices in the U.S. PJM capacity market, is close to levels that have been seen for New York City and new ISO New England capacity markets, indicating that the successful bid prices in Japan are adequate under a tight supply-demand balance.
4. Trading has started in non-FIT non-fossil value certificates. No lower limit price is set for non-FIT non-fossil value certificate trading. Prices came at 1.2 yen/kWh for non-FIT contracts (for renewable energy power sources alone) and 1.1 yen/kWh for non-FIT contracts (for any power sources). The price levels might have been based on U.S. renewable credit prices.
5. The minimum supply reserve margin of 3% for a cold winter is secured for this winter. If a cold winter is accompanied by a shutdown of a large-capacity power generation facility or any other trouble, the supply-demand balance may tighten. The Hokuriku, Kansai, and Kyushu areas could face supply shortages on a single-handed basis. Supply reserve margins cover Power Source I' that is secured for the severest weather in a decade. If no such power source is considered, the supply reserve margin is expected to slip below 3% in the eastern area.

Stable Supply

6. In Western countries as well, wholesale power market prices have weakened due to falls in electricity demand and in prices of gas, coal, and other primary energy sources (fuel prices) under the COVID-19 pandemic. In an increasing number of countries, growth in renewable power generation capacity has caused higher surcharges and power transmission/distribution costs, leading to higher electricity rates. In a rising number of countries or regions, it has become economically justifiable to have private solar photovoltaics capacity. In some cases, the combination of private solar PV capacity and storage batteries has become favorable.

◆ This report is based on the information as of December 25, 2020.

* Senior Research Fellow, Manager, Electric Power Group, Assistant Director, Electric Power Industry & New and Renewable Energy Unit, The Institute of Energy Economic, Japan

7. In an increasing number of advanced economies, conventional power generation capacity has indicated a downtrend due to the expansion of renewable power generation capacity and weak wholesale electricity prices. On August 14 and 15, the California ISO triggered rotating outages under a tightening supply-demand balance. In France where nuclear power generation capacity shutdowns have deviated from schedules, this winter has the risk of a tightening power supply-demand balance due to abnormally cold weather. Attention should be paid to the fact that the power supply-demand balance has become vulnerable to tightening caused by abnormally warm or cold weather.

   ① The Electric Reliability Council of Texas, Ireland, the United Kingdom and Northern Europe, which feature relatively smaller power grids, are taking additional measures as synchronous power generations (including fossil-fired power plants) that have rotational energy called kinetic force to stabilize frequency have decreased due to growth in non-synchronized generations (including wind and solar PV power plants). Given that strict conditions are imposed on the suppression of renewable power generation, they have additionally deployed fast frequency response (FFR) capacity that can respond to frequency drops more quickly than primary adjustment capacity. Such additional measures can work to push up power generation costs. In Japan, the Organization for Cross-regional Coordination of Transmission Operators has begun to consider how best to respond to kinetic force and other technical problems under the expansion of renewable power generation capacity. Various viewpoints are required for responding to these challenges.

8. Mainly in advanced economies, electricity demand falls and weak wholesale electricity prices under the COVID-19 pandemic have discouraged investment in power facilities. As growth in investment in power transmission/distribution facilities is increasingly criticized in some countries, needs are growing for power source management measures for voltage adjustment and other purposes, rather than equipment investment measures. Japan as well may be increasingly required to adopt power source management measures to hold down electricity rate hikes through investment expansion.

Energy, Environment and Economy

Energy transition in the post corona world

Overview

The Institute of Energy Economics, Japan

IEEJ Outlook 2021

Members

Rejean CASAUBON
Seiya ENDO
Hiroshi HASHIMOTO
Ryohei IKARII
Yoko ITO
Takehiro IWATA
KAN Sichao
Yasuaki KAWAKAMI
Kenji KIMURA
Yoshikazu KOBAYASHI
Ken KOYAMA
Ichiro KUTANI
Yuji MATSUO
Tetsuo MORIKAWA
Soichi MORIMOTO
Tomoko MURAKAMI
Yu NAGATOMI
Masayoshi NOGUCHI
Hideaki OKABAYASHI
Takashi OTSUKI
Atsuo SAGAWA
Tomofumi SHIBATA
Yoshiaki SHIBATA
Shigeru SUEHIRO
Takahiko TAGAMI
Yukari YAMASHITA
Akira YANAGISAWA
Emiri YOKOTA

Executive summary

Global energy supply and demand outlook (Reference Scenario)

Global energy consumption returning to increasing trend

- An impact of the coronavirus (COVID-19) pandemic brings about a decline in the global primary energy consumption at least in the short term. The demand for energy will increase again, however, once vaccines and therapeutic drugs are developed, leading to the global disaster over, and society and the economy return to normal. In this case, under the "Reference Scenario" which reflects changes in energy and environmental policies to date and are expected to continue, energy consumption in 2050 will increase by 1.3 times over the 2018 level.
- Emerging and developing economies are responsible for a significant portion of the recovery in global energy consumption from the impact of COVID-19. As those economies drive the increase in global energy consumption, their global share will increase from 60% in 2018 to 70% in 2050.
- Fossil fuels will continue to play a major role in meeting the enormous global energy consumption. Mainly because of growth in the power sector, natural gas will become the largest contributor and its consumption will grow at an annual rate of 1.4%. By 2050 natural gas consumption will be 1.4 times that of 2018.
- Renewable energy (excluding solid biomass) and nuclear will account for 26% of the increase in primary energy consumption by 2050. It is very difficult and unrealistic to expect that non-fossil energy would cover the entire world's energy consumption; a combination of fossil fuel and non-fossil energy is required.

Middle Eastern oil producers re-emerge as the crude oil supply core

- In the Reference Scenario, the current slump in oil demand is temporary. Crude oil production in both the Organization of Petroleum Exporting Countries (OPEC) and non-OPEC countries will increase in response to an upturn in demand. Reflecting reductions in cost, shale oil production in the United States will increase until around 2030, leading the rise in global crude oil supply.
- In the longer term, OPEC member countries in the Middle East, with their abundant reserves and cheap production costs, will meet about half of the 20 million barrels per day (Mb/d) increase between 2018 and 2050 in world oil demand. Despite being endowed with one of the world's largest reserves, Venezuela, one of the OPEC members, has experienced a remarkable decline in production in recent years. Venezuela deserves attention as to how much it will recover and increase production in the coming year.

Liquefied natural gas (LNG)

- The United States will expand its LNG supply capacity in and after the mid-2020s. The liquefaction capacity would exceed 100 Mt per year if the projects under construction are completed and if the impact of the final investment decisions that were made to operating facilities is accounted for.
- Australia, which offers one of the largest LNG supply capacity in the world, along with Qatar, will gradually increase its production in and after 2030. Future upstream natural gas resource development projects will centre on providing the required supplemental gas to existing LNG liquefaction facilities.

Coal production remains at high levels until around 2040

- Coal production will continue to decline in the European Union (EU), which guides the acceleration of low carbonization in COVID-19 economic support measures, and in North America, where coal demand does not grow. On the other hand, there is steady demand in emerging and developing economies, mainly in Asia, with high production levels expected until around 2040 in the reference scenario. Global coal production will increase until 2030, remain flat for a while, and then gradually decline.
- Steam coal production will increase mainly due to the increase in demand for power generation, but will start to decrease after peaking around 2040. Coking coal, which is mainly used as a raw material for steel production, is on the decline.

Electricity generation is rapidly expanding in Asia. Natural gas-fired power generation will be the largest power source.

- Global electricity generation will increase at an annual rate of 1.7% to 45 201 TWh in 2050, 1.7 times the 2018 level. Asia, with its rapidly growing economy, will increase generation at an annual rate of 2.0%, reaching 22 749 TWh in 2050, more than half of the world's total.
- Coal which is currently the largest power source will continue to be important, mainly in Asia, but its share will decline. Natural gas, expected to play a major role in adjusting for output fluctuation of renewable power generation, will become the largest source of electricity. Its share will reach 30% by 2050. In advanced economies, the trend of decarbonisation remains the same after COVID-19, so renewable energy (including hydro) will be the largest source of electricity.
- It is difficult for Japan, Korea, the United States, and some Western European countries to build nuclear power plants as originally planned. On the other hand, there are a number of countries, including China, which will further promote the use of nuclear in the future, and some countries, such as those in the Middle East, will introduce nuclear. As a result, global nuclear power generation capacity will gradually increase through 2050.

2% of GDP must be invested until 2050

- There is a growing movement toward "green recovery" in which the economic recovery from the corona crisis could be achieved through environmental investments. The Next Generation EU of €75 billion, by the European Commission, is a good example of that.

- On the other hand, to meet the significant increase in energy consumption in emerging and developing economies, a global investment of $77.4 trillion (in 2010 prices) in resource development, fuel transport, power generation, transmission and distribution facilities will be needed by 2050. As investments in fuel supply represent about 40% of the total, the stability of energy supplies could be threatened by an excessive fossil fuel divestment.

Advanced Technologies Scenario

- The "Advanced Technologies Scenario" envisages the strong implementation of energy and environmental policies that contribute to the securing of a stable energy supply and the introduction of climate change and air pollution countermeasures. The Scenario reduces energy consumption, particularly fossil fuels, by 15% from the Reference Scenario in 2050. Emerging and developing economies, where energy consumption is increasing and potential savings are large, play a major role.
- Oil demand peaks around 2030, due to the progress of efficiency improvement and fuel substitution. Oil demand decreases thereafter and oil supply in 2050 will be reduced to the level of 2017. As competition among suppliers intensifies, the relatively cost-competitive Middle Eastern OPEC members will increase their production the most during the period to 2050.
- Natural gas production in 2050 will be 27% lower than in the Reference Scenario. However, technological advance may lead to larger share of greener gas production capacity with more sophisticated management of greenhouse gas (GHG) emissions.
- The share of coal-fired power generation will decrease due to the progress of low-carbon technologies such as renewable energy, and the thermal efficiency of coal utilization will increase in each field of coal utilization such as power generation and steel production. Coal production will decrease from 7 804 Mt in 2018 to 4 413 Mt in 2050. A large drop in steam coal will increase the proportion of coking coal in total coal production.
- The share of renewable energies (includes hydro) in primary energy consumption will increase from 14% in 2018 to 25% in 2050, 9% percentage points above the Reference Scenario. In power generation, renewable energies such as solar, wind, biomass, etc. combined, is the largest sources of power, even if hydro is excluded.
- Nuclear will be introduced not only in advanced economies with ambitious low-carbon targets but also in emerging and developing economies in order to promote low-carbon energy while responding to the rapid expansion of electricity demand. Global nuclear power generation capacity will expand from 414 GW in 2018 to 725 GW in 2050, about 1.5 times the increase in the Reference Scenario.
- Additional investment of $6.7 trillion from the Reference Scenario is required to achieve the Advanced Technologies Scenario, bringing the cumulative investment to $82 trillion. Power generation in 2050 will be 3 900 TWh less than in the Reference Scenario, while plant and equipment investment for power generation and transmission will be $38.1 trillion, up 16% on a cumulative basis by 2050.

Post Corona World Transformation Scenario

- In the aftermath of the Corona disaster, the global economy will be in its worst condition since the Great Depression. Changes in people's behaviour and social and economic activities have dramatically reduced energy demand. It has been pointed out that a decline in energy prices, due to an oversupply, could deal a serious blow to the management of the energy industry and companies and destabilise oil-producing countries.
- In the "Post Corona World Transformation Scenario," the manifested changes in political, economic, and social structures are maintained and strengthened. The Post Corona World Transformation Scenario assumes that a departure from the free trade system and the global supply chain system in the pursuit of cost efficiency optimisation will reduce the global economic growth rate by 0.3% points per year relative to the Reference Scenario. Efforts to low carbonisation/decarbonisation will be made in accordance with the actual conditions in respective country and region. A "patchy situation" so to speak.
- Growth in global primary energy consumption will also slow down, reaching 17.7 billion tonnes of oil equivalent (Gtoe) in 2050, down 4% from the Reference Scenario. In China, energy consumption is expected to decline by as much as 7%. In India, energy consumption will increase by 2% in ASEAN, as in the Reference Scenario. These regions will become relatively more important in terms of future increases in energy demand and share.
- Digitisation plays an important role in the transformation of the economy, society, lifestyle, etc. As such, an earlier peak in oil demand and the progress of electrification become apparent. Oil demand peaks around 2040 and by 2050, demand will be 14 Mb/d lower than the Reference Scenario level. The share of electricity in final energy consumption will increase to 28% in 2050, up 2% percentage points from the Reference Scenario.
- Efforts will be made to increase the self-sufficiency rate and diversify supply sources in order to strengthen energy security. At the same time, efforts will be made to develop and introduce advanced and innovative energy sources with an emphasis on technological hegemony. Although renewables and nuclear will expand relative to the Reference Scenario, fossil fuels remain the mainstay of energy.

Circular Carbon Economy/4Rs Scenario

- In order to achieve drastic reductions in GHG emissions, it is essential to develop not only energy efficiency and renewable energy technologies but also technologies to further decarbonise fossil fuel use. The importance of "Circular Carbon Economy" (CCE), which realises the final emission reduction of carbon dioxide (CO_2) from the utilisation of fossil fuel is advocated.

- Some technologies of the 4Rs— Reduce, Reuse, Recycle, and Remove — in the Circular Carbon Economy are more or less commercialised. If several representative technologies are fully introduced by 2050, CO_2 emissions will decrease by 20% from the "Advanced Technologies Scenario" of 25.2 Gt. That level of emissions approaches the 17 Gt of the "2°C Minimising Cost Path," which minimises overall costs[1] under conditions that limit the temperature increase in 2150 to less than 2°C.
- In the Circular Carbon Economy/4Rs Scenario developed in this outlook, primary energy consumption remains almost unchanged from the Advanced Technologies Scenario. Decarbonisation of fossil fuels can significantly reduce GHG emissions while utilising fossil fuels. The introduction of *blue* hydrogen in the power and transport sectors will reduce the share of oil and coal. Much of the demand for *blue* hydrogen is generated in emerging and developing economies, where energy demand is greatly expanding. Among the 4R technologies, the amount of reduction achieved by the reduce and recycle technologies that utilise carbon capture and storage accounts for a large portion.
- 80% of *blue* hydrogen comes from natural gas, increasing natural gas consumption. However, the scale of the increase does not reach the level of the Reference Scenario, and there are sufficient resources to expand the use of *blue* hydrogen.

Pragmatic approach to climate change issue

- A practical approach to climate change would be to seek an emission reduction path that minimises the sum of the costs of "mitigation" that curbs GHG emissions, "adaptation" that curbs damage, and "damages" under conditions where temperature returns to 2°C by 2150 – the "2°C Minimising Cost Path." The total cost in this path is significantly lower than in the path that reduces global GHG emissions by half by 2050.
- Among the factors that can have a significant impact on this cost-benefit analysis, the Minimising Cost Path changes significantly by incorporating the collapse of the Antarctic ice sheet. However, even that Path does not lead to GHG emissions levels below the 2°C Minimising Cost Path.

[1] In the model calculation, the approach of utility maximisation is used.

Smart City Development Trends Centered on the Transportation and Traffic Sector in ASEAN Countries

Japan's Strengths and China's Rise in Smart City Exports to ASEAN Countries

Yumiko Iino*

1. Introduction

The push to develop smart cities is gaining momentum in urban areas around the world. While the implications of smart city development varies from country to country, in developed countries, it often refers to projects that aim to make existing cities more enjoyable places to live in by using state-of-the-art digital technologies. Such development in emerging countries, however, usually emphasizes infrastructure development projects, including energy development, and aims to address social issues stemming from rising populations and rapid urbanization. A challenge for urban development in developing countries is ensuring the city's sustainability as infrastructure is built. Development improves quality of life for people, but the consequent energy demand increases create environmental and energy security problems. Smart city development in emerging countries is therefore required to strike a good balance that takes into account such things as enhanced energy efficiency and mitigation of environmental impact with an eye to urban sustainability, alongside short-term infrastructure development efforts.

Numerous smart city development projects are currently underway in Asia, a region of rapid population growth and economic development. Countries with the technologies and expertise related to smart cities are exploring business opportunities to undertake such projects in Asia. The Japanese government is also promoting "overseas smart city exports" as one pillar of its overseas infrastructure expansion strategy going forward. Japan has been actively engaged in smart city-related exports to ASEAN countries for some time. In particular, it has provided broad-based support for traffic congestion, a social problem prevalent in ASEAN countries, through such means as road, train station, and other infrastructure development, as well as traffic control system implementation.

Traffic congestion is not just a traffic problem; it is also an energy and environmental problem. For example, vehicles traveling at low speed have terrible fuel efficiency,[1] and frequent traffic jams mean a waste of oil. The importing of oil has become a policy issue that many emerging countries in Asia cannot ignore, both in terms of anxiety about a stable fuel supply and the economic burden associated with it. As such, these countries are pushing for measures to decrease motor vehicle traffic that involves heavy oil consumption. It also goes without saying that traffic congestion causes pollution in the form of air pollution and noise. Thus, alleviating traffic congestion through infrastructure development is a solution to energy and environmental issues.

Meanwhile, recent smart city development in ASEAN countries has seen China become a significant player in infrastructure development and the promotion of digitalization. In line with its "Belt and Road Initiative," China is stepping up its involvement in large-scale infrastructure development, supporting Alibaba and other Chinese IT corporations as it seeks to play a leading role in promoting digitalization.

This paper first examines the role of smart city exports to ASEAN as part of Japan's Infrastructure Export Strategy. It then looks at social issues associated with the advancement of urbanization in ASEAN, focusing

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

[1] According to data from the Cabinet Office of Japan（https://www8.cao.go.jp/koutu/taisaku/max-speed/k_3/pdf/s9-1.pdf）, driving at an average speed of 10 km/h (a typical speed when driving through congested urban areas) reduces fuel efficiency by 50% (doubles oil consumption) compared to driving at 40 km/h.

especially on traffic congestion, which is an issue common across the region, and summarizes smart city development trends, looking at specific cases from three cities. Lastly, this paper lays out the trend of China's participation in smart city development in ASEAN and presents an outlook for future smart city development in the region.

2. Smart City Exports to ASEAN as Part of Japan's Infrastructure Export Strategy

(1) Japan's Smart City Export Strategy

At a July 2020 Ministerial Meeting on Strategy relating to Infrastructure Export and Economic Cooperation[2], the Japanese government announced that it would formulate a new strategy for the next five years aimed at laying out a plan for rolling out overseas infrastructure development efforts in 2021 and beyond. The new strategy lists addressing the digital transformation and contributing to solving social issues as key policies aimed at achieving high-quality infrastructure. Among the specific measures, a focus is placed on the "promotion of urban development and overseas development of social infrastructure," stating that efforts should be made to implement overseas roll-out of Japanese smart city projects through public-private coordination by bringing together expertise and experience accumulated in dealing with problems concerning environment, traffic, and other domestic issues, coupled with digital technologies.[3]

At an October 2019 session of the Ministerial Meeting on Strategy relating to Infrastructure Export and Economic Cooperation, discussions focused on urban (smart city) development. In the discussions, Japan remarked that Japanese companies had achieved a track record of building up experience and expertise in complex urban development in such areas as Transit-Oriented Development (TOD) and eco-friendliness in the field for strengthening urban infrastructure and promoting it as a competitive advantage and selling their business overseas, and that the Japanese companies primarily target India and ASEAN countries where demand for development is strong. [4] Smart city exports are a key component of the Infrastructure System Export Strategy for Japan, and ASEAN countries, to which such exports have already been made, are important partners in this endeavor.

(2) Coordination between Japan and ASEAN on Smart City Development in ASEAN countries

The drive to develop smart cities in ASEAN has been spurred by the establishment of the ASEAN Smart City Network (ASCN) in 2018 (explained further below). This led to the ASEAN - Japan Smart Cities Network High Level Meeting in October 2019.[5] At the meeting, Japan communicated its technologies and expertise and participants shared the issues and needs of ASEAN cities. The meeting adopted an outcome document that states the plan for cooperation between ASEAN and Japan towards developing smart cities in ASEAN. Prior to this meeting, the Japan Association for Smart Cities in ASEAN (JASCA) was also established with the aim of actively and continuously sharing information with ASEAN countries about Japan's technologies and experience, and also building bilateral public-private sector relationships with these nations. [6]

---

[2] In April 2013, Japan established the Ministerial Meeting on Strategy relating to Infrastructure Export and Economic Cooperation as a command center for supporting infrastructure system export efforts by Japanese companies. The meeting has discussed various themes concerning infrastructure exports for different regions and industries, and has made revisions to the Infrastructure System Export Strategy annually.

[3] Prime Minister's official residence (2020), "Outline of Japan's New Strategy for Infrastructure Exports," presented at the 47th session of the Ministerial Meeting on Strategy relating to Infrastructure Export and Economic Cooperation
https://www.kantei.go.jp/jp/singi/keikyou/dai47/siryou4.pdf

[4] Prime Minister's official residence, 44th session of the Ministerial Meeting on Strategy relating to Infrastructure Export and Economic Cooperation (October 7, 2019)
https://www.kantei.go.jp/jp/singi/keikyou/dai44/siryou1.pdf

[5] Urban Renaissance Agency, ASEAN Smart Cities Network High Level Meeting in Yokohama
https://www.ur-net.go.jp/overseas/AseanSmartCityNetwork/HighLevelMeeting_en.html

[6] Ministry of Land, Infrastructure, Transport and Tourism, Press release, October 2, 2019
https://www.mlit.go.jp/report/press/sogo07_hh_000544.html

3. Smart City Development Trends and Social Issues Associated with Urbanization in ASEAN

(1) ASEAN Smart Cities Network Concept

The ASEAN Smart Cities Network (ASCN) initiative was launched in April 2018, led by Singapore, which was the host country for the ASEAN summit. The ASCN aims to resolve a diverse array of social issues caused by rapid urbanization in ASEAN by utilizing technologies and digital solutions, and to improve the quality of people's lives. Comprising 26 cities selected from among 10 ASEAN member states, the ASCN seeks to promote smart city development projects through coordination with private enterprises and various foreign countries.[7] The ASCN has established the Smart City Action Plan, which sets forth strategic targets for six areas aimed at achieving sustainable urbanization.[8] It has also put together the ASEAN Sustainable Urbanization Strategy (ASUS), which lays out 18 sub-areas corresponding to these six areas aimed at creating opportunities and addressing issues concerning smart city development.[9]

Fig. 3-1: The 26 cities in 10 countries that are implementing the ASCN

Table 3-1: The 6 areas and 18 sub-areas of the ASCN

6 areas	18 sub-areas
Civil & social	-Social solidarity -Inclusive and equitable growth -Culture and legacy -Tourism
Health & well-being	-Housing and home -Healthcare -Other public services
Security	-Personal safety and security -Cybersecurity
Quality environment	-Water, wastes, sanitation -Energy -Foods
Built infrastructure	-Mobility -Buildings, construction -City's resilience
Industry & innovation	-Entrepreneurial spirit, innovation -Trade, commerce -Education

(Source) Website of ASEAN/ Table 3-1: Prepared by the Author based on ASCN document.

(2) Advancement of Urbanization and the Current Situation of Smart City Development in ASEAN

In ASEAN countries where economic growth continues, urbanization is proceeding at a rapid pace. The percentage of urban dwellers in ASEAN nations is expected to rise from 47% in 2015 to 53% in 2025, with the urban population increasing by roughly 70 million over the next 10 years.[10] Furthermore, the region stands out for having a high proportion of people living in metropolitan areas and a high population density. As of 2019, there were 28 metropolitan areas in ASEAN, each with a population over 1 million,the sum of which accounts for just under 25% (about 158 million people) of ASEAN's total population. The proportion of urban dwellers in each ASEAN country is expected to rise further going forward, raising concerns that metropolitan areas, in particular, will face increasingly severe social problems such as traffic congestion, deteriorating public safety, air pollution, and higher housing prices.

---

[7] ASEAN, ASEAN Smart Cities Network, https://asean.org/asean/asean-smart-cities-network/#
[8] ASEAN (2018), "ASEAN SMART CITIES NETWORK SMART CITY ACTION PLANS," https://asean.org/storage/2019/02/ASCN-Consolidated-SCAPs.pdf
[9] ASEAN (2018), "ASEAN Sustainable Urbanisation Strategy," https://asean.org/storage/2018/11/ASEAN-Sustainable-Urbanisation-Strategy-ASUS.pdf, P9
[10] ASEAN (2018), "ASEAN Sustainable Urbanisation Strategy", https://asean.org/storage/2018/11/ASEAN-Sustainable-Urbanisation-Strategy-ASUS.pdf, P15

Table 3-2:
Increases in ASEAN countries' urban populations

Country	Proportion of urban dwellers		Urban population increase (millions)
	2015	2025	
Singapore	100	100	0.6
Brunei	77	80	0.1
Malaysia	74	80	5.0
Indonesia	53	60	33.0
Thailand	48	55	5.6
Philippines	46	49	8.0
Vietnam	34	41	11.0
Laos	33	40	0.8
Myanmar	30	33	3.1
Cambodia	22	27	1.2
ASEAN total	47	53	68.4

Table 3-3:
Population ranking for ASEAN cities

ASEAN rank	Global rank 2019	City	Population (millions)	Population density (per km²)
1	2	Jakarta	34.54	9,756
2	5	Manila	23.09	12,330
3	16	Bangkok	17.07	5,336
4	28	Ho Chi Minh	13.31	8,132
5	45	Kuala Lumpur	8.29	3,831
6	56	Bandung	7.07	14,510
7	64	Hanoi	6.58	6,825
8	65	Surabaya	6.50	7,129
9	70	Yangon	6.31	10,463
10	80	Singapore	5.75	10,981
<Reference>				
-	1	Tokyo-Yokohama	37.98	4,614
-	4	Mumbai	23.36	24,773
-	6	Shanghai	22.12	5,436

(Source) Table 3-2: Prepared by author based on ASEAN, "ASEAN Sustainable Urbanization Strategy"
Table 3-3: Prepared by author based on DEMOGRAPHIA, "Demographia World Urban Areas"[11]

Although urbanization is progressing throughout ASEAN, the state of urban development in each country differs significantly. Singapore, which proposed ASCN, has presented three stages of smart city development among ASEAN cities. While cities at the "preliminary" stage place an emphasis on developing basic urban infrastructure, they have the potential to undergo leapfrog-style development.[12] Cities at the "emerging" stage are transitioning to initiatives that involve using digital technologies for urban development. When cities reach the "advanced" stage, they integrate various digital platforms and work to create an advanced smart city by incorporating state-of-the-art technologies.[13] While Singapore and Bangkok are listed as cities at the "advanced" stage, many ASEAN cities are either at the "preliminary" or "emerging" stages. Thus, amid promoting conventional large-scale infrastructure development, the challenge that ASEAN countries face is how to utilize digital technologies and address the environmental aspect in relation to smart city development.

The IMD Smart City Index 2019[14] indexes and ranks 102 major cities worldwide based on their level of smartness. Eight cities were chosen from ASEAN, with the top five in that region being Singapore (1st), Ho Chi Minh (65th), Hanoi (66th), Kuala Lumpur (70th), and Bangkok (75th).

(3) Traffic Congestion: An Issue Common to ASEAN Urban Development

Traffic congestion is an issue shared by many cities in ASEAN. Among the eight priority actions set forth by the ASUS are two transport and traffic related areas, namely "introduce and improve bus rapid transit (BRT) systems" and "develop and enhance traffic management systems.[15]" A survey by the ASCN of member cities

[11] DEMOGRAPHIA (2020), "Demographia World Urban Areas 16th Annual Edition 2020.06," http://www.demographia.com/db-worldua.pdf
[12] In emerging countries with no existing social infrastructure in place, new services and systems are proliferating all at once, leaping ahead of the technological developments that developed countries have achieved
[13] Urban Renaissance Agency, ASEAN Smart Cities Network High Level Meeting in Yokohama, Singapore presentation materials, https://www.ur-net.go.jp/overseas/AseanSmartCityNetwork/lrmhph00000162t5-att/Singapore.pdf
[14] IMD (2019), "IMD Smart City Index 2019," https://www.imd.org/research-knowledge/reports/imd-smart-city-index-2019/ The index evaluates 102 major cities worldwide based on the city's plenitude of infrastructure and utilization of cutting edge technologies, as well as factors such as health, safety, mobility, greening, governance, and employment and learning opportunities to determine a city's smartness.
[15] ASEAN (2018), "ASEAN Sustainable Urbanisation Strategy," https://asean.org/storage/2018/11/ASEAN-Sustainable-Urbanisation-Strategy-ASUS.pdf, P48

concerning their priority issues found that their top issues were "introduce an integrated public transport system " and "develop traffic management solutions to reduce congestion and improve efficiency," which are both transport and traffic related issues.[16]

The eight cities chosen in the above-mentioned IMD Smart City Index 2019 also listed traffic congestion among the top three priority issues cited by all ASEAN cities except for Singapore. A look at traffic indicators in the eight cities shows low scores (poor conditions) for Manila, Bangkok, and Jakarta, which have particularly large populations. Traffic congestion is a serious issue in ASEAN cities, even when compared to other populous Asian cities.

Table 3-4: Satisfaction concerning traffic in ASEAN cities

No.	City	Country	Traffic congestion is not a problem	Satisfied with public transport	Total
1	Singapore	Singapore	44.49	66.53	111.02
65	Ho Chi Minh	Vietnam	30.35	55.83	86.18
66	Hanoi	Vietnam	27.46	51.23	78.69
70	Kuala Lumpur	Malaysia	24.39	61.38	85.77
75	Bangkok	Thailand	25.14	34.43	59.57
80	Makassar	Indonesia	25.68	56.46	82.14
81	Jakarta	Indonesia	16.25	54.96	71.21
94	Manila	Philippines	5.96	25.47	31.43
<Reference>					
59	Shanghai	China	28.63	60.35	88.98
62	Tokyo	Japan	28.14	62.02	90.16
78	Mumbai	India	26.69	63.96	90.65

(Source) Prepared by author based on IMD, IMD Smart City Index 2019, and DEMOGRAPHIA, Demographia World Urban Areas 16th Annual Edition, June 2020.

4. ASEAN Smart City Development Case Study – From the viewpoint of the transportation sector

As discussed above, traffic congestion is a common and serious issue facing many ASEAN cities. For Japan, which excels at transit-oriented development and other aspects of smart city development in the transportation sector, this issue could become an area where the country could provide significant support. The ASUS indicates that China, EU, Japan, South Korea, and Germany are conducting mobility-related projects in ASEAN countries, and places an emphasis on the mobility field in its partnerships, especially those with Japan, South Korea, and Germany.[17]

This section will provide an overview of trends concerning and Japan's involvement in smart city development focused primarily on the transport and traffic sector in the Philippines (Manila), Thailand (Bangkok), and Indonesia (Jakarta), where traffic congestion is a particularly serious issue.

(1) Philippines (Manila)

The Philippines has seen economic growth of 6% or higher for seven consecutive years since 2012, and is one of the fastest growing countries even among the major ASEAN member states. Yet this rapid economic and population growth is causing a widespread worsening of traffic congestion, aging railways, and crowded harbors, making the development of public infrastructure a pressing need.

[16] ASEAN (2018), “ASEAN Sustainable Urbanisation Strategy,” https://asean.org/storage/2018/11/ASEAN-Sustainable-Urbanisation-Strategy-ASUS.pdf, P82

[17] ASEAN (2018), “ASEAN Sustainable Urbanisation Strategy,” https://asean.org/storage/2018/11/ASEAN-Sustainable-Urbanisation-Strategy-ASUS.pdf, P83, P95

(a) Policies Concerning Smart Cities

There are currently no state-level development plans concerning smart cities in the Philippines, and plans are being made on a project-to-project basis. As part of the country's major state-level infrastructure development policies, the Roadmap for Transport Infrastructure Development for Metro Manila and its Surrounding Areas, formulated with support from JICA in 2014, plays a major role in guiding transport/traffic infrastructure and urban development.[18]

The aim of this roadmap is to alleviate traffic congestion and improve mobility, connectivity, and quality of life in Mega Manila by 2030. It establishes the "promotion of sustainable suburban development and connection of cities via traffic networks" in order to alleviate congestion in Metro Manila against the backdrop of its rapid, unsystematic economic and population growth.

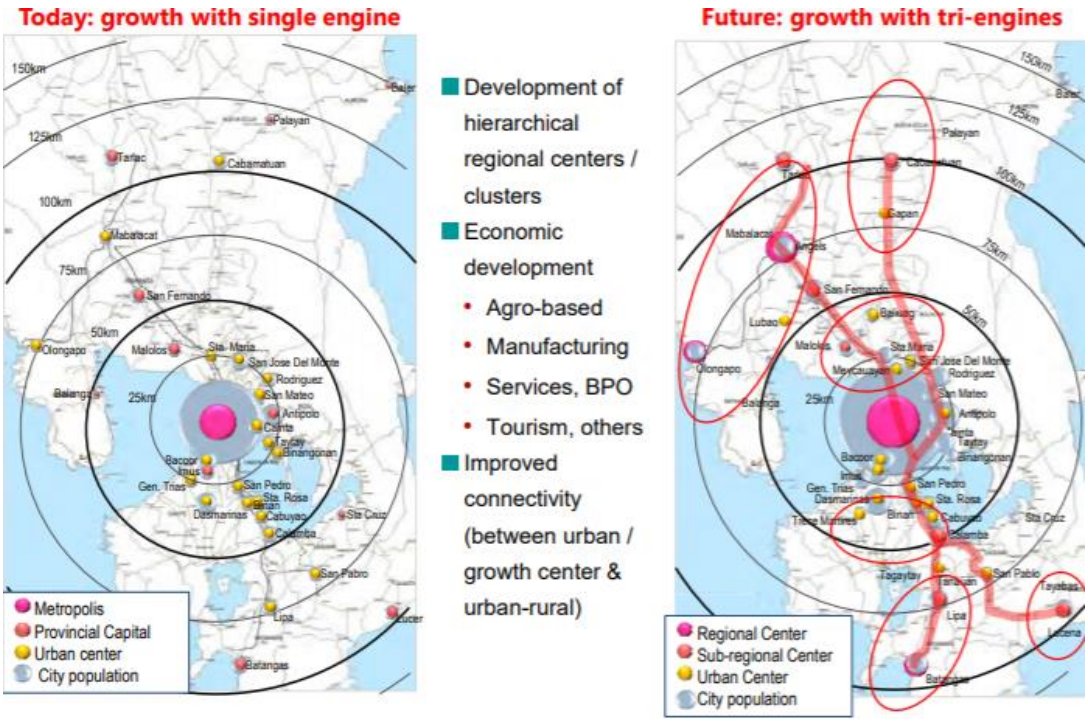


Fig. 4-1: Proposed development concept and structure for GCR

(Source) JICA, Roadmap for Transport and Traffic Roadmap for the Sustainable Development of Metro Manila and its Surrounding Areas

(b) Smart City Development Project – New Clark City Case Study

As discussed above, the government of the Philippines is developing the cities around Metro Manila in a bid to decentralize the economies and populations in the area. One such endeavor is New Clark City (NCC), which is attracting attention as Philippine's first green smart city. The above-mentioned roadmap establishes that the NCC will have an international gateway Seaport and airport, and will be a city at the core of regional cluster development through city and industrial development.

The NCC development project is a giant project seeking to develop urban infrastructure for 1.2 million people on part of the site of the U.S. Clark Air Base (total area of 9,450 hectares) that will involve the construction of

[18] JICA (2014), "Roadmap for Transport Infrastructure Development for Metro Manila and its Surrounding Areas" Final Report, https://openjicareport.jica.go.jp/548/548/548_118_12149605.html "Metro Manila" contains 16 cities and one municipality, including Manila, the country's capital. "Mega Manila" is composed of Metro Manila plus four immediate adjoining provinces. "Greater Capital Region (GCR)" is the grand scale of the study area covering Metro Manila and further surrounding area.

a new airport and high-speed rail lines, as well as the partial relocation of government offices in Manila. As part of these efforts, the Bases Conversion and Development Authority (BCDA), a government agency, created a master plan in conjunction with Japan Overseas Infrastructure Investment Corporation for Transport & Urban Development (JOIN)[19]. Phase 1 runs the five years from 2018 through 2022, with plans calling for constructing structures such as a track and field stadium, swimming pool, and government office buildings.

Development will see the utilization of, technologies and experience concerning urban development by Japanese companies, and several Japanese companies have announced plans to participate in the NCC development project, which includes announcements by Marubeni, Kansai Electric Power, Chubu Electric Power, and Manila Electric Company, the largest power distribution company in the Philippines, of plans to jointly engage in smart grid business. The government of China has also announced, during a visit to the Philippines by President Xi Jinping, that it will develop a 500-hectare industrial park in NCC.[20]

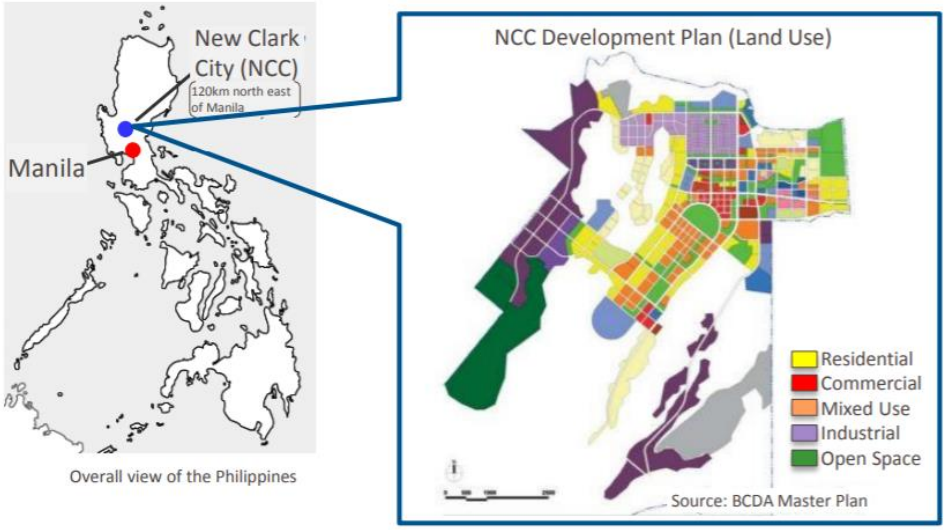


Fig. 4-2: New Clark City development plan

(Source) Website of Kansai Electric Power[21]

(c) Future Trends in Smart City Development

Under its "Build, Build, Build" large-scale infrastructure development policy, the current Duterte administration plans to invest roughly eight trillion pesos (about ¥17 trillion) over the six years from 2016 to 2022 to build a traffic network, airport, and other infrastructure in Metropolitan Manila. The transport and traffic sector accounts for 73 of the 100 major projects, indicating how the construction of roads and railways is the Philippines's top priority.[22] However, as indicated in the above-mentioned roadmap, alleviating traffic congestion in Metropolitan Manila will require simultaneously developing a traffic network connecting different cities and sustainably developing suburban areas that have appealing functions. Going forward, the world will be watching to see whether or not the country will draft a comprehensive urban development plan

[19] "JOIN" is a Japanese government-private sponsored infrastructure investment fund company established in Japan in October 2014. Our aim is to encourage Japanese companies to utilize their accumulated knowledge, technology, and experience in the field of infrastructure to expand overseas.

[20] JETRO, "Several Japanese Companies Announce Intention to Participate in New Clark City Plan (Philippines)," August 30, 2019, https://www.jetro.go.jp/biz/areareports/special/2019/0801/ad916df1d192736b.html

[21] Kansai Electric Power, Press release, April 4, 2019, https://www.kepco.co.jp/english/corporate/pr/2019/pdf/2019_apr4_2.pdf

[22] Congressional Policy and Budget Research Department House of Representatives, Press release, May 2020, https://cpbrd.congress.gov.ph/images/PDF%20Attachments/Facts%20in%20Figures/FF2020_-14_BBB.pdf

to accompany its traffic infrastructure plan.

(2) Thailand (Bangkok)

Thailand has made great strides in development driven by its rapid economic development. The next key challenge the country faces is building a sustainable society. Its definition of smart city is cited as satisfying the requirement of a smart environment along with at least one of six other themes (smart economy, mobility, energy, people, living, and governance). This indicates that Thailand highly values the environment and sustainability in development.

(a) Policies concerning Smart Cities

Thailand's smart city development concept was launched with the establishment of the National Smart City Committee, chaired by the prime minister, in 2017. Since then the country has made rapid progress with the development of policies. Initially, under the Thailand 4.0 concept[23], the country had planned to develop three smart cities; namely, southern Phuket, northern Chiang Mai, and northeastern Khon Kaen, but in November 2017, it indicated a goal of developing 100 smart cities by 2022[24]. In particular, priority is being given to the development of the three cities of Bangkok, Chonburi (part of the Eastern Economic Corridor [EEC[25]]), and Phuket, which were selected as candidate cities for ASCN.

(b) Example of Smart City Development Project: Bangkok

Bangkok is moving forward with the Study on Development of Smart City Concept for the Bang Sue Area in the Kingdom of Thailand under the support of JICA through the Ministry of Transport.

The Bang Sue Area is located within 10km north from downtown Bangkok. The Bang Sue Grand Station has railway lines serving the airport and high-speed railways. This area will become a railway terminal station and transportation hub through further development in the future. The area of the smart city covers 372 hectares. It is expected to become a new hub in Bangkok with its dense area of office functions utilizing the transportation hub function, an area with exchanges and tourism functions neighboring large-scale commercial facilities and parks, and a residential area. The plan is to move ahead with development according to three phases. First is the Bang Sue Central Station area by 2022, followed by mainly the office area by 2027, and then the residential and commercial areas by 2032.

[23] Thailand 4.0: An ambitious long-term vision that aims to put the country into the category of developed country in 20 years by shifting towards a society based on value added creation through acceleration of socioeconomic digitalization.
[24] SMART CITY Thailand (2020); Annual Smart City Thailand Report 2018, https://smartcitythailand.or.th/web?download
[25] Also known as the Eastern Economic Corridor (EEC). A core project designed to achieve the vision of Thailand 4.0 in which the government-led intensive infrastructure development is conducted in the three eastern provinces (Chonburi, Chachoengsao, Rayong).

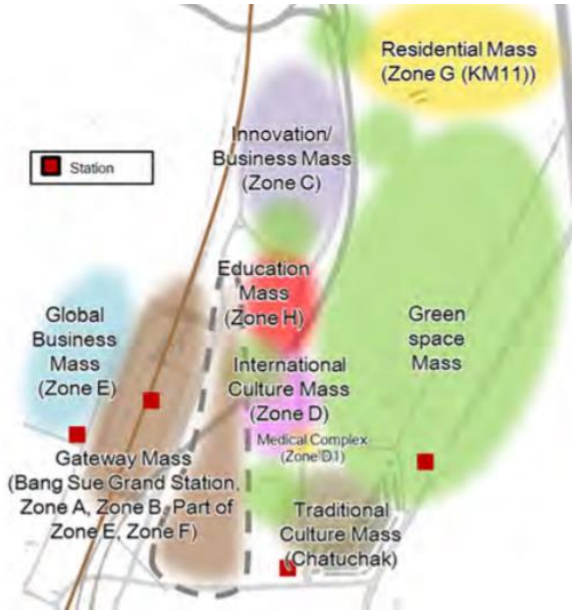


Fig. 4-3: Spatial Planning Concept for Bang Sue

Source: JICA documentation[26]

Furthermore, JICA is currently implementing two projects for Bangkok's transport and traffic sector.[27] Specifically, the projects aim to alleviate Bangkok's traffic issues and as a result achieve a low-carbon society and improve the overall happiness of city residents by introducing a traffic control system and building an evaluation system for transport and traffic policy.

(c) Trends in the Future Development of Smart Cities

In addition to the previously mentioned Bangkok, Thailand is moving ahead with the development of unique smart cities, such as the three cities under the EEC concept and Phuket, a major hub of tourism. In addition, many of the focus areas selected in phase two (2019 to 2020) are located close to the border, with an emphasis being given to the promotion of tourism and trade through the use of digital technologies.[28] In the EEC region, while a number of Japanese companies have already established a presence, China is stepping up its involvement. In addition to showing a proactive stance toward infrastructure development, China's Alibaba is increasing its presence in digital promotion.

[26] JICA (2020), "The Study on Development of Smart City Concept for The Bang Sue Area in The Kingdom of Thailand", https://openjicareport.jica.go.jp/pdf/12327367_01.pdf

[27] Smart Transportation Strategy for Thailand 4.0 (June 2018-June 2023), Visualization of Big Data and 3D Data on Digital Earth Using ICT Technology, Project to Develop A Policy Evaluation System Based on Citizens' Quality of Life/Project for Improving Traffic Congestions in Bangkok through the Establishment of Model Area Traffic Control (ATC) System (April 2019-February 2022), Project to Establish the ATC System and Improve Traffic Congestion through Introduction of Model Area Traffic Control (ATC) System in Intersections, and Development of an Operation and Maintenance Management Structure.

[28] JETRO, "Clarification on the Requirements and Benefits of Smart City Development (Thailand)," August 30, 2019, https://www.jetro.go.jp/biz/areareports/special/2019/0801/2a3db5f0d050195c.html

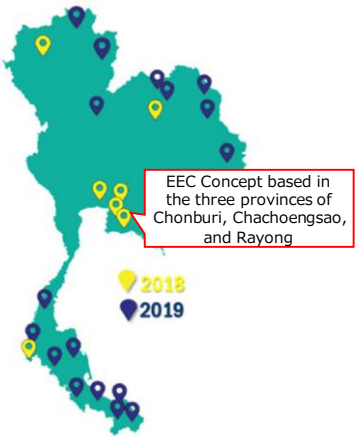


Fig. 4-4: Smart City Development Area **Fig. 4-5: Major projects on EEC**

Source: Fig. 4-4: Notes from the author on JETRO documentation [29] / Fig. 4-5: EEC documentation [30]

Thailand is one of the ASEAN countries with advanced economic growth. Excluding Singapore, it is also the country with the highest rate of aging in all of ASEAN. As a result, in its development of smart cities, Thailand must pursue sustainable development with an eye toward changes in the social structure over the medium to long term, such as increasing efficiencies with digitalization and mitigating environmental impacts, at the same time as developing infrastructure.

(3) Jakarta (Indonesia)

Indonesia is a major economic power that accounts for 40% of ASEAN's population and 35% of its total GDP. The capital of Jakarta has the second largest population in the world. Over the past several years, the country has sustained an economic growth rate of around 5%, and in July 2020 it became an upper-middle income country[31]. However, Indonesia faces the major challenge of infrastructure development supporting its expansive territory. The country is now developing this infrastructure according to the Indonesia Economic Corridor Concept, which involves the comprehensive promotion of infrastructure development and industrial promotion following six corridors.

(a) Policies concerning Smart Cities

In Indonesia, seven government ministries and agencies are collaborating together, including the Ministry of Communication and Information Technology, the Ministry of Finance, and the Ministry of National Development Planning, in implementing the 100 Smart City plan from 2017. Each city has prepared a master plan for becoming a smart city, and the government is providing support in terms of the dispatch of experts and budgeting. Additionally, as a method of measuring the achievement of this plan, the country plans to use a unique approach of conducting satisfaction surveys of the people[32].

---

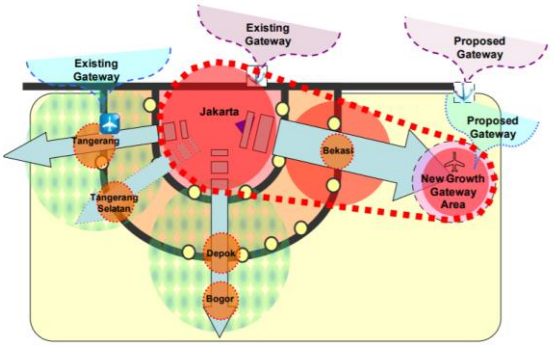
[29] ibid.
[30] EEC, "Eastern Economic Corridor Thailand," June 2017, https://www.asean.or.jp/ja/wp-content/uploads/sites/2/2017/06/20170607-J-MOI-FINAL.pdf
[31] The World Bank has defined low income economies as those with a Gross National Income (GNI) per capita of less than $1,036; lower middle-income economies are those with a GNI per capita between $1,036 and $4,045; upper middle-income economies are those with a GNI per capita between $4,046 and $12,535; high-income economies are those with a GNI per capita of $12,536 or more. Among ASEAN countries other than Indonesia, Malaysia and Thailand are considered upper middle-income economies, and the Philippines and Vietnam are considered lower middle-income economies.
[32] JETRO, "Selection of the 100 Cities as Smart Cities (Indonesia)," August 30, 2019, https://www.jetro.go.jp/biz/areareports/special/2019/0801/74b72efc489b22d1.html

(b) Progress in Smart City Development Projects: The Example of Jakarta

Smart city development in Jakarta is focusing on creating mechanisms for civic participation such as a participatory information gathering app, in addition to the development of public transportation and urban high-speed railways and development of infrastructure, such as the introduction of traffic systems.

As for infrastructure development, the concept of the Metropolitan Priority Area (MPA)[33] agreed upon between the governments of Japan and Thailand in 2010 is playing a major role. Under the MPA concept, the aim is to realize transformation from a single concentration in Jakarta to a multipolar dispersed structure utilizing regional characteristics of surrounding cities. Among the 20 major projects, six of them account for transportation infrastructure development, such as improving access to airports and ports and urban high-speed railways, or mass rapid transit (MRT). In 2015, Mitsubishi Heavy Industries and Mitsubishi Research Institute implemented the Preparatory Survey on Intelligent Transport System Project to Mitigate Traffic Congestion in Jakarta (PPP Infrastructure Project)[34] as a JICA project. This indicates that infrastructure development under the MPA concept is now in the process of moving forward.

Additionally, the Information and Communication Bureau of the Special Capital Region of Jakarta began operation of the Jakarta Smart City portal site[35] in 2015. This portal site has an information distribution function for both the government and the people. The Special Capital Region of Jakarta provides information on congestion of roads and public transportation along with the level of rivers, while users provide information to the portal site that can be utilized as data on the app called Qlue.



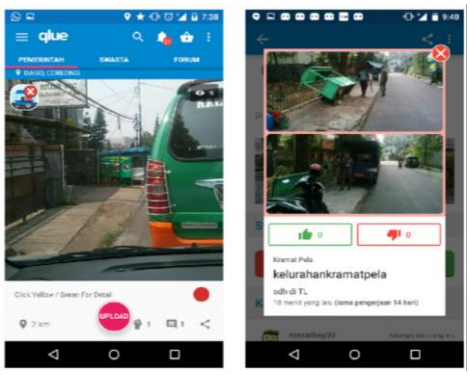


Fig. 4-6: Concept of greater Jakarta MPA **Fig. 4-7: Information confirmation using Qlue**

Source: Fig. 4-6: Jabodetabek MPA strategic plan / Fig. 4-7: GOVINSIDER[36]

(c) Trends in the Future Development of Smart Cities

While the national government is moving ahead with large-scale infrastructure development, Indonesia focuses on civic-participatory development led by local governments and companies in the development of smart cities. Also, Indonesia has the second largest number of digital start-ups with economic clout second only to Singapore in ASEAN[37]. The Special Capital Region of Jakarta concluded a memorandum of cooperation for

[33] JICA (2012), "Jabodetabek MPA strategic plan : master plan for establishing metropolitan priority area for investm ent and industry in Jabodetabek area in the Republic of Indoneshia : final report", https://openjicareport.jica.go.jp/700/700/700_108_12083945.html

[34] JICA (2015), “Republic of Indonesia, preparatory survey on intelligent transport system project to mitigate traffic congestion in Jakarta (PPP infrastructure project),”https://openjicareport.jica.go.jp/710/710/710_108_12229852.html

[35] Jakarta Smart City, http://smartcity.jakarta.go.id/

[36] GOVINSIDER, October 19, 2015, https://govinsider.asia/digital-gov/app-helps-jakarta-traffic-officials-prioritise-tasks/

[37] ASEAN (2018), “ASEAN Investment Report 2018”, http://aadcp2.org/wp-content/uploads/ASEAN_investmentRprt2018.pdf

the creation of a smart city mainly with eight local start-ups in September 2019. It is now looking at transit system integration using the technologies of Go-Jek and Grab in the field of mobility[38]. Looking ahead, it will face the challenges of combining large-scale infrastructure development using foreign capital and soft development that fits the country utilizing local companies and citizen participation.

5. Emergence of China in the Development of ASEAN's Smart Cities

(1) China and ASEAN Collaboration in the Development of ASEAN's Smart Cities

Japan is not the only country showing a proactive stance toward future smart city development in ASEAN cities, which are expected to see further economic growth and urbanization. Neighboring China is attempting to increase its influence on the development of ASEAN smart cities by linking this with its One Belt, One Road initiative.

At the One Belt One Road international forum held in May 2017, a number of infrastructure related projects such as high-speed railways, industrial parks, ports, power, and airport expansion, were signed between China and ASEAN[39]. In addition, a joint statement was issued on smart city development and the One Belt One Road initiative at the 22nd China-ASEAN Summit Meeting held in November 2019. The China-ASEAN Leaders Statement on Smart City Cooperation Initiative contains mention of sharing best practices with supervising bodies and regional governments regarding smart city development, and communication in smart city technology and industry fields, mutual certification, utilization of international standards, and cooperation for standardization using collaboration promotion for authentication[40].

Looking at the direct investment of Japan and China into ASEAN, Japan has the larger investment amount and Japan has a large percentage of its investment in the manufacturing industry. Looking at logistics, construction, and information/communication, which are considered to be deeply related to smart city development or the transport and traffic sectors, while Japan is moving ahead with investment in logistics, China is making active investment in construction and information/communication.

---

[38] JETRO, "Jakarta Special State, Collaboration with Eight Start-up Companies for Achieving a Smart City (Indonesia)," October 2, 2019, https://www.jetro.go.jp/biznews/2019/10/8a20f33f463a96e3.html Go-Jek is an Indonesian company, and Grab is a Singapore-based vehicle dispatch app management company. Both companies are expanding their businesses in the areas of logistics and settlement businesses.

[39] Mizuho Research Institute (2018), "The Development of China's Belt and Road Initiative in ASEAN Region: Progress and Challenges in Infrastructure Openness and Financial Soundness in Mekong," https://www.mizuho-ri.co.jp/publication/research/pdf/insight/as180720.pdf

[40] ASEAN(2019), ASEAN-China Leaders' Statement on Smart City Cooperation Initiative, https://asean.org/storage/2019/11/Final-ASEAN-China-Leaders-Statement-on-Smart-City-Cooperation-Initiative-2.pdf

Direct Investment Amount in ASEAN from Japan and China: by Sector (US$1 million)

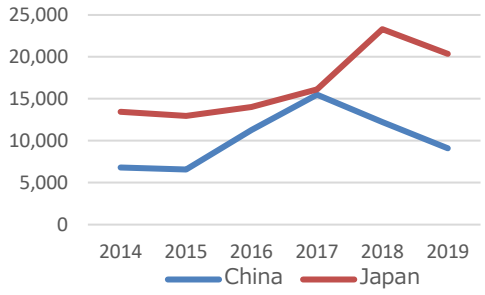


Fig. 5-1: Total Amount

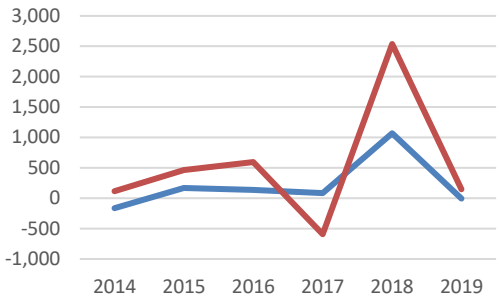


Fig. 5-2: Logistics

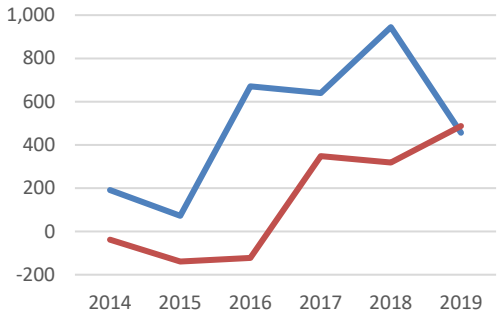


Fig. 5-3: Construction

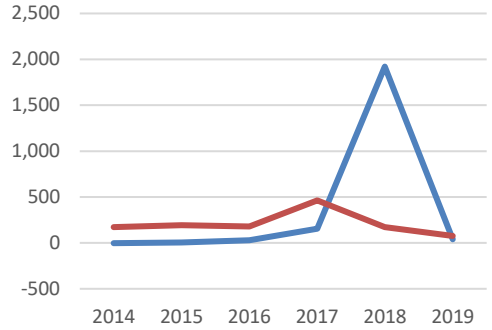


Fig. 5-4: Information / Communication

Source: Compiled by author based on ASEANStatsDataPotal[41]

Alibaba, one of China's largest IT companies, is making moves to support supporting the digitalization of each country through collaboration with ASEAN governments and expanding investment in local companies. This indicates that China is making inroads into digital fields in ASEAN countries through public-private initiatives.

(2) Data Utilization in Smart Cities as a Countermeasure Against COVID-19

China is moving ahead with the use of individual's data as a countermeasure against the recent spread of COVID-19. The app called the Health Code analyzes data such as position information of the Global Positioning System (GPS) and medical records of individuals to determine infection risks. Health Code is supported by platforms for consolidating resident data built as a national strategy by the Chinese government. The country is moving ahead with a smart city plan in more than 100 countries, and as part of this, it is believed to be gathering data using facial recognition cameras and drones.

According to Japanese government officials, as of August 2020, in the field of smart cities China has proposed seven subjects such as "guidelines on the use of data concerning residential communities related to emergency situations for public health" to the International Standards Organization (ISO) and International Electrotechnical Commission (IEC). The details of the proposals have not been made public, but they are believed to be related to a resident surveillance system related to COVID-19 based on the subjects and its table of contents. Some of these are expected to be approved or disapproved before the end of this year. As a solution to the urgent and serious crisis of COVID-19, China is aiming to establish international standards for smart city development, but Japan appears to be aiming to block China through coordination with the United States and

[41] ASEANStatsDataPotal, Flows of Inward Foreign Direct Investment (FDI) to ASEAN by Source Country and Economic Sectors (in million US$), https://data.aseanstats.org/fdi-by-sources-and-sectors

Europe. This is because if China gains control of the international standards in this field, China could threat the expansion of projects by Japan, the United States and Europe, which could in turn impact national security[42].

Looking at developments in ASEAN countries, local media in Indonesia and Vietnam have indicated that data platforms of smart cities are beneficial to countering COVID-19, which suggests that digitalization in smart city development may accelerate further. Meanwhile, alarm bells are ringing that moving ahead with digitalization as a temporary remedy hastily and without analysis or proper planning will bring undesirable impacts over the long term such as data privacy issues[43][44].

Closing

Regarding smart city development in ASEAN, after examining growing urbanization in ASEAN and the social issues accompanying it, this paper summarized projects in three cities with a focus on the transport and traffic sector, which faces particularly common and serious challenges. In addition, this paper examined the developments and collaboration between Japan and China and ASEAN in the development of smart cities in ASEAN.

From the examples of the three cities introduced, the transportation and traffic sector pertaining to smart city development in ASEAN indicates that most projects are focusing on the development of conventional large-scale infrastructure such as roads and railways. In conjunction with large-scale infrastructure development, Japan is working to alleviate traffic congestion with the introduction of traffic management systems using IT. It can be said that this aligns with the needs of many ASEAN countries. At the same time, while the situation differs depending on each country, ASEAN countries are steadily moving ahead with development of their ICT environment, and even in the transport and traffic sector, there is the potential for the introduction of leap frog-type technology. For example, as of today, although developments such as MaaS[45], which is being implemented in other countries, has yet to spread, Grab and Go-Jek are already being utilized as two major players in the ride sharing business. Among the Japanese companies, Toyota Tsusho[46] and high-speed bus manufacturer Willer[47] are using Singapore as a hub in an attempt to expand MaaS services in ASEAN countries.

In ASEAN, China has demonstrated its presence in the introduction of advanced digital technologies, not just in the transport and traffic sector. China is leveraging its experience of building digital infrastructure domestically over a short period of time in swiftly expanding projects in ASEAN countries. At the same time as increasing its involvement in large-scale infrastructure development linked with its One Belt One Road initiative, China's strategy of moving ahead with international standardization concerning the use of digital technology in smart city development could pose a threat to Japan's smart city export projects for ASEAN.

Countries around the world have been greatly impacted by the recent COVID-19 pandemic, which has also brought about changes to people's lifestyle patterns. Additionally, some large-scale infrastructure development has been forced to be delayed, while there are cases of the benefit of digitalization in smart city development being recognized once again. In the future development of smart cities in ASEAN, attention will need to be given to the priority ranking in each country, such as short-term economic development and long-term sustainability, and large-scale infrastructure development and digitalization, and how investment is allocated to development. It will also require attention in what ways Japan, China and other foreign nations should be

---

[42] Nihon Keizai Shimbun electronic version, August 4, 2020, https://www.nikkei.com/article/DGXMZO62273810U0A800C2EE8000/

[43] The Jakarta Post, July 23, 2020, https://www.thejakartapost.com/academia/2020/07/23/has-covid-19-accelerated-smart-city-initiatives-in-indonesia.html

[44] SAIGON, July 18, 2020, https://sggpnews.org.vn/science_technology/vietnam-effectively-implements-smart-city-model-to-fight-against-covid19-87615.html

[45] Mobility as a Service (MaaS): An integrated mobility service that combines various modes of transportation services into one as demanded utilizing digital technology.

[46] Toyota Tsusho, Press release, January 23, 2020, https://www.toyota-tsusho.com/english/press/detail/200123_004541.html

[47] Nikkei XTREND, November 14, 2019, https://xtrend.nikkei.com/atcl/contents/18/00234/00009/

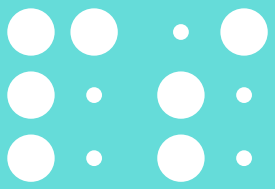
conducting development support in a balanced manner over the short, medium and long-term and in which fields.

IEEJ Energy Journal Vol. 16, No. 1 2021

Editor: Hisashi Hoshi

Publisher: The Institute of Energy Economics, Japan
Inui Bldg., Kachidoki, 13-1,
Kachidoki 1-chome, Chuo-ku, Tokyo
104-0054, Japan
e-mail: report@tky.ieej.or.jp

Please contact the editor for inquiry
e-mail: hisashi.hoshi@tky.ieej.or.jp



The Institute of Energy Economics, Japan