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Economic and Energy Outlook of Japan for FY2024 ◆

Despite improvements of energy consumption per GDP and progression towards decarbonization, the CO_2 reduction pace lags behind the target

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Summary of economic and energy outlook [Reference Scenario]

Macro economy | Real GDP growth rate will continue to rise, but at a slower pace Inflation will continue.

Real GDP for FY2024 will increase for the fourth year in a row but the rate of increase is decelerating (+1.0%). For the third year in a row, the consumer price index will exceed 2%; inflation will continue. Led by automobile production, the index of industrial production will rise for the first time in three years led by automobile and will reach its highest level since FY2020 (+1.2%).

Energy supply and demand | Total primary energy supply will decrease slightly for the second year in a row. LNG imports will be about 30Mt lower than the record high of 89 Mt reached ten years ago in FY2014. The CO_2 reduction will continue but it is lagging behind its target.

Total energy consumption will decrease three years in a row due to a fall in ethylene production and a rise in energy prices, the result of the subsidy program for fuel prices being phased down (-0.6%). With progress in energy savings led by higher energy prices and a continuous relatively high increase of the tertiary industries and non-energy intensive industries, the primary energy supply per GDP will decline reaching less than 80% of the FY2013 ratio (-1.5%). LNG imports will fall lower than 60Mt for the first time since FY2005. The additional LNG imports that were required after the Earthquake are no longer needed because of nuclear power plants restart, the addition of solar PVs, and the start-up of newly installed coal-fired power plants.

For the third year in a row, CO_2 emissions will decrease. The decrease from FY2023 will be of 2.0% down to 909 Mt. However, that level represents a change of only 26.4% from FY2013, compared to the 29.2% required to be in line with the Paris agreement target, which is to cut emissions cut by 45% by FY2030 from FY2013.

Energy sales | Electricity sales will slightly rise. City gas sales will increase for the first time in three years but remain lower than FY2022. Total fuel oil sales will decrease for the third year in a row and be less than 60% of the record high in FY1999.

Electricity sales will be 0.1% slightly higher than FY2023. Reflecting a production recovery in iron and steel, automobile, and service industries, and despite some energy savings resulting from higher electricity prices, overall sales for power services will grow (+0.3%). Sales for lighting services will, however, slightly decrease (-0.1%), primarily due to a penetration of higher efficiency appliances and energy-saving actions brought by higher electricity prices and a cooler summer than in the previous year, despite a colder winter.

City gas sales will increase slightly (+0.1%). While sales to the commercial sector and other sectors will decrease, slight increases in sales to the household and increases in sales to the general industry will contribute to the overall increase in city gas sales. However, gas sales except for the general industry will be lower than FY2022 due to progression of energy-savings while city gas prices are lower.

◆ Created based on the published research in the 446th Forum on Research Works with the information available as of December 2023.

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Fuel oil sales will decrease by 1.2% primarily because less will be used for power generation and as feedstock of ethylene. Other factors include fuel switching and energy savings, the result of higher oil prices brought by the removal of the fuel subsidy program. Gasoline will slightly fall with improved fuel efficiency and diffusion of HVs despite the recovery of transportation demand. Diesel oil will fall due to problems in logistics for 2024.

Renewable power generation | The FIT power generation capacity will reach 107 GW by the end of FY2024.

The installed renewable energy-based power generation capacity (including capacity subject to FIT contract expiration) will reach 107 GW by the end of FY2024. While the addition of residential solar and biomass will accelerate, the expansion pace for non-residential solar will be decelerating. Even so, non-residential solar will reach at 64.1GW in FY2024. Wind capacity will accelerate and reach 6.8 GW due to growing pressures to get FIT brought by setting operation deadline and expiration date for non-operating plants. Renewable power generation in FY2024 will total 212.1 TWh (including 98.8 TWh for solar PV, 44.5 TWh for small and medium-sized hydro plants, 51.6 TWh for biomass, 13.3 TWh for wind), accounting for 21.1% of Japan's total power generation. With the inclusion of large-scale hydro, renewable power generation will account for 24.6%.

Table 1 | Summary of Reference Scenario

		Historical				Projection		Year-over-year		
		FY2013	FY2020	FY2021	FY2022	FY2023	FY2024	FY2022	FY2023	FY2024
Energy	Primary energy supply (Mtoe)[1]	490.5	415.5	430.1	416.5	413.0	410.7	-3.2%	-0.8%	-0.6%
	Oil[2] (GL)	234.5	170.0	175.1	172.8	169.4	166.7	-1.3%	-2.0%	-1.6%
	Natural gas[2] (Mt of LNG equiv.)	90.1	78.4	73.9	70.4	66.3	60.7	-4.7%	-5.9%	-8.3%
	Coal[2] (Mt)	194.6	174.6	184.6	177.1	172.6	173.7	-4.1%	-2.5%	0.6%
	Nuclear (TWh)	9.3	37.0	67.8	53.5	82.8	113.7	-21.0%	54.6%	37.5%
	Renewable electricity[3] (TWh)	118.5	196.8	208.1	221.2	237.5	247.5	6.3%	7.4%	4.2%
	FIT generation (TWh)	76.5	158.1	169.3	185.2	199.2	212.1	9.4%	7.5%	6.5%
	Self-sufficiency ratio	6.5%	11.3%	13.3%	12.6%	14.8%	17.0%	-0.7p	2.1p	2.2p
	Electricity sales[4] (TWh)	(871.5)	820.9	837.1	822.2	820.6	821.6	-1.8%	-0.2%	0.1%
	City gas sales[5] (Billion m^3)	39.82	39.51	41.15	40.24	39.83	39.86	-2.2%	-1.0%	0.1%
	Fuel oil sales (GL)	193.6	152.0	153.8	150.8	148.9	147.1	-1.9%	-1.3%	-1.2%
	Energy-related CO_2 emissions (Mt)	1,235	967	987	958	928	909	-2.9%	-3.2%	-2.0%
	(Changes from FY2013)	-	-21.7%	-20.1%	-22.5%	-24.9%	-26.4%	-2.4p	-2.5p	-1.5p
Prices	Crude oil, import, CIF ($/bbl)	110	43	78	103	85	91	32.6%	-17.5%	6.9%
	LNG, import, CIF ($/MBtu)	16.2	7.5	12.1	18.0	12.2	12.2	48.8%	-32.1%	0.1%
	Steam coal, import, CIF ($/t)	108	80	162	361	204	167	122.7%	-43.5%	-18.2%
	Coking coal, import, CIF ($/t)	135	105	195	338	256	211	73.4%	-24.4%	-17.6%
Economy	Real GDP (JPY2015 trillion)	532.1	528.8	543.6	551.8	560.5	566.2	1.5%	1.6%	1.0%
	Industrial production (CY2020=100)	111.7	99.7	105.2	104.9	104.2	105.4	-0.3%	-0.7%	1.2%
	Balance of trade (JPY trillion)	-13.8	1.0	-5.7	-22.0	-7.7	-5.5	288.7%	-65.1%	-29.1%
	Fossil fuel imports (JPY trillion)	28.4	10.6	19.9	35.3	26.9	25.6	77.1%	-23.7%	-4.9%
	Exchange rate (JPY/$)	100.0	106.0	111.9	135.0	144.8	140.0	20.6%	7.3%	-3.3%
	Cooling degree days	511	442	407	506	614	416	24.4%	21.2%	-32.2%
	Heating degree days	1,024	863	966	850	902	971	-12.0%	6.2%	7.6%

Notes:

1. Mtoe = 10^{13} kcal

2. Conversion factors for oil: 9,145 kcal/L; Natural gas: 13,016 kcal/kg; Steam coal: 6,203 kcal/kg; Coking coal: 6,877 kcal/kg since FY2013.
Conversion factors for oil: 9,139 kcal/L; Natural gas: 13,068 kcal/kg; Steam coal: 6,203 kcal/kg; Coking coal: 6,866 kcal/kg since FY2018.

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

Topic |

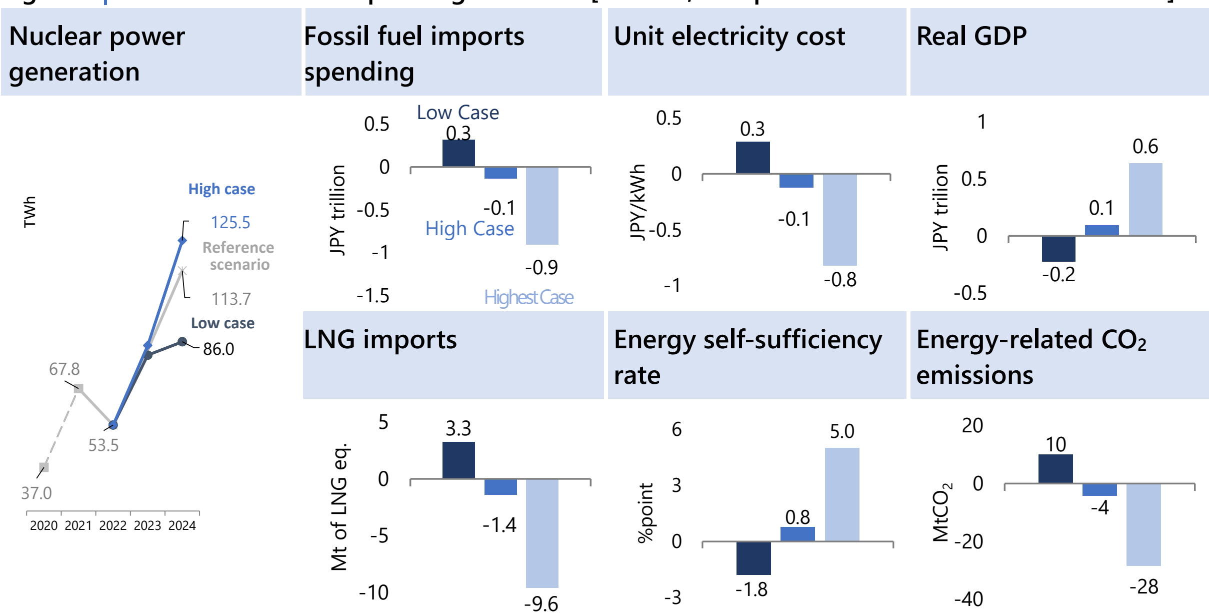
1 Impacts of the subsidy program for fuel prices

The subsidy program to lower fuel prices will be extended until April 2024 and will be phased down after May. If the subsidy program for fuel prices was extended to the end of FY2024, energy prices would lead to lower commodity prices, drive up economic growth and spur industrial production. On the other hand, the subsidy program would have pushed upward energy consumption and CO_2 emissions. As such, the program could be interpreted as temporarily delaying energy savings and postponing reductions in CO_2 emissions. An extension of the subsidy program for fuel prices would also have substantially increase government spendings. The challenge will be to introduce appropriate phase-out measures to minimize the negative effects of the subsidy while recognizing there will be, as in the past, fluctuations in fossil fuel prices. In addition, it is important to reduce energy expenditures by enhancing efficiencies through assistance programs for energy savings in the short term and supply energy through domestic energy such as restart of nuclear power generation and acceleration of install of renewable energy in the middle to long term. Combining and implementing such short, middle and long-term measures are essential in the development of an exit strategy for the subsidy program.

2 Impacts of the progresses of nuclear plant restarts

We assessed the impacts of nuclear power generation on 3Es – economy efficiency, energy security and environment. In the High Case compared to the reference scenario, one more plant would return to operation in FY2024. In such Case, the cost of fossil fuel imports would be reduced by JPY100 billion, the self-sufficiency rate would be improved by 0.8 points, and CO_2 emissions would be reduced by 4 Mt. Considering what each nuclear power plant can contribute to the 3Es, a smooth restart of the plants would be benefits.

Figure 1 | Effect of the nuclear power generation [FY2024, compared with the Reference Scenario]



Overview

In the third quarter (July-September) of 2023, Japan posted a negative GDP growth (-0.7%) for the first time in four quarters. In addition to private consumption and capital investment, inventories made a negative contribution, and the contribution of private demand was -0.6%. Private consumption was at the same level as the previous year as face-to-face services such as restaurants and accommodation, etc. increased due to the recovery after the COVID-19 pandemic, while consumers were saving-oriented due to consumer price rises. Moreover, capital investment in machinery is sluggish due to sluggish global demand, and the decline in demand as a consequence of global inflation is weighing on economic growth. Exports of cars were solid, so product inventories centered on cars decreased.

The factors behind rises in oil import prices from January 2023 onward included Europe's shift from natural gas to oil and the continued reduction of production of crude oil by 2Mb/d by OPEC+, etc. while the factors behind falls included concerns about the slowdown of the world economy and emerging countries and developing countries taking over purchases of Russia-produced crude oil, etc., so the price was fluctuating in the $80-$90/bbl range. However, due to concerns that the attack on Israel by the Palestinian Islamic organization Hamas in October could obstruct the crude oil supply, the price rose to the $90-$100/bbl range for the first time in ten months. Moreover, the foreign exchange rate is also weighing heavily on the Japanese economy still recovering from the pandemic.

Regarding the consumer price index (CPI), the subsidy program to curb excessive price increases was introduced for electricity and city gas in addition to fuel oil from January 2023 and from February 2023 onward, energy has continued to contribute to the decrease in the CPI compared to the same period in the previous year. However, in addition to the entrenchment of the depreciation of the yen, higher prices are continuing to be passed on to consumers, so rises of 3.0% or more compared to the same period in the previous year were seen for 15 consecutive months from August 2022 onward.

As for nuclear power, 27 plants have applied for the safety assessment in accordance with the new regulation standards: 17 have passed the assessment based on the installation permit standard and 12 have restarted. However, three out of those 12 reactors remained shut down for extended periods in FY2022 for not completing the construction of their specialized safety facilities (SSFs) in time.

Major Assumptions for the Reference Scenario

World economy

The global economic growth rate is estimated at +3.0% for 2023 and +2.9% for 2024. In 2023, growth slowed down due to the war in Ukraine, inflation, and interest rate rises implemented by the US and Europe to combat inflation. In 2024, growth will slow down due to the escalation of the real estate crisis in China in addition to the prolonged monetary tightening by the US and Europe. For the second year in a row, it will be much lower than +3.8%, the average from 2000 to 2019, before the COVID-19 pandemic.

Import CIF prices of fossil fuels

Japan's average oil import price is assumed at $85/bbl for FY2023 ($84/bbl in the first half, $86/bbl in the second half) and at $91/bbl for FY2024. The LNG price tracks the crude oil price with a delay and is assumed at $12.2/MBtu for FY2023 and $12.2/MBtu for FY2024. The price of steam coal is assumed at $204/t for FY2023 and $167/t for FY2024, and that of coking coal is estimated at $256/t for FY2023 and $211/t for FY2024 ("International Oil Market Outlook for 2024" by Morikawa, "Gas Market Outlook for 2024" by Hashimoto, and "Coal Market Outlook for 2024" by Takahashi, IEEJ).

Foreign exchange rate

The average USD/JPY exchange rate is assumed at JPY144.8/USD for FY2023 and at JPY140.0/USD for FY2024.

Subsidy program to curb excessive price increases

Until April 2024, the subsidy program to curb excessive price increases will subsidize fuel oil 100% when more than 17 yen higher than 168 yen and 60% when less than 17 yen higher than 168 yen, and it is assumed that city gas will be 15 yen/m^3 for households and for companies with annual contract amounts less than 10 million m^3 and electricity will be subsidized at 3.5 yen/kWh for low voltage and 1.8 yen/kWh for high voltage. It is assumed that from May 2024 onward, the subsidy rate for fuel oil will be phased out by three-tenths each month. It is assumed that city gas and electricity will be half price from May to September.

Nuclear power

Power plant restarts are expected to move forward with the progress in safety assessments in accordance with the new regulatory standards. In FY2023, three new nuclear plants restarted in turn and the average operating period is estimated at 9 months. The total estimated power output is 82.8 TWh (up 54.6% year-on-year). In FY2024, three plants are expected to restart in turn, bringing the total number of plants that have restarted since the Great East Japan Earthquake to 16. A total of 113.7 TWh of electricity will be produced (up 37.5% year-on-year) with an average operating period of 11 months.

Temperature

Based on the three-month forecast of the Japan Meteorological Agency, for the winter of FY2023, the temperature is likely to be higher than the average year, and is then expected to be similar to the average year thereafter. In FY2023, the summer was hotter than the previous year (+1.4°C) and the winter was colder (-0.6°C) compared to the previous year. For FY2024, the summer is forecast to be cooler than the previous year (-2.1°C) and the winter colder (-0.3°C).

Macroeconomy

In FY2024, real GDP will rise for a fourth year, though only at a moderate pace. The consumer price index will rise at more than 2% for the third year in a row and inflation will be entrenched

Real GDP will grow 1.6% yoy in FY2023 as it recovers centered on foreign demand. Private consumption will increase, centered on face-to-face services, but the consumption of food products and daily goods, etc. will decrease due to people holding back on purchasing as a consequence of consumer price rises, so it will be only a slight increase (+0.2%). Capital investment will increase slightly (+0.1%). Although the willingness of companies to invest will recover, construction costs will rise and the semiconductor market conditions will be sluggish. Private demand will contribute a decrease of 0.1%, partly because there was a decline in inventories. Public demand will contribute a 0.3% increase due to the increase in medical expenses and foreign demand will contribute a 1.3% increase due to the increase in automobile exports and inbound business demand and the decrease in imports due to sluggish domestic demand.

In FY2024, real GDP will increase driven by domestic demand but at a slower pace of +1.0% yoy. Private consumption will increase (+1.1%) because, although consumer prices will continue to rise, a demand recovery centered on face-to-face services will continue and in addition, the shortage of semiconductor components will ease for automobiles. Capital investment will increase (+2.3%) despite price rises for investment goods such as personnel expenses, buildings, software, etc. as corporate revenue picks up with the economic recovery. In addition to informatization investment and research and development investment for streamlining and digitalizing business operations, climate investment for decarbonization will accelerate. Private demand will contribute to an increase of 0.9%, though the demand will be smaller than the record high in FY2018. Public demand will contribute an increase of 0.2%, marking a record high with an increase in public investment such as for the Action Plan for National Resilience, and for the government spending on healthcare and nursing care costs which are increasing due to the ageing of the population and on increased defence expenditure, and so on. Despite the continuing increase of inbound business demand and auto exports, foreign demand will post a negative contribution of 0.1% caused by an increase in imports due to the recovery of domestic demand.

Regarding the consumer price index in FY2024, due to the rise in personnel expenses and logistics costs brought by a tight supply, among other factors, higher prices will continue to be passed on to consumers, particularly for food products, and the rate of the rise will be higher than 2% for the third year in a row. The subsidy program to curb excessive price increases will be reduced and energy will contribute to the rise.

Table 1 | Macroeconomy

	Historical				Projection		Year-over-year		
	FY2013	FY2020	FY2021	FY2022	FY2023	FY2024	FY2022	FY2023	FY2024
Real GDP (JPY2015 trillion)	532.1	528.8	543.6	551.8	560.5	566.2	1.5%	1.6%	1.0%
Private demand	408.1	389.3	398.5	409.3	409.2	414.2	(2.0%)	(-0.1%)	(0.9%)
Private consumption	306.0	285.3	290.4	298.1	298.6	302.0	2.7%	0.2%	1.1%
Private residential investment	21.5	18.9	18.9	18.3	18.6	18.6	-3.4%	1.9%	-0.4%
Private non-residential investment	82.0	85.5	86.9	89.9	90.0	92.1	3.4%	0.1%	2.3%
Public demand	131.2	143.3	145.2	145.2	146.7	147.8	(-0.0%)	(0.3%)	(0.2%)
Government consumption	103.1	114.0	117.7	119.3	120.1	120.8	1.4%	0.7%	0.6%
Public investment	28.1	29.4	27.5	25.9	26.6	26.9	-6.1%	2.9%	1.3%
Net exports of goods and services	-7.4	-4.1	0.5	-1.9	4.3	3.9	(-0.5%)	(1.3%)	(-0.1%)
Exports of goods and services	85.1	92.4	103.9	108.8	112.1	114.4	4.7%	3.1%	2.0%
Imports of goods and services	92.5	96.5	103.4	110.7	107.9	110.5	7.1%	-2.6%	2.4%
Nominal GDP (JPY trillion)	512.7	539.0	553.6	566.5	597.0	614.8	2.3%	5.4%	3.0%
Balance of trade (JPY trillion)	-13.8	1.0	-5.7	-22.0	-7.7	-5.5	288.7%	-65.1%	-29.1%
Exports	70.9	69.5	85.9	99.2	105.0	107.8	15.5%	5.9%	2.6%
Imports	84.6	68.5	91.5	121.3	112.7	113.3	32.5%	-7.0%	0.5%
Fossil fuels	28.4	10.6	19.9	35.3	26.9	25.6	77.1%	-23.7%	-4.9%
Oil	18.7	5.8	11.2	17.8	15.5	15.9	58.3%	-13.0%	2.9%
LNG	7.3	3.2	5.0	8.9	5.9	5.2	77.6%	-34.0%	-11.4%
Current account (JPY trillion)	2.4	16.9	20.1	8.3	24.9	28.7	-58.9%	201.2%	15.4%
Domestic corporate goods price index (2020=100)	99.4	99.9	107.0	117.2	119.6	120.1	9.5%	2.1%	0.4%
Consumer price index (2020=100)	95.2	99.9	100.0	103.2	106.1	108.5	3.2%	2.8%	2.3%
Unemployment rate (%)	3.9	2.9	2.8	2.6	2.6	2.4	[-0.2p]	[+0.0p]	[-0.2p]

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 Activity

In FY2024, industrial production will increase for the first time in three years and reach its highest level since FY2020 as production increases mainly in the automobile sector which has been slow to recover. On the other hand, the three energy-intensive materials industries, except for iron and steel, will be lower than in FY2022

The industrial production index for FY2023 will fall yoy (-0.7%) as, despite the increased production of automobiles, demand for consumer electronic equipment will decrease due to people holding back on purchasing caused by rising product prices and due to the shift to the consumption of services, and in addition demand for industrial equipment will decrease, centered on electronic components and devices, including semiconductor memory. In FY2024, in addition to the increased production of automobiles, capital investment for digitalization and greening will progress, so the industrial production index will rise (+1.2%), centered on heavy electrical equipment.

In FY2023, crude steel production will increase slightly (+0.2%) as exports recover centered on the United States and South Korea, even though domestic demand for construction and electric machinery will fall. In FY2024, crude steel production will increase (+0.5%) due to increased production of automobiles. Domestic demand will decrease slightly even though demand centered on electric machinery and automobiles will increase, because regulations on the upper limits to working hours have been applied under laws related to workstyle reforms in the construction industry, so the construction periods have been prolonged and construction materials will decrease. Exports will increase as a consequence of the recovery in exports for China and ASEAN.

In FY2023, ethylene production will decrease slightly yoy due to sluggish domestic demand (-0.3%). Exports will increase due to the rebound after the excess production of China was sold cheaply to the Asian market in the previous fiscal year. Domestic demand will decrease centered on demand for food packaging containers due to rising consumer prices. In FY2024, in the Asian market, ethylene production will decrease (-2.8%) as cheap ethylene with ethane derived from natural gas as the raw material becomes available from the United States in addition to China and exports fall. Even though demand will be stagnant due to rising consumer prices, demand for synthetic resin will increase due to increased production of automobiles and domestic demand will increase.

In FY2023, cement production will decline and fall below 50 Mt for the first time since FY1968 (-5.3%). Domestic demand will decrease as a consequence of labor shortages on construction sites, heavy rainfalls, and record-breaking extreme heat. Exports will decrease due to rises in raw material costs. In FY2024, cement production will decrease very slightly (-0.2%) as domestic demand will decrease, despite the increase in exports. Even though there will be construction projects, domestic demand will decrease as the construction period becomes more prolonged because regulations on the upper limits to working hours have been applied under laws related to workstyle reforms in the construction industry. Exports will increase centered on Australia as raw material costs fall.

In FY2023, paper and paperboard production will decrease (-4.4%) because of people holding back on purchasing daily goods due to rising consumer prices in addition to decreases in demand for newspapers, paper for events and publishing due to the structural factor of digitalization, and in addition because paperboard for electronic commerce applications will also decrease. Production will decrease (-1.2%) in FY2024 as well due to the long-term decline of newspapers, office paper, etc. amid a structural change toward digitalization, even though the use of paperboard for electronic commerce applications will increase slightly.

In FY2023, automobile production will recover as a consequence of the easing of the impact of the shortages of on-vehicle semiconductors, etc. (+9.9%). However, the semiconductors shortages will continue, so automobile production will be slightly higher than FY2009 levels (8,865 thousand units), when the bankruptcy of Lehman Brothers occurred. In FY2024, automobile production will continue to increase as the impact of shortages of on-vehicle semiconductors will be further eased (+4.3%). However, it will not return to the level of FY2019 (9,489 thousand units). The rate of increase in domestic shipments will slow down as the waiting time for vehicle delivery eases. Exports will increase on the back of demand in North America.

Table 2 | Production Activity

		Historical				Projection		Year-over-year		
		FY2013	FY2020	FY2021	FY2022	FY2023	FY2024	FY2022	FY2023	FY2024
Production	Crude steel (Mt)	111.5	82.8	95.6	87.8	88.0	88.5	-8.2%	0.2%	0.5%
	Ethylene (Mt)	6.76	6.04	6.10	5.48	5.47	5.32	-10.2%	-0.3%	-2.8%
	Cement (Mt)	62.4	56.1	55.7	51.5	48.7	48.7	-7.6%	-5.3%	-0.2%
	Paper and paperboard (Mt)	26.7	22.7	24.0	23.3	22.3	22.0	-3.0%	-4.4%	-1.2%
	Automobiles (Million units)	9.91	7.97	7.55	8.10	8.90	9.29	7.4%	9.9%	4.3%
Production indices	Mining and manufacturing (2020=100)	111.7	99.7	105.2	104.9	104.2	105.4	-0.3%	-0.7%	1.2%
	Food and tobacco	103.6	99.6	99.2	98.5	97.7	97.6	-0.6%	-0.8%	-0.1%
	Chemicals	107.2	99.3	105.2	102.6	100.1	101.4	-2.5%	-2.4%	1.3%
	Non-ferrous metals	110.9	100.0	106.8	105.5	103.7	104.2	-1.2%	-1.7%	0.5%
	Machinery	111.3	100.0	106.7	108.6	109.1	111.5	1.8%	0.5%	2.2%
Tertiary industry activity index (2015=100)		100.8	95.3	97.5	99.6	101.8	103.1	2.2%	2.2%	1.3%

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

Domestic Primary Energy Supply

In FY2024, slight decreases in energy demand will continue. LNG imports will be 30 Mt lower than the record high of 89 Mt reached ten years ago in FY2014. CO_2 emissions will continue to fall but progress toward the achievement of the FY2030 target is lagging behind

In FY2023, the domestic primary energy supply will decrease yoy due to declining production in energy-intensive industries (-0.8%). In FY2024, the supply will decrease for the third year in a row, with the declining production of ethylene and the rises in energy wholesale and retail prices due to the ending of the subsidies to curb excessive price increases contributing to this result (-0.6%). In addition to improving energy efficiency, the increases in activity by non-energy-intensive industries and tertiary industries will grow relatively, so energy intensity per unit of GDP will improve and decrease for the third year in a row (FY2023: -2.4%, FY2024: -1.5%). It will go lower than 80% of the FY2013 ratio.

New energy, etc. including solar PV, wind power and biomass will grow yoy mainly among non-residential solar PV and biomass using FIT (FY2023: +4.9%, FY2024: +3.3%). In FY2024, it will account for 7% of the domestic primary energy supply.

Nuclear power will increase yoy as three plants restarted in FY2023 and a further three plants will restart in turn in FY2024 (FY2023: +53.1%, FY2024: +36.0%).

In FY2023, oil supply will decrease despite the recovery in transportation demand and the increased production of ethylene, as the availability factor of oil-fired thermal plants falls, energy efficiency improves, and fuel conversion encouragements (-2.0%). In FY2024, the oil supply will decrease due to the decrease in naphtha with the decrease in ethylene production and progress in energy savings due to the rise in oil product prices as a consequence of the subsidies to curb excessive price increases ending (-1.6%).

In FY2023, coal supply will decrease due to a decrease in the use of coal in industry as a consequence of the decrease in cement production (-2.6%). Supply of coal for electricity uses will increase because three coal-fired thermal plants (1,800 MW) will start operations, while only one plant (175 MW) will be closed and biomass combustion is making progress at the existing coal-fired thermal plants. In FY2024, coal supply will increase due to higher crude steel production and the coal-fired thermal plants which started operations in FY2023 will be operating during the fiscal year (+0.5%).

Natural gas supply will decrease yoy (FY2023: -5.9%, FY2024: -8.3%) chiefly for power generation, as coal-fired thermal plants and solar PV power plants start operations and the restarts of nuclear power plants proceed in FY2023 and FY2024. In FY2024, LNG imports will decrease to 50-60 Mt for the first time since FY2005 and the significant increase since the Great East Japan Earthquake will be largely erased (-8.6%).

The self-sufficiency rate will rise for the second year in a row as the supply of new energy, etc. and nuclear power increases (FY2023: +2.1p, FY2024: +2.2p). In FY2024, it will be 17.0%, but progress toward achievement of the FY2030 target (about 30%) is lagging.

Energy-related CO_2 emissions will decrease for three years in a row to 909 Mt in FY2024 (FY2023: -3.2%, FY2024: -2.0%). However, at a 26.4% decrease compared with FY2013, there is more CO_2 than the FY2024 target value (29.2% reduction) shown on the straight line to the FY2030 reduction target (45% reduction compared to FY2013), so the progress of reduction continues to lag behind the target.

Table 3 | Domestic Primary Energy Supply

	Historical				Projection		Year-over-year		
	FY2013	FY2020	FY2021	FY2022	FY2023	FY2024	FY2022	FY2023	FY2024
Primary energy supply (Mtoe)	490.5	415.5	430.1	416.5	413.0	410.7	-3.2%	-0.8%	-0.6%
Coal	126.1	110.7	118.9	114.0	111.0	111.6	-4.1%	-2.6%	0.5%
Oil	214.4	155.4	160.0	157.9	154.8	152.4	-1.3%	-2.0%	-1.6%
Natural gas	117.3	102.5	96.6	92.0	86.6	79.4	-4.7%	-5.9%	-8.3%
LNG imports (Mt)	87.7	76.4	71.5	70.5	64.0	58.5	-1.3%	-9.2%	-8.6%
Hydro	16.6	16.2	16.3	16.0	16.7	16.3	-2.1%	4.5%	-2.3%
Nuclear	1.9	7.9	14.5	11.5	17.6	23.9	-20.8%	53.1%	36.0%
New energy, etc.	14.1	22.7	23.9	25.1	26.3	27.2	5.2%	4.9%	3.3%
Self-sufficiency rate	6.5%	11.3%	13.3%	12.6%	14.8%	17.0%	-0.7p	+2.1p	+2.2p
Primary energy supply per GDP (FY2013=10(	100.0	85.2	85.8	81.9	79.9	78.7	-4.6%	-2.4%	-1.5%
Energy-related CO_2 emissions ($MtCO_2$)	1,235	967	987	958	928	909	-2.9%	-3.2%	-2.0%
Change from FY2013	-	-21.7%	-20.1%	-22.5%	-24.9%	-26.4%	2.4p	2.5p	1.5p

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

Electricity Sales, Power Mix (for electricity businesses), and Prices for Electric Power and Lighting

In FY2024, electricity sales will only increase slightly even though demand for electricity will turn to increase. Due to nuclear power plant restarts and the continued growth of renewable energy, the ratio of non-fossil power sources will go above FY2010 for the first time since the Great East Japan Earthquake

In FY2023, overall electricity sales will decrease slightly yoy (-0.2%). The sales for power service will slightly decrease because of the decrease in the production of machinery and devices and ethylene, etc., even in the context of an increase in the production of automobiles and increased activity in the service business (-0.1%). The sales for lighting services will decrease (-0.5%) due to the fall in the stay-at-home rate and the progress in energy saving due to growing awareness of power saving, even though the winter will be colder. In FY2024, electricity sales will increase only slightly (+0.1%). The sales for power service will increase (+0.3%) due to increased production of iron and steel and automobiles and increased activity in the service business, despite the progress of energy saving. The sales of lighting service will decrease slightly (-0.1%) due to the progress in energy saving and the continued awareness of power saving due to electricity price rises and in addition because the summer will be cooler, even though the winter will be colder.

The electricity price will fall yoy in FY2023 (-16.1%) due to a decline in fuel prices, the fall in renewable energy surcharges as a consequence of the rising fuel prices in the previous fiscal year, and the effect of the subsidies to curb excessive price increases. In FY2024, the price will rise (+7.9%) due to rises in fuel prices, rises in the renewable surcharges based on the fall in fuel prices in the previous fiscal year and the fact that the subsidies under the subsidy program to curb excessive price increases will be removed during the fiscal year, but it will be below the record high in FY2022.

As for the power mix, in FY2023, nuclear power will increase as the restarts of three plants proceed (+3.2p). In FY2024, restarts of a further three plants will proceed, so nuclear power will increase (+3.4p). Renewables (excluding hydropower) will increase mainly for non-residential solar PV, rising 1.3p yoy in FY2023 and 1.4p yoy in FY2024. Non-fossil power sources will increase by 4.7p in FY2024 to 39.5%, going above FY2010 (38.2%) for the first time since the Great East Japan Earthquake. However, continued expansion is necessary for the achievement of FY2030 NDC (non-fossil ratio of about 59%).

In FY2024, the share of coal will increase (+0.3p) as the three coal-fired power plants which started operations during FY2023 (Yokosuka 1, Saijo 1, and Yokosuka 2; 1,800 MW in total) will be operating during the fiscal year. The share of oil, etc. will decrease in FY2024 (-0.4p) mainly as oil-fired thermal power (burning Bunker C and crude oil) will decrease. The share of LNG will be 24.4% (-4.5p) in FY2024 due to the increase in non-fossil power sources and lower costs of coal-fired power, falling below the share of coal for the first time since the Great East Japan Earthquake.

Table 4 | Electricity Sales, Power Mix, and Prices for Power Service and Lighting Service (for electricity businesses)

	Historical				Projection		Year-over-year		
	FY2013	FY2020	FY2021	FY2022	FY2023	FY2024	FY2022	FY2023	FY2024
Electricity sales (TWh)	(871.5)	820.9	837.1	822.2	820.6	821.6	-1.8%	-0.2%	0.1%
Lighting service	284.3	278.0	278.1	270.3	268.9	268.5	-2.8%	-0.5%	-0.1%
Power sercice	(587.2)	543.0	559.0	552.0	551.7	553.1	-1.2%	-0.1%	0.3%
Extra-high and High voltage	(545.8)	506.7	523.3	516.9	516.5	518.2	-1.2%	-0.1%	0.3%
Low voltage	(41.3)	36.2	35.7	35.1	35.2	34.9	-1.8%	0.4%	-0.9%
Electricity generated and purchased (TWh)	(963.5)	920.3	945.5	916.7	914.8	915.9	-3.0%	-0.2%	0.1%
Hydro	(8%)	9.5%	9.5%	9.6%	10.0%	9.8%	0.1p	0.4p	-0.2p
Fossil fuels	(89%)	74.0%	70.1%	70.0%	65.1%	60.5%	-0.1p	-4.8p	-4.7p
Coal	(30%)	27.8%	27.7%	28.0%	27.7%	27.9%	0.2p	-0.3p	0.3p
LNG	(44%)	38.6%	33.8%	33.0%	29.0%	24.4%	-0.8p	-4.0p	-4.5p
Oil, etc.	(15%)	7.5%	8.6%	9.0%	8.5%	8.1%	0.5p	-0.5p	-0.4p
Nuclear	(1%)	4.0%	7.2%	5.8%	9.0%	12.4%	-1.3p	3.2p	3.4p
Renewables (excluding hydro), etc.	(2%)	12.5%	13.2%	14.6%	15.8%	17.3%	1.3p	1.3p	1.4p
Electricity prices (JPY/kWh)	(20.8)	20.5	22.2	29.5	24.7	26.7	32.6%	-16.1%	7.9%
Lighting service	18.1	26.0	27.9	33.9	24.4	27.7	21.6%	-27.9%	13.2%
Power sercice	(20.5)	17.5	19.0	27.3	24.9	26.2	43.9%	-8.9%	5.4%

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 FY2013, and its figures since FY2016 are estimated values.

Hydro includes pumped, and LNG includes city gas.

City Gas Sales and Price for City Gas (for gas businesses)

In FY2024, city gas sales for commercial use and for other uses will decrease, but overall sales will increase for the first time in three years, mainly due to the increase in sales for manufacturing uses. However, they will be lower than FY2022

City gas sales[1] will decrease yoy in FY2023 (-1.0%) mainly due to a decrease in industrial uses, despite an increase in commercial uses. They will increase slightly in FY2024 (+0.1%) due to the slight increase in residential uses and an increase in manufacturing uses, despite the decrease in commercial uses and other uses. Even though prices will be lower than FY2022, due to progress in energy saving, etc. all uses except manufacturing uses will be below FY2022 levels.

The sales of city gas for residents will continue to decline structurally due to the progress of electrification including the spread of full electrification, etc. and due to the progress in energy saving including the spread of energy-efficient water heaters, etc. They will decrease slightly yoy in FY2023 (-0.2%) due to a decline in the stay-at-home rate and the progress in energy saving, even though the winter will be colder. They will increase slightly in FY2024 (+0.1%), even in the context of the progress in energy saving and the effect of rising awareness of gas saving due to city gas price rises, because the winter will be colder.

The sales for manufacturing will decrease yoy in FY2023 (-0.6%) due to a decreased production of machinery and devices, despite the increased production of automobiles. They will increase in FY2024 (+0.6%) due to the continued increased production of automobiles and recovery of the production of machinery and devices, but they will be lower than in FY2021 when there was a demand increase due to the rebound after the COVID-19 pandemic. In FY2023, the sales of city gas for power generation (electricity utility) decreased (-6.1%) as the operation of relatively high-cost gas-fired power generation plants decreased in the context of falling market prices for electricity. In FY2024, they will remain mostly flat (+0.0%). As a result, total sales for industrial use will decrease in FY2023 (-1.9%) and increase in FY2024 (+0.4%).

The sales of city gas for commercial use will increase yoy in FY2023 (+1.1%) due to increased activity and increased demand for hot water supply and heating from the previous year, particularly in the face-to-face activities such as accommodations, eating and drinking services sector and the living-related services and amusement services sectors, and due to the increase in demand for cooling because it was extremely hotter. In FY2024, they will decrease (-1.4%) because of energy saving progress due to upgrades to highly efficient GHPs, etc. and because cooling demand will decrease due to the cooler summer. The sales for other uses will increase in FY2023 (+0.4%) mainly because the winter will be colder. They will decrease in FY2024 (-0.9%) due to the progress in energy saving and the cooler summer even though the winter will be colder.

The city gas price will fall yoy in FY2023 (-16.9%) due to the decline in raw material prices and the effect of the subsidies to curb excessive price increases. In FY2024, it will rise (+10.7%) due to rises in raw material prices, the depreciation of the yen, and the removal of the subsidies under the subsidy program to curb excessive price increases during the fiscal year, but it will be below the record high in FY2022.

[1] Gas businesses excluding former community gas utility businesses

Table 5 | City Gas Sales and Price (for gas businesses)

	Historical				Projection		Year-over-year		
	FY2013	FY2020	FY2021	FY2022	FY2023	FY2024	FY2022	FY2023	FY2024
City gas sales (Billion m^3)	39.82	39.51	41.15	40.24	39.83	39.86	-2.2%	-1.0%	0.1%
Residential	9.55	10.02	9.91	9.34	9.32	9.33	-5.8%	-0.2%	0.1%
Commercial	4.49	3.65	3.70	3.82	3.86	3.81	3.2%	1.1%	-1.4%
Industrial	22.73	22.76	24.37	23.92	23.47	23.57	-1.9%	-1.9%	0.4%
Manufacturing	20.90	17.43	18.91	18.28	19.85	18.28	-3.3%	8.5%	-7.9%
Electric utilities	1.83	5.33	5.46	5.63	5.29	5.29	3.2%	-6.1%	0.0%
Others	3.04	3.08	3.16	3.16	3.17	3.14	0.0%	0.4%	-0.9%
City gas prices(JPY/m^2)	115.2	83.3	96.0	143.8	119.4	132.3	49.7%	-16.9%	10.7%
Residential	193.8	165.4	175.0	222.0	204.7	217.6	26.9%	-7.8%	6.3%
Commercial	112.0	85.75	95.55	143.4	118.1	130.9	50.1%	-17.7%	10.9%
Industrial	81.71	52.23	65.18	114.9	88.04	101.0	76.2%	-23.3%	14.7%
Others	106.7	78.05	88.01	133.6	104.2	117.1	51.8%	-22.0%	12.3%

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

Fuel Oil and LPG Sales, and Crude Oil Throughput

In FY2024, fuel oil sales will decrease overall due to large decreases in the sales of fuel oil for automobiles, as feedstock for ethylene and for power generation. This will be a decrease for the third year in a row and sales will be less than 60% of the record high in FY1999

The sales of fuel oil will decrease yoy in FY2023 (-1.3%) mainly due to the large impact of the decline in sales for automobiles and power generation. In FY2024, they will decrease (-1.2%) due to fuel conversion and energy saving resulting from rising prices caused by the ending of the subsidies to curb excessive price increases and in addition due to the decline in sales for automobiles, feedstock for ethylene, and power generation.

The sales of gasoline will decrease in FY2023 (-0.5%) due to improvements in fuel efficiency and the spread of HVs, despite the recovery in transportation demand after the COVID-19 pandemic. They will continue to decrease in FY2024 as well (-0.7%) as the improvements in fuel efficiency and spread of HVs continue, despite the fact that the recovery of transportation demand will also continue.

The sales of naphtha will decrease slightly yoy in FY2023 (-0.3%), impacted mainly by the decrease in domestic demand caused by rising consumer prices, etc. They will decrease in FY2024 (-1.3%) mainly due to a fall in ethylene exports for Asia.

The sales of jet fuel oil will increase in FY2023 and FY2024 (+6.1%, +5.6%) due to the recovery in aviation demand.

The sales of kerosene will decrease yoy in FY2023 (-2.1%), even in the context of a colder winter, as fuel conversion progresses. In FY2024, they will continue to decrease due to fuel conversion (-1.1%), even though the winter will be colder.

The sales of light oil will decrease slightly in FY2023 (-0.3%), even though the activity in the service business will increase, the impact of the reduction in transportation focused on the preparation for the workstyle reforms in the logistics industry in 2024 (logistics problems in 2024) will occur. In FY2024, they will decrease (-0.9%) as the impact of the logistics problems in 2024 will emerge, reducing freight transportation.

The sales of Bunker A will decrease yoy in FY2023 (-2.2%) as fuel conversion for industrial use makes progress, despite a recovery in activity in the service sector and fuel conversion from Bunker C for ships. They will decrease in FY2024 as well (-1.9%) as the decrease due to fuel conversion for industrial use continues, even though the increase in activity in the service sector and the fuel conversion from Bunker C for ships will continue also.

The sales of Bunker B and C will decrease overall in FY2023 (-13.1%) due to the fact that energy efficiency and fuel conversion have made progress in sales for industrial use and ships and in addition due to the large rebound decline in sales for power generation which increased due to the electricity crunch in FY2022. In FY2024, sales will decrease (-7.1%) due to the progress of energy efficiency and fuel conversion and in addition due to the reduction in sales for power generation as a result of nuclear power plant restarts and coal-fired power plants starting operations.

The sales of LPG will decrease yoy in FY2023 (-5.1%) due to the rebound decline of the sales of LPG for calorific value adjustment of city gas, which soared in the previous fiscal year, even though sales for use as chemical feedstock will increase due to the rising availability factor of ethylene plants. In FY2024, although household use will grow due to the colder winter, sales of LPG will decrease (-3.6%) due to the declining availability factor of ethylene plants in use as a chemical feedstock, fuel conversion in industrial and business use, and the progress in energy saving.

Crude oil throughput will decrease in FY2023 by even more than fuel oil sales (-3.2%), impacted by shutdowns of refineries due to regular repair increases and breakdowns, etc. In FY2024, crude oil throughput will decrease slightly (-0.1%) in the context of fuel oil sales decreasing due to transportation fuel exports increasing.

Table 6 | Fuel Oil and LPG Sales, and Crude Oil Throughput

	Historical				Projection		Year-over-year		
	FY2013	FY2020	FY2021	FY2022	FY2023	FY2024	FY2022	FY2023	FY2024
Fuel oil sales (GL)	193.6	152.0	153.8	150.8	148.9	147.1	-1.9%	-1.3%	-1.2%
Gasoline	55.5	45.5	44.5	44.8	44.5	44.2	0.6%	-0.5%	-0.7%
Naphtha	45.7	40.3	41.7	38.2	38.1	37.6	-8.2%	-0.3%	-1.3%
Jet fuel	5.1	2.7	3.3	4.0	4.3	4.5	21.6%	6.1%	5.6%
Kerosene	17.9	14.5	13.5	12.2	12.0	11.9	-9.4%	-2.1%	-1.1%
Diesel oil	34.1	32.0	32.1	31.7	31.6	31.3	-1.3%	-0.3%	-0.9%
Heavy fuel oil A	13.4	10.2	10.1	10.4	10.2	10.0	2.8%	-2.2%	-1.9%
Heavy fuel oils B and C	21.9	6.6	8.5	9.5	8.2	7.6	10.7%	-13.1%	-7.1%
For electric utilities	14.4	2.8	4.4	5.1	4.1	3.6	14.3%	-19.6%	-12.3%
For other users	7.5	3.9	4.1	4.4	4.2	4.1	6.8%	-5.5%	-2.1%
LPG sales (Mt)	15.5	12.9	13.4	14.0	13.3	12.8	4.4%	-5.1%	-3.6%
Crude oil throughput (GL)	200.4	139.3	147.5	156.2	151.3	151.1	5.9%	-3.2%	-0.1%

Renewable Power Generation (FIT power sources)

Installed renewable capacity to reach 107GW

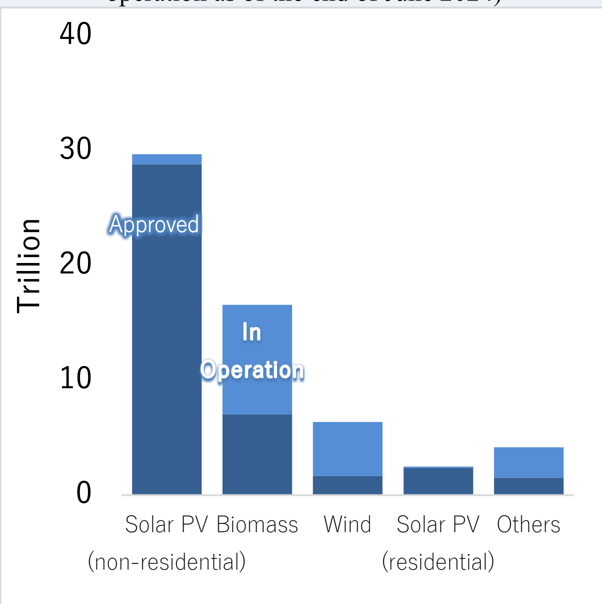
The licensed FIT power capacity is 101.8 GW as of the end of June 2023. If all of this licensed capacity, including both approved and operating capacities[2], were to enter operation, the cumulative burden on consumers would be 59 trillion yen[3]. This is equivalent to a rise in rates of 2.2 yen/kWh—a 10% raise for households and 14% for industry.

The installed capacity (including those whose purchase period has expired) will reach 107 GW at the end of FY2024. Residential solar PV and biomass are growing while the growth in non-residential solar PV is slowing down. Despite that, non-residential solar PV will expand to 64.1 GW at the end of FY2024. Furthermore, onshore wind power will expand to 6.8 GW as the introduction of a deadline to commence operation and a license expiry date will push non-operating projects to start operating earlier. In FY2024, the FIT power output will reach 212.1 TWh (including 98.8 TWh of solar PV, 51.6 TWh of biomass power, 44.5 TWh of medium- and small-sized hydropower, and 13.3 TWh of wind power), accounting for 21.1% of the total power generation; renewable energy as a whole, including large-scale hydropower, will account for 24.6%.

Due to the FIP (Feed-in Premium) system launched in FY2022, the weighted average successful bidding price of commercial solar PV went below approximately 8 yen/kWh and the minimum successful bid price went below 8 yen/kWh, but further cost reductions are required to reach international levels.

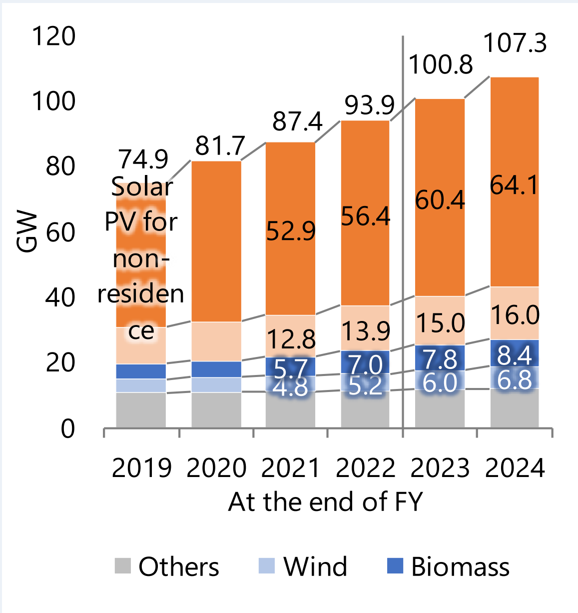
The steady expansion of installation is required to meet the target share of renewables of 36–38% in the 2030 power mix, but harmony with the environment and consensus-building with residents are crucial. At the same time, it is important to put into practice measures to expand installation at new frontiers, such as offshore wind power and perovskite solar PV, etc.

Figure 1 | Cumulative Cost Burden throughout the FIT Purchase Period (for capacities licensed or in operation as of the end of June 2024)



(Note) The purchase period is 10 years for residential solar PV, 15 years for geothermal, and 20 years for other sources

Figure 2 | Installed Renewable Energy Capacity (in operation)



(Note) Includes capacities whose FIT purchase period has expired.

[2] A capacity that was installed before the start of the FIT system and was transferred to the system after it began.

[3] The remaining purchase periods of the transferred systems are taken into account. Avoidable costs were calculated from various materials. Due to the rise in fuel prices the actual value for avoidable costs in 2022 rose to 22.5 yen/kWh, but the actual value for 2023 (until the middle of November) settled down to 11.7 yen/kWh and this level is anticipated going forward as well. However, this is a higher level than the previous anticipated value of 7.7 yen/kWh, so the consumer burden has significantly reduced. The utilization factor is estimated to be 24.8% for wind power, 13.7% for solar PV, 70% for geothermal, 45% for hydropower, and 70% for biomass.

Topic 1: Impacts of the subsidy program on fuel prices

The impact of the subsidy program on fuel prices will be positive in the short term but could also be increasingly negative in the medium to long term. Strengthening the resistance of economic society to energy cost rises is essential for the exit strategy

It has been decided to continue the subsidy program to curb excessive price increases until April 2024 and although the down of the subsidy has partially begun, the issue is the exit strategy

It has been decided to continue the subsidy program to curb excessive price increases (subsidy program of fuel prices) for fuel oil, electricity and city gas until April 2024. Regarding fuel oil, the lowering of the subsidy rate with a focus on the exit plan was implemented from June 2023, but due to fuel oil prices rising again, the re-expansion of subsidies under a new program to curb prices was carried out from September 7. The situation with a lack of progress toward ending the program continues. The subsidies for electricity and city gas were reduced by half from September 2023 partly due to the fall in fossil fuel import prices. Initially, the plan was to end the program in October 2023, but then a decision was made to continue the program and the end of the program was postponed to April 2024 or later.

In the Comprehensive Economic Measures for Completely Overcoming Deflation (November 2, 2023, Cabinet Decision), the government announced the continuation of the subsidy program to curb excessive price increases for fuel oil, electricity, and city gas as one of its countermeasures against rising consumer prices. Due to this, a program under which fuel oil keeps the gasoline price to about 175 yen/L will be continued until April 2024. For electricity, subsidies of 3.5 yen/kWh for the low voltage contracts of households, etc. and 1.8 yen/kWh for the high voltage contracts of companies, etc. and city gas subsidies of 15 yen/m^3 for households and companies, etc. with annual contract amount less than 10 million m^3 will continue until April 2024. Furthermore, the goal of phasing out all of the programs from May 2024 was incorporated in the decision.

Under the Reference Scenario, based on the government announcement, it is assumed that for fuel oil the subsidy rate will be phased out by three-tenths each month from May 2024. For electricity and city gas, it is assumed that a subsidy of half the April level will be continued from May until September, and the subsidies will be removed entirely in October. In this section, the analysis systematically compared the "subsidy program through FY2024" case in which the subsidies as of April 2024 will continue during FY2024, and calculated the impacts on the economy and energy in the case that the subsidies are increased.

If the subsidy program to curb excessive price increases is continued until the end of the fiscal year, consumer prices will fall and the economy will be boosted

As a vast range of industries consume energy, in the case that the government subsidy program to curb excessive price increases is continued during the fiscal year, the beneficiaries will be diverse, encompassing households, manufacturers, service businesses, agriculture, and transportation businesses. In the subsidy program through the FY2024 case, the consumer price index will be lower than in the Reference Scenario (-0.5%) as energy prices will remain lower. The domestic corporate goods price index, which has a larger percentage of energy, will fall even more than the consumer price index (-0.6%) while real GDP and the industrial production index

Table 7 | Impact of the Subsidy Program to Curb Excessive Price Increases [FY2024]

		Reference	Subsidy program through FY2024	Changes from Ref
Price	Domestic corporate goods price index (2020=100)	120.1	119.4	-0.6%
	Consumer price index (2020=100)	108.5	107.9	-0.5%
Economy	Real GDP (JPY2015 trillion)	566.2	566.4	+0.0%
	Trade balance (JPY trillion)	-5.5	-6.0	(-0.5)
	Index of Industrial production (2020=100)	105.4	105.5	+0.0%
	Fossil fuel imports (JPY trillion)	25.43	25.47	+0.2%
Energy	Primary energy supply (Mtoe)	410.7	411.3	+0.1%
	Oil (GL)	166.7	166.9	+0.1%
	Natural gas (Mt of LNG equiv.)	60.7	61.0	+0.5%
	Electricity sales (TWh)	821.6	823.3	+0.2%
	City gas sales (Billion m^3)	39.9	40.0	+0.3%
	Fuel oil sales (GL)	147.1	147.4	+0.1%
Environment	Energy-related CO_2 emissions (Mt)	909	911	+0.1%

will be pushed up (+0.0%, +0.0%). However, in the context of no change to fossil fuel import prices, energy consumption will increase, so fossil fuel imports will increase and the balance of trade will deteriorate (-0.5 trillion yen). In other words, the subsidy program will strengthen the dependence on energy imports and act against energy security.

Subsidy program drives up energy consumption, CO_2 emissions and spending on fiscal stimulus

An extension of the subsidy program boosts energy sales by lowering the price. In terms of buyers, this will affect industry more than households or transportation because the industry will see a change in production with fluctuations in domestic demand, and the progress of its energy conservation efforts will also be affected by changes in production costs. Among the types of energy sold, the rate of increase will be the greatest for city gas sales. This is because city gas has a higher share of industrial use than fuel oil or electricity, and since in the subsidy program through the FY2024 case, the subsidy has just one standard rate of 15 yen/m^3, its effect will be comparatively large for industrial city gas whose unit price is low.

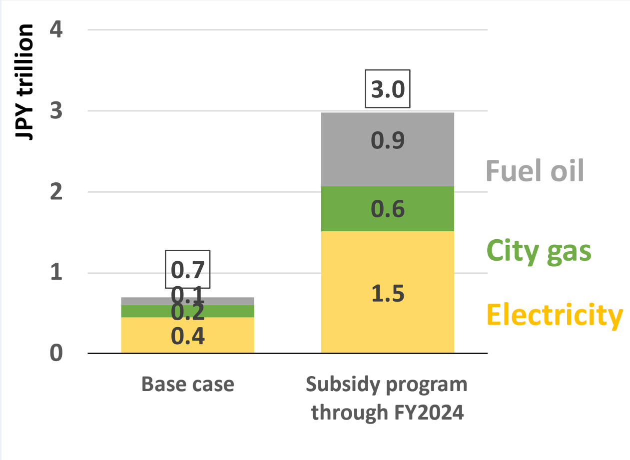
The subsidy program through the FY2024 case will generate more CO_2 emissions (+0.1%) because its energy consumption will be larger (+0.1%) than in the Reference Scenario. In other words, the subsidy program will temporarily reverse the progress in energy efficiency and CO_2 reduction. Furthermore, regarding spending on fiscal stimulus, the total amount of subsidies in FY2024 in the subsidy program through FY2024 case on top of the Reference Scenario will be 2.3 trillion yen (1.1 trillion yen for electricity, 0.8 trillion yen for fuel oil, and 0.4 trillion yen for city gas).

Short term and medium to long term responses assuming expanded fluctuations in fuel prices are essential for the exit strategy

The subsidy program to curb excessive price increases is positive in that it definitely curbs price increases in the short term, but it also has negative aspects in the medium to long term, such as reversing the progress in energy security, energy conservation, and CO_2 reduction, and increasing spending on fiscal stimulus. On the other hand, there is still a risk of rising fossil fuel import prices due to the Russia/Ukraine problem, the destabilization of the Middle East situation, the continuing depreciation of the yen, etc., making the future highly uncertain. The issue going forward is to secure an exit strategy while monitoring the increasing fluctuations in the fossil fuel import prices which have emerged recently.

The Comprehensive Economic Measures for Completely Overcoming Deflation presented the encouragement of energy efficiency and the strengthening and promotion of subsidies for renewable energy and nuclear power as "strengthening the resilience of economic society with respect to energy cost rises." In the short term, the encouragement of energy efficiency is effective. If the trends of the GX (Green Transformation) Implementation Council and the amended Act on Rationalizing Energy Use are taken into account, acceleration of the installation of energy-saving equipment such as heat pumps and cogeneration systems for industrial use and heat pumps and fuel cells for household use and in addition, subsidies for the installation of secondary batteries and control systems for expansion of the demand response are necessary. It will perhaps be necessary to consider allocating the funds being utilized in the present subsidy program to curb excessive price increases to these fields contributing to energy security. When doing so, probably it will be necessary to devise ways to expand installation; for example, changing the subsidy rate based on the income status of each household. Furthermore, in the medium to long term, it is important to develop domestic production of energy. In addition to maximizing existing technologies such as renewable energy and nuclear power, it is necessary to accelerate investment into innovative technologies such as hydrogen and ammonia which are based on hydrogen, synthetic methane, and synthetic fuel. On the assumption that the fluctuations of fossil fuel import prices will expand going forward, steadily executing a well-balanced combination of short term and medium to long term measures will be essential for the exit strategy from the subsidy program to curb excessive price increases.

Figure 3 | Difference in Subsidies with the Reference Scenario [FY2024]



Topic 2: Impact of the progress of nuclear plant restarts

Significant contribution of nuclear power to the 3E principle

This section assesses the impact of varying amounts of nuclear power on energy security, the environment, and economic efficiency—collectively the 3Es principle.

The Reference Scenario assumes that the number of operating plants will increase from 10 currently with six plants restarting according to the operating plan by the end of FY2024, meaning that 16 plants will be operating by then. Furthermore, the analysis systematically compares a High Case, in which the assessment of the remaining plant finishes earlier than the Reference Scenario and the plant will be restarted in FY2024. Another case is the Low Case, in which the risks of delays in assessment and construction materialize before the end of FY2024 and the four plants will not be able to be restarted. Furthermore, based on the Long-term Energy Supply-Demand Outlook of the Ministry of Economy, Trade and Industry, a third case, the Highest Case, is simulated assuming that 80% of the 27 plants that have applied for assessment based on the new regulation standards will be restarted.[4]

Table 7 | Impact of Different Amounts of Nuclear Power Output [FY2024]

		Low Case	Reference Scenario	High Case	Highest Case	Changes from Reference: Low	High	Highest
Nuclear assumptions	Restarted nuclear reactors	12	16	17	27	-4	+1	+11
	Power generation (TWh)	86.0	113.7	125.5	193.4	-27.7	+11.8	+79.6
	Share in generation and purchases	8.7%	11.5%	12.6%	19.5%	-2.8p	+1.2p	+8p
Economy	Electricity unit cost[1] (JPY/kWh)	10.86	10.59	10.48	9.83	+0.27	-0.11	-0.76
	Fuel cost	6.81	6.55	6.43	5.78	+0.27	-0.11	-0.76
	FIT purchasing cost	4.05	4.05	4.05	4.05	-	-	-
	Total fossil fuel imports (JPY trillion)	25.95	25.63	25.50	24.73	+0.32	-0.13	-0.91
	Oil	15.95	15.91	15.90	15.85	+0.03	-0.01	-0.06
	LNG	5.49	5.20	5.08	4.35	+0.29	-0.12	-0.85
	Trade balances (JPY trillion)	-5.70	-5.45	-5.35	-4.76	-0.25	+0.10	+0.70
	Real GDP (JPY2011 trillion)	565.98	566.19	566.29	566.82	-0.22	+0.09	+0.62
Energy and environment	Primary energy supply							
	Oil (GL)	167.1	166.7	166.6	166.0	+0.4	-0.1	-0.8
	Natural gas (Mt of LNG eq.)	64.0	60.7	59.3	51.1	+3.3	-1.4	-9.6
	Self-sufficiency rate	15.2%	17.0%	17.7%	22.0%	-1.8p	+0.8p	+5.0p
	Energy-related CO_2 (Mt)	919	909	905	881	+10	-4	-28
	Changes from FY2013	-25.6%	-26.4%	-26.7%	-28.7%	+0.8p	-0.3p	-2.3p

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

In terms of economic efficiency, the value of fossil fuel imports will be lower than the Reference Scenario by 130 billion yen in the High Case and by 910 billion yen in the Highest Case. If oil and LNG prices rise due to changes in the international situation, the saving effect would be even greater as Japan would depend less on thermal power. As a result of reducing fuel import payments to other countries, disposable income will increase, pushing up real GDP by 90 billion yen in the High Case and 620 billion yen in the Highest Case.

The unit cost of electricity will decrease by 0.11 yen/kWh in the High Case and 0.76 yen/kWh in the Highest Case.

Amid mounting geopolitical risks due to the Ukraine situation, there is heightened interest in energy security. LNG imports will be lower than the Reference Scenario by 1.4 Mt in the High Case and 9.6 Mt in the Highest Case. The self-sufficiency rate, which is a

[4] Japan aims for a share of around 20-22% for nuclear power in the FY2030 power mix, and considers that this is achievable as energy conservation will make progress and electricity demand will decrease.

major indicator of energy security, will be 0.8p higher for High Case and 5.0p higher for the Highest Case than the Reference Scenario.

CO_2 emissions, an environmental indicator, will be 4 Mt lower in the High case and 28 Mt lower in the Highest Case than the Reference Scenario. Compared to FY2013 levels, which is the base year for Japan's targets in the Paris Agreement, the emissions will be lower by 26.7% in the High Case and by 28.7% in the Highest Case.[5]

In May 2023 the GX (Green Transformation) and Decarbonized Power Sources Act was established and the government confirmed a policy of utilizing the existing nuclear power plants as decarbonized power sources as much as possible. Smooth restarts through appropriate reviews based on the situations of individual plants will contribute to the 3Es of Japan.

[5] Japan's target is to reduce greenhouse gases by 46% by FY2030 from FY2013 levels, including a 45% reduction in energy-related CO_2. Japan expects that it will be able to meet the target through energy efficiency and the introduction of renewables, in addition to nuclear power.

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Outlook for International Oil Market in 2024

- Can OPEC+ Support Oil Prices? –

<Summary> ◆

Tetsuo Morikawa*

Key points of this report

1. Demand in 2024 will increase gradually to 103 million b/d. Regardless of the voluntary additional output cuts by some OPEC+ member countries in the first quarter of 2024, supply in 2024 will increase to 103.1 million b/d, partly because of an increase by non-OPEC+ countries such as the U.S. As a result, demand and supply will be largely balanced throughout the year, if not a slight oversupply.
2. International (Brent) crude oil price in 2024 is forecasted to hover at the central level of $85/bbl. The main uncertainty lies in the unity of OPEC+ member countries, sluggish demand due to economic slowdown, and the situation in the Middle East, such as production volume in Iran.

Oil demand and supply

3. Global oil demand increased by 2.6 million b/d (2.6%) to 102.8 million b/d in the third quarter of 2023, compared to the same period last year. While there is a possibility of sluggish demand due to economic slowdown, demand is currently at a steady level.
4. Demand from China is growing rapidly, increasing by 2.6 million b/d (19.2%) year on year in the third quarter of 2023 to 16.1 million b/d. However, with the real estate sector going through a serious recession in the country, the GDP growth rate is expected to slow down from 5.0% in 2023 to 4.2% in 2024. While the import volume of "Malaysian" crude, most of which are believed to originate from Iran, is increasing, there is also a possibility that these imports may be subject to sanctions by the U.S.
5. Global oil supply increased by 0.9 million b/d (0.9%) to 102 million b/d in the third quarter of 2023, compared to the same period last year. Under the impact of stronger output cuts by OPEC+, the pace of increase in supply is not keeping up with demand.
6. At the meeting held on November 30, some OPEC+ countries decided to reduce supply by an additional 2.2 million b/d in the first quarter of 2024. Although the deepened cuts from the current volume of output cuts is limited to 700,000 b/d, a short-term price crash was avoided. However, OPEC+ as a whole could not reach an agreement on the additional output cuts, and with Angola opposing the downward revision of its production target, the unity among OPEC+ member countries will come under scrutiny.
7. There is limited possibility that the Israel-Hamas military conflict, which erupted on October 7, may become a direct cause of disruption to the oil supply. However, if the U.S. were to strengthen sanctions on Iranian oil exports, it would reduce Iran's production volume. There is also a risk of supply disruption if the Houthi or others were to attack oil fields and tankers.
8. Crude oil production volume of the U.S. increased by 1 million b/d (8.7%) year-on-year to 13.09 million b/d in the third quarter of 2023. It is maintaining a gradual increase in production by concentrating on highly productive oil wells.
9. OECD commercial inventory for October 2023 was 2.81 billion barrels, while government stockpiles were 1.21 billion barrels. Although commercial inventories increased due to the stock releases and easing of supply and demand balance in 2022, they have not reached the 5 year average under the impact of the strengthening of output cuts by OPEC+.

Macroeconomics and financial markets

10. Global GDP growth rate is expected to fall slightly from 3.0% in 2023 to 2.9% in 2024. While inflation has eased in the U.S., the real estate crisis in China, the impact of rising interest rates, climate change, and geopolitical conflicts have been pointed out to be risk factors. The risk of an economic slowdown in China, which is the world's largest oil importer, poses significant uncertainty for the oil market.

◆ Created based on the published research in the 446th Forum on Research Works with the information available as of December 2023.

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446th Forum on Research Works on 21 & 22 Dec. 2023

Gas Market Outlook for 2024

- Amid a looser LNG market, uncertainty persists with challenges to stabilize the market -

<Summary> ◆

Hiroshi Hashimoto*

Outlook for LNG prices

1. The average LNG import price in Japan is expected to be around USD 12.1 in 2024, down from an estimated USD 13.4 per million BTU in 2013, while spot LNG prices to Northeast Asia are expected to average USD 14 or less in 2024, also down from USD 16 in 2023.
2. The global natural gas and LNG markets as a whole were relaxed in 2023, and this trend is expected to continue in 2024. Modest paces are expected for both the commencement of operations of new LNG production plants and increases in gas demand. Market sentiments have drastically relaxed since the end of 2022, pushing spot gas prices significantly down to around USD 15 in December 2023. This trend has been due to weak gas demand in the Northern Hemisphere in the year, notably attributable to measures to reduce gas demand in the European Union and demand destruction in the region caused by earlier higher prices. LNG supply has been steady from sources led by the United States, without significant troubles.

Outlook for LNG Supply and Demand

3. The global LNG market is expected to expand by 7% - 8% per year from 400 million tonnes (mt) in 2023 to 430 mt in 2024 and 460 mt in 2025.
4. Although new LNG production projects are expected to start operations in North America, Africa and Asia, the pace of supply expansion will be modest. The slim supply capacity margin may lead to occasional tightness attributable to seasonal demand fluctuations and supply outages.

Factors affecting the LNG market balance in 2024 and 2025

5. It is essential for the LNG industry to keep new and expanding LNG production projects starting and ramping up operations as planned, maintaining the global stability of LNG supply. Notably, LNG production in the United States has been resilient coming from multiple projects. However, a supply glitch at an individual large-scale project could have a global impact, as evidenced by the fire incident at the Freeport LNG plant in Texas in June 2022 and the ensuing outage of operation until February 2023.
6. The slim supply capacity margin against the anticipated demand on an annual basis until 2025 may lead to occasional tight markets in case of seasonal ups and downs of gas demand and unexpected outages of LNG supply facilities. European and Chinese gas demand continues to hold the key to balancing the global LNG market. The Chinese gas market has returned to its growth path in 2023 after its first ever shrinkage in 2022. However, the growth rate has not been as large as in the past and the level of consumption has not been as high as that of 2021. As pipeline gas imports and domestic gas production increase, LNG imports have grown only modestly lately.

Issues surrounding the future of the LNG market

7. Projects have advanced around the world to increase LNG supply. Project development has become more difficult in frontier areas as relatively accessible ones have been already developed. Risks have been more apparent accompanying LNG supply

◆ Created based on the published research in the 446th Forum on Research Works with the information available as of December 2023.

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project development around the world.

8. Delays and cost overruns after FIDs and troubles after operations start have become more common. Australia, which supplies the largest volume of LNG to Japan, have implemented legislative and regulatory reforms having implications for LNG production projects. LNG consumers should keep a close eye on policy developments in LNG producing countries regarding securing their domestic gas supply and measures against climate change, to consider measures to cope with those policy developments. Russia's new LNG production projects entail uncertainty for their futures, due to the Ukraine War underway after the project investment decisions. Even those projects already in operation now have more risks of operational troubles. Risks of prolonged outages of LNG supply related to troubles with liquefaction and infrastructure facilities, as well as risks of labour disputes, are now a reality.
9. As well as flexibility in the LNG market, ensuring stable LNG supply today entails more importance. Under the current highly uncertain market conditions, it is necessary for the public and private sectors, in a cooperative manner, to pursue paths to ensure a stable LNG supply over the long term. A clearer standard of transition-proof LNG and accompanying measures to mitigate emissions of methane and other greenhouse gases are gaining more importance to stabilise the LNG market.

Notable developments in 2023 and issues to watch in 2024 in the LNG market

10. The United States became the largest LNG exporting country in the world in 2023. While the country is expected to add new LNG production capacity further and produce more volumes in 2024, additional project development activities continue attracting attention, including FIDs, long-term offtake deals underpinning those investment decisions, and regulatory approval processes.
11. Progress of Qatar's major LNG production capacity expansion projects under construction and planning in 2023 included long-term offtake agreements with the foreign equity partners of the projects. Eyes in 2024 will be on further progress of LNG marketing from the remaining capacity and potential new equity partners in the projects.

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Coal Market Outlook for 2024

- High demand will continue in China and India, but demand will continue to be weak in developed countries –

<Summary> ◆

Yoshiaki Takahashi*

Coal price

1. The FOB price for Australian thermal coal exports dropped greatly from 2022, when it soared after the invasion of Ukraine and reached over 400 dollars per ton, and its 2023 average was about 170 dollars. In the short term, the demand for coal will be weak due to the impact of the mild winter trend, the decrease in demand for electricity due to economic stagnation, and the easing of LNG supply and demand since last year, among other factors. In November, the price fell to the 120-dollar range, but in the short term, it is rebounding slightly.
2. Similarly, the FOB price for Australian metallurgical coal exports surged sharply after the March 2022 invasion of Ukraine, reaching over 400 dollars, but its 2023 average was about 270 dollars. In the short term, it is about 300 dollars due to the additional procurement of imported metallurgical coal because of stronger India's steel production.
3. Based on this current supply-demand balance, we expect the FOB price for Australian thermal coal exports in 2024 to decline from the 2023 average of about 170 dollars to an annual average of about 130 dollars, and the FOB price for Australian metallurgical coal exports in 2024 to decline from the 2023 average of about 270 dollars to about 250 dollars.

Demand trends

4. The coal import trade volume in 2023 is expected to be 1.47 billion tons, an increase of 100 million tons from 1.37 billion tons in the previous year. In 2024, continuing from the previous year, China and India will increase their domestic coal production to accommodate strong coal demand while imported coal demand will remain high to supplement their increased domestic production. On the other hand, it is predicted that in developed countries (Japan, South Korea, and the EU) thermal coal demand, especially for power generation, is expected to remain weak, so the import trade volume in 2024 forecasted to increase slightly to 1.49 billion tons from the previous year.
5. In China, raw coal production has continued to increase similarly to the previous year and was a cumulative 3.85 billion tons in the January - October period (up 160 million tons from the same period in last year). The government is working to strengthen safety in parallel with increasing production, so depending on the actions taken, there is a possibility of a decrease in domestic coal supply. In the first half, thermal power generation was running at high utilization due to the slump in hydropower generation, which led to a high demand for coal in electricity power as well as a high demand for imported coal. Following the EU and Japan's ban on Russian coal due to the invasion of Ukraine, China has increased Russian coal imports and resumed imports of Australian coal in January of this year in order to secure an adequate coal supply volume in China.
6. India enhances its policy of responding to growing coal demand with increased domestic coal production. Cumulative January - October raw coal production totaled 790 million tons (an increase of 87.7 million tons year-on-year). The government has taken measures to maximize thermal power generation as a response to droughts and rising temperatures to secure the electricity supply. With economic activity also strong, coal-fired power generation in the January-October period totaled 106 billion kWh (+9.2% year-on-year), which compares favorably with the 12.6 billion kWh (-7.2% year-on-year) of hydroelectric power generation in the same period. The policy of increasing domestic coal production is working, so coal imports remained at 180 million tons (down 1.6 million tons year-on-year) in the January-September period. In 2024, we forecast that domestic coal production will continue to increase to support the growing demand for coal due to economic growth.

◆ Created based on the published research in the 446th Forum on Research Works with the information available as of December 2023.

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7. Japan's cumulative imports from January to October totaled 83.5 million tons of thermal coal (down 12.6 million tons year-on-year) and 52.2 million tons of metallurgical coal (up 100 k-tons). South Korea imports 70.2 million tons of thermal coal (down 4.7 million tons) and 25.6 million tons of metallurgical coal (up 1.3 million tons). Both countries saw a large drop in thermal coal imports due to the impact of decreased electricity demand.
8. In 2022, the EU experienced a one-time increase in coal demand due to resume coal-fired power plants after the invasion of Ukraine, however, that demand increase was eliminated in 2023 and the coal demand will return to a downward trend as it has been in the past.

Supply trends

9. Australian supply has recovered from the impact of last year's bad rains. However, January-October year-to-date exports have increased compared to 2022, however, they are still below the 2021 level prior to the heavy rains. Despite the lifting of China's import ban and increased demand from India, Australia's export volume is still sluggish due to the impact of reduced demand for coal from Japan and South Korea. In 2024, we expect that the export volume is slightly increase from the previous year.
10. In Indonesia, there was no export ban, which was the case in the previous year, and the weather has been stable, resulting in strong production. Export volume for the January-September period totaled 380 million tons (up 31.3 million tons from the same period last year), a significant increase. Though it will depend on the result of the presidential election in February 2024, the export volume is basically expected to increase in 2024.

Key points going forward

11. Both Chinese and Indian governments support a policy of primarily expanding domestic coal production to accommodate the growing demand for coal. While the imported coal will contribute to adjusting the domestic supply-demand balance, the huge demand in both countries will have a significant impact on the trade market, so continue closely watching their movements.
12. A couple of coal companies are re-evaluating their coal assets through the transaction of coal interests and business restructuring, and we expect this trend to continue in 2024. We expect that the impact on production will be minimal in the short term, but it is necessary for us to look at supply capabilities from a medium- to long-term viewpoint.
13. In Australia, the federal government and state governments have differing views on coal mining operations and future development. The federal government intends to strengthen its environmental policies in the mining sector, but the state governments intend to avoid any drastic impact on the industry, which supports a large part of the state economies. In the meantime, the coal company has expressed concern about the increasing royalties of the state governments, so caution is necessary to be careful about the medium-term impact of these two factors on the coal industry, especially coal supply stability in the future.
14. Indonesia has adopted the domestic market obligation (DMO) to secure the coal necessary for their own domestic economic growth, so, it is necessary for us to keep an eye on the operational trends after the February 2024 presidential election.

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The 2024 Outlook for the Middle East

- Global divisions deepen as the Palestinian Gaza conflict continues -

<Summary> ◆

Shuji Hosaka*

Unresolved issues facing the Middle East

1. The conflict between Israel and Palestine that broke out in Gaza in October 2023 has become a major, world-shaking event. While Qatar, Egypt, the U.S., and others have stepped in as mediators, the fundamental solution is still far from being reached and the division between pro-Israeli and pro-Palestinian forces has become apparent. If the conflict spreads to surrounding regions and divisions deepen further, it could have an impact on the global economy and energy.
2. In addition to Palestine, there are ongoing civil wars in Syria, Yemen, Libya, and Sudan, and security turmoil such as terrorism and sectarian conflicts are spreading across the borders of these countries.
3. On the economic front, the Gulf States are primarily on a recovery track thanks to the COVID-19 pandemic subsiding and rising crude oil prices from 2021 onwards, but some countries suffer from rapidly deteriorating economies due to the depreciation of their own currencies and rising inflation.
4. In Iran, the focus is on whether progress will be made in rebuilding the Iran Nuclear Deal (JCPOA). Furthermore, an economic recovery is expected if relationships with the Arab nations normalize.
5. In countries such as Saudi Arabia and Iran, there are concerns about the aging and poor health of the leadership (the emir of Kuwait passed away on December 16th, 2023).

The conflict between Israel and Palestine

6. While there have been temporary pauses in the fighting for hostage exchanges, it remains unclear whether a true ceasefire can be achieved. Israel insists it will annihilate Hamas, but the feasibility of this goal is being questioned.
7. A key point of focus remains on whether the conflict can be prevented from spreading to surrounding nations such as Lebanon, Syria, Yemen and Iran. Already, there have been skirmishes between Israel and Shi'ite forces in Lebanon, and Houthis in Yemen have attacked ships sailing near the Bab el-Mandeb Strait, and there are concerns of even greater disruption to navigation around the Red Sea and the Arabian Sea. Furthermore, there is a risk of a greater crisis if Iran takes direct military action against Israel.
8. The Gulf States maintain a firm pro-Palestinian stance, but there are questions about how far they can suppress national sentiment. If the public's anger toward Israel turns into dissatisfaction with the government, these states could take strong measures against pro-Israel countries, such as by weaponizing their oil exports. The course of the conflict could have a major impact on crude oil prices.

Gulf States' vision and decarbonization

9. The oil-producing Gulf States gave high praise to the COP28 outcome document for avoiding any statements that called for an incremental shift away from fossil fuels. However, the challenge is whether the Gulf States' vision for moving away from their dependency on oil can be connected to progress towards decarbonization.
10. Starting from 2024 in Saudi Arabia, international companies will be removed from government projects if they do not establish a regional headquarters in Saudi Arabia. The focus will be on whether this leads to competing interests with neighboring countries that lead to conflicts and other friction.

◆ Created based on the published research in the 446th Forum on Research Works with the information available as of December 2023.

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The tug-of-war between the U.S., China, and Russia in the Middle East

11. The U.S. policy towards the Middle East will change depending on whether the Democratic or Republican party wins the upcoming presidential election. In particular, if former President Trump wins the election, Israel's military actions will accelerate further leading to a higher risk of conflicts between Israel and Iran and the U.S. and Iran.
12. As Middle Eastern countries expand their participation in the Shanghai Cooperation Organization and BRICS, China may gain even more political and economic influence in the Middle East.
13. Russia is expected to strengthen its cooperation with Saudi Arabia and other oil-producing Gulf States through OPEC+, and to use this as a check against the anti-Russian West in the conflict in Ukraine.

The role of Japan

14. How the pro-Palestinian Arab countries view Japan's position regarding the Gaza conflict is a major point of focus. Criticism of Japan has already begun to arise, and the contrast made with China, which has taken a consistently pro-Palestinian stance, is becoming clearer. There is a risk Japan's presence in the Middle East will decrease further.
15. Beyond energy and conventional business relationships, it is important to strengthen initiatives in new fields such as entertainment (anime, video games, esports), sports, tourism, outer space, and robotics.
16. While economic relations with Turkey are expected to strengthen in celebration of the 100th anniversary of the establishment of diplomatic relations between Japan and Turkey, economic relations with Israel may stall due to the ongoing conflict in Gaza.

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The 2024 Outlook for Russia

- Oil and gas developments in response to sanctions -

<Summary> ◆

Sanae Kurita*

The current state of oil production and exports, and the outlook for 2024

1. Russia, a member of OPEC+, began voluntary production cuts in March 2023 (reducing crude oil production by 500,000 b/d, scheduled to continue until December 2024). Furthermore, Russia is implementing voluntary export cuts different from a conventional OPEC+ production cut. It reduced oil exports by 500,000 b/d in August 2023, 300,000 b/d from September to December 2023, and is reducing crude oil exports by 300,000 b/d and petroleum products by 200,000 b/d from January to March 2024. Rather than making additional voluntary crude oil production cuts, Russia is promoting a cooperative stance with OPEC+ both domestically and internationally by extending its export cuts.
2. While the G7 and EU have applied sanctions against Russia's crude oil and petroleum products and price caps on Russia's crude oil and petroleum product exports to cut off its source of war funding, Russia has responded by offering discounts for its oil sales and diversifying its export partners. While Russia has forfeited its primary European market, it has expanded sales to countries not participating in the Russian oil sanctions such as India and China and avoided an overall decrease in its export volume. Despite Russia's increasing discount sales, the market price itself rose significantly in 2022, and the market price of crude oil remained at approximately $80 thereafter, meaning that Russia has not experienced a significant drop in income. The weak ruble is furthermore supporting Russia's ruble-based income. It is difficult to say the G7 and EU led price cap system itself is functioning as intended.
3. Russia has taken the stance that if Brent prices are around $85, the fiscal deficit will remain below 1% in 2024. Under these circumstances, Russia will probably seek to maximize profits by maintaining the current level of production, rather than making deeper voluntary production cuts. On the other hand, for the G7 and EU additional restrictions could destabilize the demand and supply in the international market or cause a crude oil price surge, which are both undesirable. Due to these factors, the above situation regarding Russia is not expected to change significantly in 2024.

The current state of gas production and exports, and the outlook for 2024

4. From 2022 onwards, Russian gas exports via the European pipeline have dropped sharply, and if the EU's Russia-decoupling strategy continues this trend will continue in 2024 with exports remaining at a minimum.
5. The U.S. and EU have prohibited the provisioning of LNG technology and services to Russia as part of their economic sanctions, and Russia has strengthened investments in its domestic LNG technology and ship development. As Russia focuses on commercializing its Arctic LNG business, the U.S. announced additional sanctions against Russia's Arctic LNG businesses and companies in November 2023 to cut off its source of future income.
6. While the EU and Japan will continue decoupling from Russia in 2024, they will maintain LNG imports from the perspective of preserving energy security. For Russia, it is extremely difficult to redirect European pipeline gas to other markets in the short-term due to limitations of the delivery infrastructure.

Focus going forward

7. **Oil:** Maturation and depletion are progressing in Russia's key West Siberian oil field. To compensate for natural decline and maintain crude oil production, new development is essential in the Arctic region, tight oil, and deep-water drilling, and East Siberia. Western sanctions prohibit the provision of financing, technology, and services related to upstream development of the Arctic region, tight oil, and deep-water

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drilling making it difficult to develop and increase crude oil production in the medium to long term.

8. **Gas:** Russia is making efforts to develop domestic LNG technology and transportation ships. Questions remain about whether the technology and services of Russia and cooperating countries can maintain the related equipment and facilities sufficiently.
9. **U.S. government outlook:** It is possible additional sanctions and actions will be taken targeting Russia's future energy production, export capabilities, and sanction evasions to cut off funding for the war in Ukraine. With the presidential election in 2024, however, the current administration will likely carefully consider actions that could disrupt the international energy market and thereby cause major damage to the U.S. economy and consumers.

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Climate Change Policy Challenges in 2024

- Pathways to 2035 Reduction Targets and Addressing Emerging Policy Challenges -

<Summary> ◆

Junko Ogawa*

Overview

1. The energy crisis in Europe, triggered by Russia's invasion of Ukraine in 2022, has affected the whole world. As a result, major advanced economies, including Japan, have implemented subsidy programs to reduce the burden of soaring energy prices on consumers. In addition, some advanced economies are becoming more careful about implementing policies that could increase energy costs. For example, in September 2023, British Prime Minister Sunak acknowledged that inadequate explanations had been given to the public regarding the high-cost policies put in place to date with the aim of achieving net-zero targets. He expressed a commitment to more practical measures, transparently disclosing the relevant costs, and seeking public consent for the implementation of measures. This change in approach by the UK, one of the world's climate change leaders, is significant when forecasting global climate change policies for 2024.

2. In 2024, the primary focus among international climate change-related events is on the submission of Nationally Determined Contributions (NDCs) for 2035 by member economies. These new NDCs will be formulated in response to the outcomes of the Global Stocktake (GST), as agreed at the 28th Conference of the Parties (COP28) to the UN Framework Convention on Climate Change (UNFCCC). Furthermore, the first post-Brexit European Parliament elections are scheduled to be held in June, while the U.S. presidential elections are scheduled to take place in November. The outcomes of these events may also have an impact on global climate change policies and the formulation of NDCs by each country.

3. With regard to Japan's agenda for 2024, the main policy event will be the reviewing and formulating policies that ensure the achievement of the NDCs target for 2035. In particular, the year 2024 will be crucial for intensive discussion on development of operational details for growth-oriented carbon pricing.

Overview of the 28th Conference of the Parties (COP28) to the UN Framework Convention on Climate Change (UNFCCC)

4. The focus of COP28, convened in Dubai, United Arab Emirates, was the first outcome of the Global Stocktake (GST) that assesses the progress of global efforts to achieve the long-term goals set out in the Paris Agreement.
5. In the GST, with regard to the 1.5°C target, a decision was adopted that "recognizes" the need to reduce global greenhouse gas emissions by 43% by 2030 and 60% by 2035, compared to 2019 levels, and to achieve net zero CO2 emissions by 2050. With regard to coal-fired power generation, it was decided (as in COP27) that efforts will be made to "phase down" rather than "phase out" coal power generation, and text on promoting "transitioning away from fossil fuels in a just, orderly, and equitable manner" was included.
6. A decision was adopted to put into operation new financial measures (including funds) to address losses and damages, with the establishment of a new fund under the World Bank. Japan expressed its readiness to contribute US$10 million toward the initiative.

Formulation of New DNC with goals for 2035

7. In 2024, countries around the world will be formulating their NDCs until 2035 based on the outcomes of the first GST. These NDCs are to be submitted to the UNFCCC secretariat by the first quarter of 2025, which is nine months before the convention of COP30 in 2025.
8. Looking at the trend for GHG emissions, while emissions are on a falling trend in developed countries, a gap exists between the GST

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pathways. On the other hand, in the "Advanced Technologies Scenario" presented in IEEJ Outlook 2024 that projects the maximum adoption of technologies and policies, there is a gap between emissions and the GST pathways. In emerging economies including China and India, an even greater gap exists between GST pathways and actual emissions.

9. As for Japan, even if the reduction trend in the 2030 NDCs were to be extended, there would still be a 6% gap with its GST pathway in 2035. Questions such as how to close this gap, and whether or not to set tougher targets, will be key topics in debates on energy and climate change policies in the coming year.

Perspectives on policy reviews in Japan's next NDCs

10. In 2024, it will be necessary to mobilize all expected policies that contribute to reduction measures when setting Japan's goals for 2035. In the process of formulating new policies, it is essential to first review existing policies for achieving efficient emission reduction measures. It is also crucial to consider the formulation of comprehensive strategies to address both domestic and international climate change issues.
11. When using powerful policy tools that could increase energy costs—a vital resource for citizens and a base for industrial activities—or that could significantly change society and lifestyles, it is essential to conduct thorough reviews and provide clear, careful explanations to the public. This is an indispensable process to gain society's support.

Growth-oriented carbon pricing system design

12. The Act for Promoting a Smooth Transition to a Decarbonized Growth-Oriented Industrial Structure (GX Promotion Act), enforced in May 2023, prescribes the introduction of growth-oriented carbon pricing. Looking ahead to the full-scale operation of the emission trading system (GX-ETS) in FY2026, there are plans to introduce a GX-Surcharge in FY2028 and a specified business operator contribution (the emission allowance paid auction scheme for the power generation) in FY2033.
13. 2024 will be an important year for establishing the operational rules for these systems. The detailed operational rules will become a focal point, for example, a review of measures toward further improving the GX-ETS participation rate, a review of private third-party certification to verify if targets are aligned with government guidelines, and measures to strengthen discipline (guidance and supervision, duty of compliance, etc.) for the steady operation of systems.

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Topics for Electric Power Policy in FY2024

- Providing stable electricity supplies -

<Summary> ◆

Kenichi Onishi*

Japan continues to face challenges in securing a stable electrical power supply

1. Japan, like the countries of Europe, is seeing its thermal power plants decrease in operational hours and utilization due to the large-scale introduction of renewable power plants. This is decreasing the incentive for operators to maintain power plants and invest in new power plants.
2. Power shortages were observed on March 22, 2022, centered around the Tokyo area due to a spike in demand due to the cold weather and sharply reduced solar power generation. While the trend of insufficient power supply is increasing, our dependency on solar power is also growing, requiring measures to handle the risk of solar power output dropping.
3. All areas in Japan are predicted to maintain the minimum level of 3% reserve supply capacity required for stable power supplies for the FY2023 winter, but Tokyo only has approximately 4% reserve supply capacity, requiring continued vigilance. After the FY2023 winter, from 2024 onwards supply capacity reserved on the capacity market will be delivered, meaning stable power supplies can be expected. However, to secure electric power supply (kWh) in addition to supply capacity (kW) it is essential to ensure stable fuel supplies over the mid- to long-term.

Japan's initiatives to provide stable electric power supplies

4. Until FY2023, the Additional Reserve Capacity Public Offering has been implemented to provide supplementary power in response to short notice demand when there is a risk of power shortage, in addition to promoting electricity saving efforts. From FY2024 onwards, the capacity market will deliver power based on the actual supply secured four years prior.
5. The main auction of the capacity market, however, does not provide sufficient incentive to invest in new power plants. Therefore, the Long-term Decarbonized Power Source Auction is planned for January 2024 as a special auction of the capacity market. A Reserve Capacity Scheme is also under review to maintain a degree of reserve supply capacity for emergencies drawn from thermal power sources not offered or bid upon in the capacity market.

Background and challenges facing initiatives to provide stable electric power supplies

6. With the deregulation of electricity in the retail market, the capacity market was introduced to provide a method to secure required supply capacity over the mid- to long-term without relying entirely on the wholesale market.
7. However, supply capacity is reserved on the capacity market based on annual contracts, and suppliers are not guaranteed bids at every yearly auction. This system does not provide sufficient incentive to invest in new power plants that must pay back fixed costs over a long period of time.
8. In response to the above, the Long-term Decarbonized Power Source Auction was introduced to promote investment in power sources that will contribute to achieving carbon neutrality and stable electricity supplies, as well as provide predictability of recovering the associated long-term investments. Successful bids provide predictability of recovering fixed costs, etc., but 90% of profits earned on other markets (spot market, etc.) must be returned.
9. While there is a low risk of being unable to recover fixed costs with the Long-term Decarbonized Power Source Auction, there is concern the profits from other markets will be limited for power sources that have highly variable costs like the charging cost for storage batteries. For this reason, the 90% profit refund stipulated in the Long-term Decarbonized Power Source Auction may reduce the incentive to invest

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in power plants. Recovering costs during construction is also a major concern for power sources that have long construction lead times.

10. Adopting a cap and floor system, which requires refunds after exceeding a defined limit of profit, but also provides compensation below a floor, and introducing a framework to allow certain power sources to recover costs during the construction period can increase the incentive to invest in power plants.

Hints for Japan in initiatives overseas to support investment in new power plants

11. Europe is starting to introduce frameworks that make recovering long-term investments more predictable. For example, in the UK, the Regulated Asset Base (RAB) model is applied to new nuclear power plants to guarantee a degree of profit and allow cost recovery during construction. Europe is also moving towards introducing a cap and floor system that sets an upper and lower limit on profits for new non-fossil power sources, in which operators refund profits gained above the cap, but receive compensation when profits fall below the floor to guarantee a degree of profit.
12. Measures to increase the incentive to invest in new power plants are likely to be one topic of the next strategic Energy Plan.

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Renewable Energy Policy Challenges in 2024

- Expansion of Renewable Energy Concentrated in China and Focused on Solar Power -

<Summary> ◆

Yasushi Ninomiya*

Further acceleration in the increase in renewable energy generation capacity through 2024

1. Global renewable energy generation capacity is expected to accelerate further in 2023 and 2024, with adoption advancing at a high level of 450-500 GW per year, significantly exceeding the 300 GW per year increase in 2022. The annual rate of increase rose from about 8% per year before 2020 to 10% per year after 2020 and will accelerate further to about 13% per year in 2023 and 2024. Amidst growing interest in global energy security and decarbonization, the momentum for growth in the renewable energy sector will be thrown into sharper relief.
2. Particularly in China, the annual rate of increase in 2023 and 2024, compared to 2022, will double for solar power and increase by 50% for onshore wind power; this is a significant increase when compared to the rest of the world (excluding China). China is becoming a driving force behind the rise of renewable energy worldwide.
3. Solar power will make up more than 70% of the global increase in renewable energy generation capacity in 2023 and 2024, indicating a pronounced trend of a heavy emphasis on solar power. On the other hand, wind power, which makes up a large percentage of equipment production outside of China, will see sluggish growth due to the strong impact of soaring material prices and rising interest rates.
4. Naturally variable renewable energy (VRE) sources, such as solar and wind power, will make up 95% of the global increase in renewable energy generation capacity in 2023 and 2024, and the adoption of VRE will progress further.

More prominent concentration of renewable energy generation-related industries in China

5. China will make up 60% of the total growth in renewable energy worldwide in 2023 and 2024. Moreover, 80% of the world's solar panels are produced in China, and the heavy emphasis on solar power in the growth of renewable energy will lead to further concentration in China even in the aspects of renewable energy facilities supply. There may be growing global interest in the implications of such concentration in China.
6. Renewable energy generation capacity for the world, excluding China, will increase at an annual rate of 9% in 2024. On the other hand, renewable energy generation capacity will grow significantly in China at a much higher annual rate of 20%.
7. The background factors contributing to the rapid growth of renewable energy in China include the government-driven adoption of renewable energy under the 14th Five-Year Plan, the relatively small impact of soaring global raw material prices due to the complete domestic supply-chain, and greater cost advantage of solar power generation due to the 30% to 40% fall in solar panel prices compared to 2022 as a result of increased solar panel production within China.

Potential for renewable energy to make up the top share of global power output in 2024

8. As a result of the increase in renewable energy generation capacity, the share of renewable energy (including hydropower) in the world's total power output is expected to increase up to a maximum of about 34% in 2024. Hence, there is a possibility that renewable energy may overtake coal, which had been the largest power generator previously, and take the top place for the first time. The share of naturally variable renewable energy (VRE) of solar and wind power, combined, is expected to grow to 16%, and there is an increasingly real possibility that the implementation of measures to integrate VRE, which have a large share, will become a medium- to long-term challenge.

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Trends in Japan's renewable energy market

9. Renewable energy generation capacity, excluding large-scale hydropower of 30 MW or above, will reach 107 GW by the end of FY2024. The power output for renewable energy, based on this definition, will reach 212 TWh in FY2024. If large-scale hydropower of 30 MW or above is included, the share of renewable energy in total power output is expected to reach 24.6% (hydropower: 7.6%, non-hydropower: 16.7%) in FY2024.
10. The annual rate of increase in the amount of renewable energy adopted in Japan peaked in FY2014 and has since remained on a long-term trend of decline. The volume of increase in FY2024 is expected to remain at the same level as the previous fiscal year at about 6.5 GW per year. While this is a different situation from the acceleration in the adoption of renewable energy worldwide, Japan is expected to be on track to achieve its renewable energy target for 2030 if it maintains this adoption level.

Challenges and measures accompanying the adoption of renewable energy in 2024

11. Challenges accompanying the adoption of renewable energy in 2024, which are shared by countries around the world, include rising production and installation costs of renewable energy facilities due to global inflation and rise in interest rates, project delays due to the wait for connection to the power grid, delays in approval processes by administrative agencies, and ensuring the flexibility of the power grid accompanying the increase in VRE share, among other challenges. To address rising costs due to inflation, in the short-term, it is necessary to raise bidding prices and make subsequent adjustments for inflation to contract prices such as PPA. On the other hand, there is also a need to pay close attention to society's tolerance for the rise in energy prices. With regard to waiting for the connection to the power grid, the primary factor is that long-term investment in the power grid is not keeping pace with the rapid growth of renewable energy. Therefore, it is essential to formulate and implement long-term power grid improvement plans with a view to expanding renewable energy, as well as provide policy support to promote long-term investment toward achieving that. With regard to ensuring the flexibility of the power grid accompanying the increase in VRE share, it is necessary to maintain demand and supply regulating power sources, provide policy support for the improvement of power storage systems, and establish policies to promote the proactive use of DR.
12. Challenges that confront Japan in 2024 include the decline in the number of locations to install renewable energy generation facilities, building consensus with the community on renewable energy projects and the approach to coexistence with the local community, and the need to establish new renewable energy business models such as FIP and PPA in a post-FIT environment.

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Hydrogen/Ammonia Policy Challenges for 2024

- Continuous discussions required from diverse viewpoints while developing systems to support introduction -

<Summary> ◆

Yoshiaki Shibata*

Global Hydrogen Adoption Outlook

1. If all announced hydrogen projects (including those under construction, final investment decision, feasibility study, and concept announcement stages) come into the production stage, hydrogen supply is expected to reach up to 38 million tons (on a hydrogen basis; the same applies hereafter) in 2030, according to the Global Hydrogen Review 2023 by the International Energy Agency. The total projected supply (27 million tons from water electrolysis and 10 million tons from fossil fuels with CCUS (Carbon dioxide Capture, Utilization and Storage)), though representing a 50% increase from a year-earlier projection, falls far short of the 70 million tons required for 2030 under the IEA's Net Zero Emissions by 2050 scenario. Hydrogen supply under projects with final investment decisions is limited to only 4% of the total.
2. By region, Europe and North America lead the market. Europe has a tendency to use renewable energy sources for water electrolysis hydrogen, while the United States has a trend of using fossil fuels with CCUS for hydrogen production. On the other hand, hydrogen projects in Japan are very limited.

2024 hydrogen policy focus

3. Japan plans to introduce price difference compensation (contract for difference: CfD) and production base development systems to support hydrogen projects, as seen in Europe and the United States. Japan's framework for selecting hydrogen projects not only from the viewpoint of efficiency but also from various other perspectives is commendable. Hydrogen policy challenges include how to distribute a limited budget for supporting hydrogen projects and how to judge the rationality of hydrogen production and use.

Need to secure hydrogen demand

4. Japan will have to import a certain amount of hydrogen. However, buyers, or off-takers, have yet to be fixed for about 60% of announced hydrogen trade projects. Due to the high maturity of commercialized transportation technologies, ammonia accounts for most hydrogen carriers in the hydrogen trade.
5. In order to secure hydrogen demand, costs should be reduced for cracking ammonia into hydrogen and for other hydrogen carriers such as liquefied hydrogen and methylcyclohexane (MCH).
6. Next, from the viewpoint of users, hydrogen demand is categorized into existing and new one. Given that equipment and distribution networks have been developed for existing gray hydrogen with high carbon intensity, only the conversion of gray hydrogen into clean hydrogen may be required. However, attention should be paid to the impact of the conversion on existing processes and the expected scale of CO2 reduction. With regard to new hydrogen demand, it is important to identify and secure applications that are difficult to realize decarbonization without hydrogen, including long-distance and large-scale transportation, industrial high-temperature heat demand, and cold-region heat demand.
7. In order to secure and expand demand for hydrogen, it is necessary to consider not only financial support such as price gap compensation (CfD) and tax incentives and carbon pricing for inducing hydrogen use, but also mandatory hydrogen usage obligations promoted under the European Union's renewable energy directive.

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Issues regarding domestic hydrogen network development

8. The key is how to economically transport and distribute hydrogen to consumers. As for imported hydrogen, liquefied hydrogen, MCH, ammonia, e-methane, and e-fuel are being considered as hydrogen carriers. For domestic hydrogen networks, compressed hydrogen and hydrogen pipelines as well are technology options. The optimal network type differs depending on distances from hydrogen import ports and domestic hydrogen production bases to consumers, the scale of hydrogen demand, and geographical constraints. It is necessary to discuss desirable future hydrogen networks by taking into account the whole of imports and domestic distribution.

Need to enhance Japan's international competitiveness in water electrolysis

9. While the Basic Hydrogen Strategy aims to increase the share of Japanese products in the global water electrolysis market, it is expected that market shares for European, U.S., Chinese, and Indian products will be high. In order to increase the market share for Japanese products, Japanese companies should not only expand sales of parts and equipment, but also market hydrogen energy management systems that aim optimal operations from hydrogen production with water electrolysis to hydrogen supply to consumers. To this end, it is necessary to strengthen domestic Power-to-Gas initiatives.

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CCUS Policy Challenges for 2024

- Towards materialization of CCS and carbon recycling projects -

<Summary> ◆

Yoshikazu Kobayashi*

1. The year 2023 featured the acceleration of policy efforts to materialize CCS (Carbon Capture and Storage) projects, including feasibility studies on seven CCS projects in Japan and other countries and full-scale discussions on a new business act that would have jurisdiction over CCS projects. In 2024, a CCS business act is scheduled to be submitted to the ordinary National Diet session, while the above-mentioned feasibility studies on seven CCS projects continue, with a survey planned on the transportation of CO2 by ship. Efforts to materialize CCS projects will thus make further progress.

2. In order to commercialize CCS, it is essential to provide business operators with support for both initial investment (capital expenditure, or CAPEX) and operational expenditure (OPEX). Other countries, such as Canada and Norway, which are leading the way in CCS projects that do not include enhanced oil recovery, have support packages for both CAPEX and OPEX. In order to achieve the Japanese government's target of starting CO2 storage in 2030, business operators need to make investment decisions by around 2026, with a government support system in place. In order to enable business operators to make investment decisions on such a schedule, discussions on the design of a detailed support system are expected to be deepened in 2024.

3. Carbon recycling (CR) is a decarbonization technology based on a novel idea that considers captured CO2 as a useful resource and makes effective use of it. In 2023, a roadmap was revised to indicate that an estimated 100-200 million tons of CO2 may be recycled in 2050. In 2024, support for technological development aimed at further cost reductions should be promoted, with the consideration of model cases being deepened for inter-industry collaboration in the commercialization of CR.

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Nuclear Policy Challenges for 2024

- Continue Discussions from a Long-term Viewpoint –

<Summary> ◆

Kenji Kimura*

Recent situation regarding nuclear energy

1. As countries have set ambitious greenhouse gas emission reduction targets in recent years, nuclear energy as a zero-emission baseload power source has been attracting attention.
2. Furthermore, fossil fuel prices have soared globally since 2021, leading countries to give priority to securing a stable energy supply including electricity. This trend has intensified as Russia's invasion of Ukraine has destabilized international energy markets. In this way, the contribution of nuclear energy to energy self-sufficiency and its characteristics as a stable baseload power source has been increasingly recognized. At the 28th Conference of the Parties to the United Nations Framework Convention on Climate Change, known as COP28, the United States and 21 other countries issued a multilateral declaration to triple nuclear power generation capacity by 2050.

Global focuses of attention in 2024 and beyond

3. In the United States, large-scale nuclear support measures have been enacted, including the Civil Nuclear Credit (CNC) program and tax credits under the Inflation Reduction Act. In addition, the process of exporting large light-water reactors to Bulgaria and Poland is underway. France is selecting new nuclear power plant sites and has taken other various nuclear policy measures, such as the nationalization of Electricité de France (EDF) and the development of legislation to simplify the procedure for new construction in the vicinity of existing nuclear facilities. The effects of these policies and initiatives will be closely watched from the perspective of Japan's nuclear energy policy.
4. In addition to the United States and France, many countries have positioned nuclear power promotion as part of their climate change countermeasures and energy security, proceeding with their nuclear energy plans (including those related to new reactors). They include not only developed countries in Europe and North America, but also several emerging countries, indicating that the number of countries using nuclear energy is gradually expanding. However, nuclear energy projects launched in 2023 were domestic nuclear power plant construction and exports by China and Russia, making their dominance of the global nuclear energy market more remarkable. It is important to continue to pay attention to the balance of power in the global nuclear market.
5. In November 2023, it was announced in the United States that NuScale and a Utah consortium would cancel their small modular reactor (SMR) project. As SMR trends have attracted global interest, the fate of the other SMR projects will be closely watched hereafter.

Japan's nuclear energy outlook and focuses of attention

6. If nuclear power plant operation and restart plans published by Japanese electric utilities are realized, nuclear power generation is expected to increase by about 30 TWh in FY2024 due to the restart. However, the risk of protracted safety review and construction works for safety improvement cannot be ignored.
7. In 2023, Units 1 and 2 of the Takahama nuclear power station were restarted in August and September, respectively. Construction work plans for Unit 2 of the Shimane nuclear power station were approved in August. In November, the service life for Units 1 and 2 of the Sendai nuclear power station in Kyushu was extended to 60 years. Important progress was thus made towards the restart and prolonged operation of existing reactors. While ensuring safety is a major premise, it is expected that existing reactors will continue to be used effectively as highly economical decarbonized power sources.
8. In May 2023, the GX Decarbonization Power Supply Act was enacted, including the revision of the nuclear reactor service life system. The

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act will allow nuclear power plant operators to extend the deadline for the termination of a nuclear reactor's operation by the length of time required for operation suspensions for such purposes as inspections and lawsuits. The rules for the extension should be clarified and detailed before the enforcement of the Act in 2025. From the viewpoint of ensuring nuclear safety, it is necessary to pay attention to the fact that reactors age even during their shutdown periods, although radiation embrittlement does not occur during such periods. It will become more important than ever to assess the aging of each piece of equipment and take anti-ageing measures in a fine-tuned manner according to the age of each piece of equipment. In October 2023, the Nuclear Regulation Authority (NRA) began accepting advanced applications for the assessment of anti-ageing measures based on a new system. Attention should be paid to how many electric power companies will apply in 2024.

9. In August 2023, ALPS (Advanced Liquid Processing System) treated water accumulated at the Fukushima Daiichi Nuclear Power Station began to be discharged. Regarding the backend of the nuclear fuel cycle, the Tsushima city assembly in the same month adopted a petition for the first stage of the process for selecting a final disposal site for high-level radioactive waste, but the Tsushima mayor decided not to accept it the following month. In August, Kaminoseki Town in Yamaguchi Prefecture announced that it would accept a survey on the establishment of an interim storage facility for spent nuclear fuel.
10. Overall, Japan made some progress in 2023 regarding many issues related to nuclear energy. It will be important whether this trend will continue in 2024 and beyond. In particular, discussions on the next Strategic Energy Plan are expected to advance in 2024. The government may have to reclarify the role of nuclear energy in 2050 in the new plan. It may also have to consider policy measures according to the role and relevant timetable. Since the effective use of existing reactors is an important challenge for Japan, the government should consider streamlining screening procedures for idled reactors towards their restart.

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Energy Efficiency Policy Challenges for 2024

- Energy Efficiency Measures Required to Be Accelerated –

<Summary> ◆

Naoko Doi*

2024 energy efficiency policy outlook

1. As the impact of global inflation on business activities and households becomes more serious, energy efficiency and demand-side measures that require additional costs have entered a short-term adjustment phase. At the 28th Conference of the Parties to the United Nations Framework Convention on Climate Change known as COP28, meanwhile, an agreement came to enhance global efforts to double the pace of improvement in energy intensity from the current level by 2030. In response, in 2024, each country will consider and formulate specific policies for enhancing domestic energy efficiency measures and for developed countries' support for developing countries, while taking into account burdens on consumers.
2. Regarding energy efficiency technologies that hold the key to achieving the carbon neutrality goal, the manufacturing industry is supported under industrial policy mainly in developed countries and will continue to be so in 2024. This point needs to be closely watched from the perspective of the Japanese manufacturing industry's international competitiveness.
3. For the residential sector, where direct regulation is difficult, European and other countries have taken an important step toward strengthening measures to decarbonize or carbon-neutralize heat demand. Developed countries will take the lead to continuously enhance comprehensive measures for the promotion of consumers' energy efficiency investment, including the development of national debate, appropriate information services for consumers, and subsidies.
4. Japan's support for Asian and other emerging market countries that have room to further improve energy efficiency, including financing for capital investment, energy management know-how transfers, and energy efficiency policy formulation, will remain important for achieving the goal of doubling the pace of improvement in energy intensity.

Background factors for energy efficiency sector

5. **Industry:** Energy efficiency investment was sluggish in 2022 due to soaring energy prices in Europe and other countries before recovering moderately in 2023.
6. **Transport:** In 2023, almost half of the road sector's global energy efficiency investment was related to electrification. In China, government subsidies for new energy vehicles (NEVs) (covering battery electric vehicles, plug-in hybrid vehicles, and fuel cell vehicles) were abolished in 2023. As the auto sales lineup expanded in response to tax incentives and NEV regulations, however, NEVs accounted for about 30% of passenger car sales.
7. **Buildings:** Rising borrowing costs, soaring building materials prices, and economic uncertainties were limiting growth in energy efficiency investment in 2023. In Germany, there are concerns about a slowdown in investment in residential buildings due to soaring materials prices and increasing borrowing costs.

Trends in major economies

8. **Europe**: The industry sector moderately increased energy efficiency investment in 2023. Regarding the carbon neutralization of the demand side (heating and hot water supply), Germany and other countries have taken an important step forward, such as requiring new heating equipment to operate with an electricity mix including a renewable energy share of at least 65% in newly developed areas from January 1, 2024. Amid a cost-of-living crisis, the challenge is to strike a balance between strengthening energy efficiency measures and

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mitigating their impact on the poor.

9. **U.S.**: Driven by tax credits, subsidies, and low-interest loans under the Inflation Reduction Act, industry, transport, and building sectors are materializing investment in energy efficiency and carbon neutralization. There are also moves to improve the efficiency of water heaters and boilers and tighten automobile fuel efficiency regulations. The carbon neutralization of heating and hot water supply equipment differs by region.
10. **Asia**: Asian countries are continuously strengthening energy conservation as a medium to long term measure. In 2023, Malaysia enacted an energy conservation law and Indonesia expanded the scope of energy management and reporting obligations in the industry sector. Thailand and the Philippines have implemented power-saving measures.
11. **Japan**: Under consideration for the demand side are (1) the carbon neutralization of water heaters, (2) the introduction of DR (demand response) -ready equipment, and (3) energy retailers' introduction of a pledge-and-review system for the demand side. In order to achieve the energy conservation target of 62 million kL in FY2030 (a cut from FY2013) under the current Strategic Energy Plan, the government will provide energy conservation subsidies worth about 700 billion yen to the manufacturing industry over the next three years.

Implications for Japan

12. As the top priority towards long-term green growth, each country is enhancing support for the manufacturing industry regarding energy efficiency technologies under industrial policy. With a view to strengthening the international competitiveness of Japan's manufacturing industry, the government should commit and spread medium- to long-term support for energy efficiency and other private investments in domestic green transformation.
13. For the residential sector, where direct regulation is difficult, attention is being paid to the decarbonization or carbon neutralization of heat demand that is being promoted in Europe and other countries. In Japan, which aims to achieve carbon neutrality by 2050, it is important to steadily promote the carbon neutralization of the residential sector. In doing so, Japan should present a long-term path while taking into account region-by-region differences in climate and demand, as well as future cost reductions, and changing technology standards and diffusion targets over time.

An Analysis of export competitiveness of clean energy-related products

Yuko Hoshino* and Junko Ogawa**

Clean energy-related products are indispensable for the transition to clean energy and are also expected to be one of the new growth industries in terms of industrial policy. In this study, silicon transistors, photoelectric conversion elements, lithium-ion batteries and electric vehicles are taken as clean energy-related products, and the current status of export competitiveness and resistance to price competition are analyzed. Armington elasticity was estimated for each product category, and it was confirmed that the smaller the Armington elasticity, the less likely the product is to be exposed to price competition. Using the Armington elasticity, a sensitivity analysis was also conducted on the impact of higher domestic electricity prices on the competitiveness of exports of products from Japan via domestic output prices. For products that are more likely to be exposed to price competition, we confirmed that higher domestic energy prices lead to a certain degree of export decline. This suggests that stable domestic energy prices contribute to the transition to clean energy and the growth of related industries.

Keywords : Clean energy-related products, Armington Elasticity, Export Competitiveness, Energy Price

1. Introduction

The importance of expanded adoption of renewable energy and progress in electrification have been highlighted as measures to achieve the goals of the Paris Agreement. These measures would be supported by such clean energy products as solar photovoltaic panels, storage batteries, power semiconductors, and electric vehicles. The Green Growth Strategy prepared in 2021 notes expectations for growth in clean energy related industry from the standpoint of industrial policy. This research focuses on the import and export competitiveness of clean energy related products in Japan that are becoming increasingly important from the standpoint of both the transition to clean energy and securing industrial competitiveness. We also analyzed the impact of the rising electricity prices that remain a concern moving forward as the international energy situation changes drastically.

2. Export competitiveness for clean energy products

2.1 Clean energy-related products analyzed in this paper

Table 1 lists the clean energy-related products analyzed for this paper and their HS codes. For this paper, we looked at silicon transistors, represented by the common power semiconductor that supports electrification technology, photoelectric conversion devices which are semiconductors used for solar photovoltaic power generation, lithium-ion batteries installed in stationary storages or onboard electric vehicles, and various electric vehicles such as hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), and battery electric vehicles (BEV). We covered products dating from the year 2012 and later, the year after the Great East Japan Earthquake.

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Table 1. Clean energy products analyzed for this paper

Item	HS code (Export/Import)
Silicon transistor	854129910 / 854129010
Photoelectric Conversion Device	854140990 / 854140090
Lithium-ion battery	850760000 / 850760000
Electric Vehicl (HEV)	870340900 / 870340000
Electric Vehicle(PHEV)	870360900 / 870360000
Electric Vehicle(BEV)	870380900 / 870380000

Source: Trade Statistics, Ministry of Finance [1] "Export Statistics Item Tables" and "Import Statistics Item Tables”

2.2 Trade Specialization Index

We first calculated the changes in the Trade Specialization Index (TSI) in the following manner as an indicator of the export competitiveness of each product.

Trade Specialization Index = (Export amount - Import amount)/(Export amount + Import amount)

By definition, the TSI ranges from -1 to 1. When the TSI is

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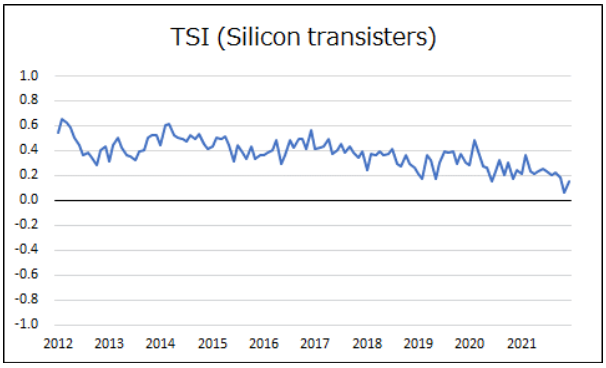
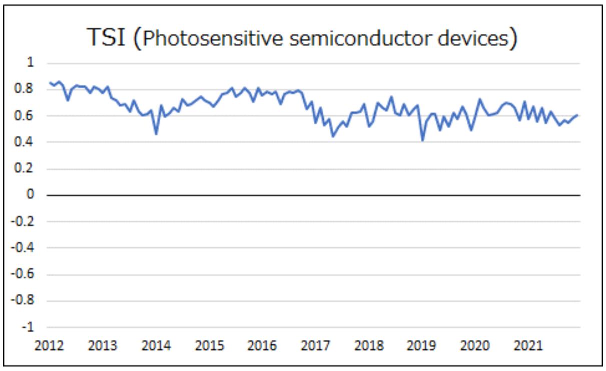
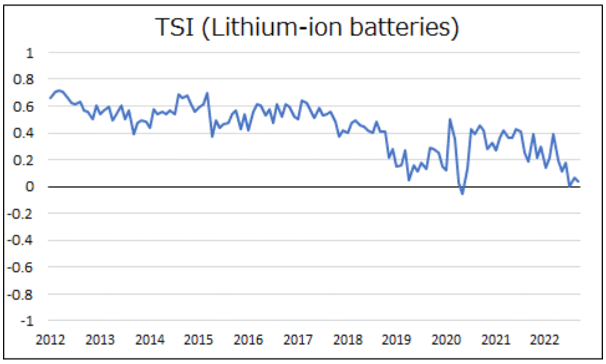


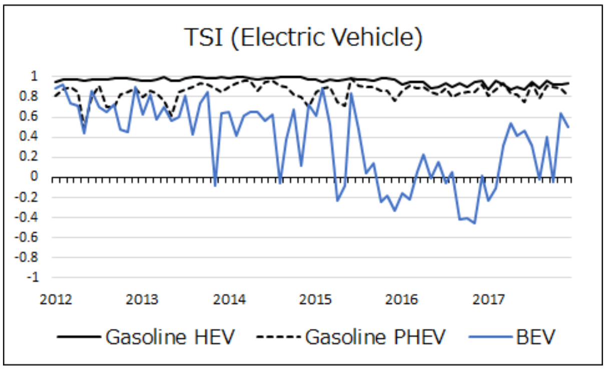
Source: based on Trade Statistics, Ministry of Finance [1].



Source: from reference [2].



Source: from reference [2].



Source: based on Trade Statistics, Ministry of Finance [1].

Figure 1: Trade Specialization Index for Clean Energy Products

close to 1, it is considered export specialized, or in other words, it denotes that the product has high export competitiveness. On the other hand, when the number is close to -1, it denotes that the product is import specialized, or that it has low export competitiveness. Horizontal trade, a state common in much of the trade of goods where products in the same category are simultaneously imported and exported, has been observed, in which case the TSI becomes close to 0. This tendency is notable for goods with a high level of product differentiation.

Figure 1 shows the monthly changes of the TSI for the clean energy products listed in Table 1. The TSI for silicon transistors, a primary component for power semiconductors, has been gradually trending downward, and broke 0.2 at the end of 2021. The TSI for photosensitive semiconductor devices, a primary component in solar photovoltaic panels, also declined slightly from 0.8 in 2012 to 0.6 in 2021. Furthermore, a downward trend is continuing for the TSI of lithium-ion batteries, and has been approaching zero since the summer of 2022. Finally, a look at the three types of electric vehicles (hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), and battery electric vehicles (BEV)), shows that the TSI for HEVs has remained stable as export specialized at around 0.8 to 0.9, despite a slight decline from 2020. In comparison, the TSI for BEVs is beginning to trend towards import specialized with months in the negative increasing in frequency since 2020 despite major fluctuation in part due to inadequate domestic demand.

However as noted before, when the TSI approaches zero, it means that the level of horizontal specialization is high in the relevant product category, and this cannot be directly connected to a decline in export competitiveness.

3. Elasticity of substitution between domestic and imported goods

One factor behind increased horizontal specialization in the same product category is product differentiation. According to Armington[3] , when domestic goods and imported goods are not homogeneous, but rather are related as differentiated imperfect substitutes, then horizontal specialization will occur with the simultaneous import and export of the same product.

Here we consider a model of two countries: country A and country B. The goods produced in each country are differentiated. The total demand for the goods from country A XA are the total of the domestic demands for countries A XA_A and B XA_B, while the total demand for the goods from country B XB are also the total of the domestic demands for countries A XB_A and B XB_B. In this case, the substitution elasticity between the domestic goods and imported goods in country A (the Armington elasticity) is equivalent to β in Formula (1) below. Here P_A is the production price in country A, while P_B is the production price in country B.

$$XA_A = b_A(P_A/P_B)^{\beta} XB_A \qquad (1)$$

Estimation of Armington elasticity according to its original definition requires data on domestic demand for each of the products in Table 1 equivalent to XA_A and XB_A. To avoid this, we estimate the following model using only trade data, based on the referenced literature [4].

For the sake of simplicity, assuming that the demand for each product in each country depends on the economic scale (such that the demand in country B is λ times country A), the export and import volume of country A are set as E_A and M_A respectively. Similarly, the export and import volume of country B are set as E_B, M_B respectively. Accordingly, E_A and M_A can be shown in the following manner.

$$E_A = M_B = XA_B = \lambda XA_A \qquad (2)$$

$$M_A = E_B = XB_A \qquad (3)$$

From equations (1)-(3), we obtain the following equation (4). Here, α is a constant.

$$E_A/M_A = \alpha(P_A/P_B)^{\beta} \qquad (4)$$

Equation (5) is formulated as a state-space model by taking the logarithm of equation (4).

$$\begin{aligned} log(E_A/M_A) &= \mu_t + \beta log(P_A/P_B) + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \\ \mu_{t+1} &= \mu_t + v_t + \xi_t, \quad \xi_t \sim N(0, \sigma_\xi^2) \\ v_{t+1} &= v_t + \zeta_t, \quad \zeta_t \sim N(0, \sigma_\zeta^2) \qquad (5) \end{aligned}$$

Table 2 shows the estimation of the parameter β equivalent to the Armington elasticity when monthly dummy data is added to equation (5).

When the absolute value of β is small, then the impact on trade volume when the price of the imported good changes relative to the domestically produced good is small, and changes in factors other than the price may have led to increased product differentiation. However, when the absolute value of β is high, it means that the trade volume changes elastically when the relative price changes. Looking at Table 2, we see that the elasticity of lithium-ion batteries is particularly high at -4.6, and that it responds to relative price changes very sensitively. Conversely, the elasticity of hybrid and plug-in hybrid vehicles is low at -0.13 and -0.35 respectively, and these products are therefore less likely to be exposed to price competition compared

Table 2: Armington Elasticity of Clean Energy Related Products

Item	β(Armington elasticity)	t-value	R^2	Estimation Period
Silicon transistor	-0.8332	-7.13	0.489	2012.1-2021.12
Photoelectric Conversion Device	-0.7449	-10.59	0.694	2012.1-2021.12
Lithium-ion battery	-4.6074	-3.72	0.746	2020.1-2021.12
Electric Vehicl (HEV)	-0.13036	-0.612	0.561	2017.1-2021.12
Electric Vehicle(PHEV)	-0.35274	-0.875	0.280	2017.1-2021.12
Electric Vehicle(BEV)	-0.8336	-2.896	0.406	2017.1-2021.12

Notes: Estimation results for β in equation (5).

to BEVs, silicon transistors, and photosensitive semiconductor devices, or in other words that they are highly resistant to price competition. Note that according to reference [2], the Armington elasticity of photosensitive semiconductor devices and lithium-ion batteries was estimated, resulting in numbers of 0.702 from January 2012 to December 2021, and 1.663 from January 2012 to September 2022 respectively. Because they used data on export price rather than domestic output price, the results are different than Table 2.

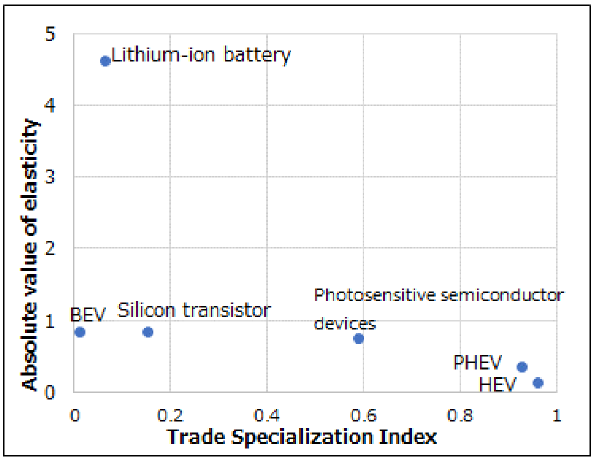
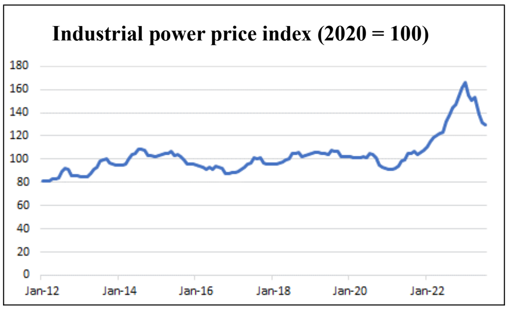


Figure 2: Armington Elasticity (absolute value) and the Trade Specialization Index

Figure 2 shows the distribution of the analyzed products with the horizontal axis representing the TSI for the last month of the analyzed period (December 2021) and the vertical axis representing the absolute value of the Armington elasticity. As we have shown, products with a TSI close to 1 and a low Armington elasticity (absolute value) have a high degree of product differentiation and high export competitiveness. We can see that of the products we analyzed, this applies to HEVs and PHEVs. In contrast, we can see that the TSI of lithium-ion batteries is close to 0 and that the Armington elasticity (absolute value) is high. Even ignoring lithium-ion batteries, we can see from Figure 2 that the lower the Armington elasticity, the higher the TSI. In other words, export specialized products tend to be less exposed to prices.

4. Sensitivity Analysis: Impact of Higher Electricity Rates

Figure 3 shows the changes in the industrial power price index according to the Corporate Goods Price Index from the Bank of Japan. Here we can see that the price of electricity temporarily doubled in 2020 compared to the price between 2007 and 2010, influenced by the increase in fuel prices following the invasion of Ukraine by Russia. Below, we estimate a model to regress the domestic output price of each product on the domestic industrial power price in order to carry out sensitivity analysis on the impact of higher domestic electricity prices on the export competitiveness of products from Japan via the domestic output price.



Source: compiled from Bank of Japan, "Corporate Goods Price Index" [5].

Figure 3: Industrial Power Price Index

Equation (6) below is a model that regresses the output price P_A of the clean energy-related products we analyzed for country A on the industrial power price index P_E. As in equation (5), it is formulated as a state-space model.

$$
\begin{aligned}
log(P_A) &= \mu_t + \gamma log(P_E) + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \\
\mu_{t+1} &= \mu_t + v_t + \xi_t, \quad \xi_t \sim N(0, \sigma_\xi^2) \\
v_{t+1} &= v_t + \zeta_t, \quad \zeta_t \sim N(0, \sigma_\zeta^2) \qquad (6)
\end{aligned}
$$

Table 3 shows the estimation of parameter γ by adding monthly dummy data to equation (6). Because we could not obtain the separate data for hybrid vehicles, plug-in hybrid vehicles, and battery electric vehicles from the domestic output price data used in the analysis, we used the average output price for electric vehicles here. According to Table 3, the product for which the output price was influenced the most by the rise in electricity prices was silicon transistors, with a rise of 0.15% in output price per 1% rise in electricity prices. In comparison, the output price for electric vehicles (average) only rose 0.02% for each 1% rise

Table 3: Elasticity of Output Prices of Clean Energy Related Products to Electricity Prices

Item	γ(elasticity to electricity rates)	t-value	R^2	Estimation Period
Silicon transistor	0.1458	2.04	0.069	2012.1-2021.12
Photoelectric Conversion Device	0.083	2.38	0.157	2012.1-2021.12
Lithium-ion battery	0.0639	6.71	0.306	2020.1-2021.12
Electric Vehicl (average)	0.0242	1.92	0.71	2017.1-2021.12

Notes: Estimation for γ in equation (6)

in electricity prices.

Next, Table 4 shows the results when we double P_E for country A in equation (6) and make the output price P_B for country B unchanged, and look at the changes in export volume E_A via equations (5) and (6). Because we were using the same output price for electric vehicles, we used BEVs which had the

Table 4: Sensitivity Analysis vs. Doubled Electricity Prices

Item	output price	export volume
Silicon transistor	up 10.6%	down 8.1%
Photoelectric Conversion Device	up 5.9%	down 4.2%
Lithium-ion battery	up 4.5%	down 18.5%
Electric Vehicl (average)	up 1.7%	down 1.4%

largest Armington elasticity in Table 2 for this calculation.

Table 4 shows that the product for which the output price is influenced the most is silicon transistors, but looking at the influence on export volume, lithium-ion batteries are influenced the most. This is because the Armington elasticity (absolute value) estimated in Table 2 was the highest for lithium-ion batteries. The next highest influence is silicon transistors, and the import volume decline is 18.5% and 8.1% respectively. Meanwhile, while the Armington elasticity of electric vehicles (BEVs) is almost the same as silicon transistors, the sensitivity of the domestic output price thereof to electricity prices is low, and therefore the impact on export volume is limited.

4. Conclusions

Clean energy related products are not only essential for the transition to clean energy, but expectations for the domain to become a growth industry from the standpoint of industry policy are rising. This paper considered several clean energy products and analyzed their current export competitiveness and resistance to price competition. We confirmed that for products that can easily be exposed to cost competition, a rise in domestic energy prices leads to a certain reduction in exports. Therefore, it can be said that stable domestic energy prices contribute to the transition to clean energy and related industry growth.

The rising prices of resources due to international instability are becoming a driving factor that accelerates the transition to clean energy primarily in Europe. However, because the energy density of renewable energy is generally low, a relatively large amount of resources are required to use it. As a result, the transition to clean energy can easily lead to demand pressure and rising prices on resources, including critical minerals and related materials. This analysis examines the impact of energy costs on production prices and imports and exports of clean energy-related products. The results indicate that the growth of clean energy-related industries requires that the costs of decarbonisation policies, including energy prices, and their impact on product exports be fully considered when formulating policies. This is crucial not only for achieving Japan's carbon neutrality targets, but also for its industrial strategy.

The results also suggest that when considering the export competitiveness of clean energy related products, it is important to prepare for price fluctuations not only in energy prices but with relation to the procurement of raw materials and related materials.

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Regional Energy Demand Analysis Using Household CO_2 Statistics:

Implications of the Carbon Pricing Policy in Japan

Junko Ogawa *, Yuko Hoshino **

To maximize the effectiveness of carbon pricing and minimize its burden, it is critical to understand Japan's energy demand characteristics accurately. Therefore, this study focuses on analyzing the regional energy demand of the household sector using the Ministry of the Environment's Household CO_2 Statistics. It uncovers significant regional variations in energy consumption, shaped by climate, socioeconomic factors, and infrastructure. The investigation into utility costs and the tax burden reveals regional disparities and a regressive effect on lower-income households and rural regions, implying that imposing a uniform carbon pricing system is not feasible. Instead, a system design tailored to specific circumstances is required.

Additionally, the study looks at international cases from the US, UK, and France, highlighting the challenges they faced in introducing energy and carbon taxation, including experiences of public backlash.

In conclusion, the analysis underscores the need for clear and detailed communication about policy impacts to build public support and ensure equitable and effective policies for climate change.

Keywords: Carbon pricing, Energy Price, Household Energy, Regional disparity, Tax Burden

1. Introduction

In May 2023, Japan enacted the "Act on Promoting a Smooth Transition to a Decarbonized Economic Structure (GX Promotion Act)." The act is designed to facilitate the development and implementation of innovative decarbonization technologies aimed at achieving Japan's 2050 carbon neutrality target. The primary mechanism established under this act involves the issuance of "Climate Transition Bonds" totaling 20 trillion yen over the next decade, starting from FY2023. These bonds are used as a financial resource for technologies and policies that contribute to the transition to carbon neutrality.

To ensure the financial viability of these bonds, the next three programs, collectively referred to as "the Growth-Oriented-Carbon Pricing," are slated to be implemented as tools for collecting financial resources. These programs are a voluntary emissions trading scheme from FY2026, a fossil fuel surcharge on fossil fuel importers from FY2028, and a specific surcharge on electricity producers related to emissions allowances from FY2033.

Understanding the intricate impact of carbon pricing on an economy necessitates assessing the anticipated reduction impacts and costs within the context of a society's energy demand characteristics and socio-economic backgrounds. For instance, in the residential sector, the effects and cost burdens of carbon pricing are influenced by a myriad of factors including household income, dwelling types, availability of alternative energy sources, regional climates, and advancements in energy efficiency technologies.

In microeconomics theory, the impact of price changes on consumption can generally be categorized into income effects and substitution effects. Typically, households with higher incomes or access to a variety of energy alternatives tend to exhibit stronger substitution effects, whereas lower-income households or those with limited alternatives experience more pronounced income effects. Hence, a thorough understanding of the characteristics of targeted energy demand sectors is essential for maximizing the effectiveness of the carbon pricing.

Therefore, this paper analyzed the energy demand characteristics of Japan's residential sector, which is indispensable as basic information for policy consideration, using the Ministry of the Environment's "Statistical Survey of CO_2 Emissions from the

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Household Sector (Household CO_2 Statistics)". Given the susceptibility of residential energy demand to climatic influences compared to other sectors, this analysis attempted to identify regional energy demand trends based on a classification system as outlined in Table 1.

The analysis revealed that there were significant differences in energy demand, utility costs, and tax burdens in the residential sector across regions. This implied that the impact of the introduction of carbon pricing depends on socioeconomic conditions, such as regional climate, population characteristics, and infrastructure development, and that it was difficult to apply a uniform policy. In particular, the burden of utility costs on households was particularly heavy in rural areas and among households with low incomes, highlighting the problem of regressivity.

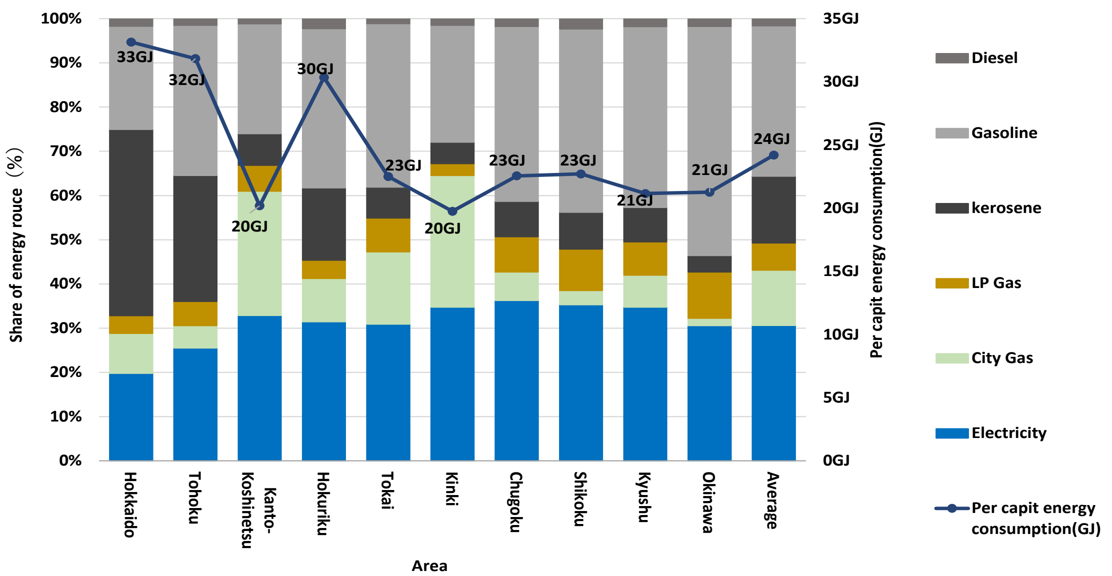
Table 1. Regional Classification in Japan Used for the Analysis

Regional Classification	Prefectures
Hokkaido	Hokkaido
Tohoku	Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima
Kanto-Koshinetsu	Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, Kanagawa, Yamanashi, Nagano
Hokuriku	Niigata, Toyama, Ishikawa, Fukui
Tokai	Gifu, Shizuoka, Aichi, Mie
Kinki	Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama
Chugoku	Tottori, Shimane, Okayama, Hiroshima, Yamaguchi
Shikoku	Tokushima, Kagawa, Ehime, Kochi
Kyushu	Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima
Okinawa	Okinawa

2. Regional Characteristics of Energy Demand and Utility Costs

3.1. Regional Per Capita Demand by Energy Source

Figure 1 illustrates the per capita energy consumption and the proportion of fuels used in the residential sector by region. The Hokkaido, Tohoku, and Hokuriku regions show significantly higher per capita energy consumption, which is primarily due to heating needs in winter. In particular, the use of kerosene is remarkably high. Conversely, in the southwestern regions, such as Okinawa, Kyushu, Shikoku, and Chugoku, heating demand in winter is relatively low, but the demand for automotive gasoline is prominent.



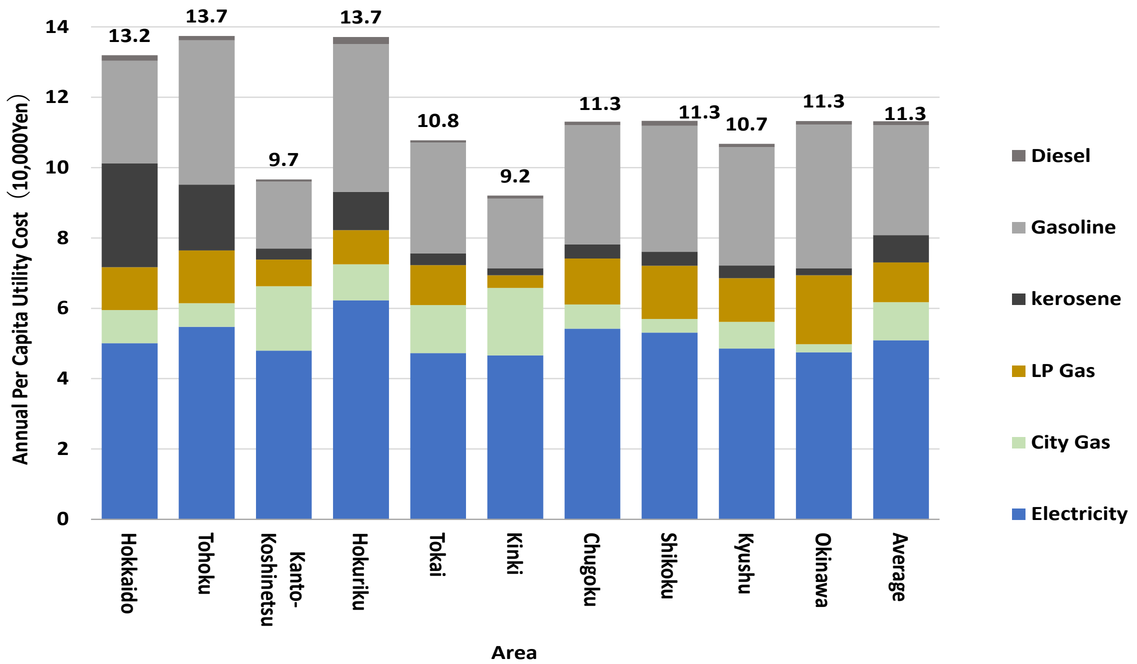
Source: Based on the Ministry of the Environment's "Household CO_2 Statistics"

Figure 1: Regional Per Capita Total Energy Demand and Proportion by Energy Source (2020)

Furthermore, in major urban areas, including Kanto-Koshinetsu, Kinki, and Tokai regions, per capita energy consumption is lower, with a higher usage ratio of electricity and city gas. This phenomenon is influenced by the characteristics of urban areas: high public transport infrastructure and smaller residential floor areas. In addition, the proportion of the working population is higher in urban areas,(2) resulting in shorter time spent at home. However, recent promotions of telework may have reduced these differences.(3) Such changes in social circumstances are considered to be new factors affecting household energy demand. In conclusion, it was revealed that household energy demand varies based on the region.

3.2. Utility Costs

Figure 2 presents regional characteristics of per capita utility costs in the residential sector. Per capita utility costs are significantly higher in colder regions, such as Tohoku, Hokuriku, and Hokkaido, compared to other regions, due to the greater heating demand as previously mentioned. For example, according to the statistics on heating degree days and cooling degree days,(4) Sapporo, in the colder region, has 2.4 times the national average of heating degree days, whereas Fukuoka, in a warmer climate, remains at 1.4 times the national average for cooling degree days. On the other hand, Kinki, Kanto-Koshinetsu, and Tokai regions exhibit the lowest level of utility costs. As shown in 2.1, these regions, which include large urban areas, feature a relatively warm climate, well-established city gas networks, compact housing, less home time, and a comprehensive public transportation network, resulting in lower energy demands. These factors combine to make the per capita utility costs in these metropolitan areas the lowest among all regions.



Source: Based on the Ministry of the Environment's "Household CO_2 Statistics"

Figure 2: Annual Per Capita Utility Cost in the Residential Sector (2020)

3.3. Level of Utility Cost Burden

In addition to the level of utility costs, the ratio of utility costs to income is an important indicator in assessing the level of burden to each household. A higher ratio of utility costs to income implies that less financial capacity is left for other consumer purchases. Figure 3 arranges the regions by the average per capita income and shows the ratio of utility costs (electricity, city gas, LPG, kerosene, gasoline, diesel) to income. Note that the average per capita income is calculated by dividing the average household annual income by the number of household members, including non-working members, such as the elderly and children, hence it is typically lower than the general per capita annual income statistics.

In terms of per capita income levels, Kanto-Koshinetsu ranks the highest, followed by other metropolitan areas, such as Tokai and Kinki. Conversely, Okinawa has the lowest per capita income, followed by southwestern regions outside of Honshu, such as Shikoku and Kyushu. In contrast, the proportion of utility costs relative to per capita income (utility cost burden rate) exhibits an opposite trend, being lower in Kanto-Koshinetsu, Kinki, and Tokai, and higher in Okinawa, Tohoku, Hokuriku, and Hokkaido. A relatively strong negative correlation is observed between per capita income and the utility cost burden rate, indicating that regions with lower incomes tend to have higher utility cost burdens.

Source: Based on the Ministry of the Environment's "Household CO_2 Statistics"

Figure 3: Regional Per Capita Income and the Ratio of Utility Costs to Income (2020)

3. Energy-Related Taxes

To what extent do taxes and surcharges constitute the utility costs paid by households? In fact, when purchasing energy, consumer focus tends to be on the final price, with little awareness of the specific amount of taxes paid on electricity and gas used at home or gasoline and diesel purchased at gas stations. While the per liter price of gasoline at gas stations is considered important, the amount of tax embedded in the price is not a major concern. Even in cases where the renewable FIT surcharge is explicitly charged to the electricity price, only a few consumers are aware of it. For instance, a survey conducted in August 2022(5) found that only 19% of respondents understood the meaning of the renewable energy surcharge. The breakdown of this 19% is as follows: 8% understood and were dissatisfied, and 11% understood and had no particular dissatisfaction.

On the other hand, an understanding of the current state of taxes and surcharges related to energy is essential for the concrete design of carbon pricing schemes. This is because, in addition to the current burden on consumers, a carbon price will be imposed. Therefore, when introducing a new system, it is crucial to thoroughly understand the existing burden and carefully consider the design of the system. Consequently, this section analyzes the types of taxes and surcharges imposed on household energy demand and the burden they place on consumers.

3.1. Overview of Energy-Related Taxes

A variety of taxes and surcharges on energy use are already imposed under the current tax system. The total amount collected in fiscal year 2022 includes approximately 2.7 trillion yen from the Renewable Energy Feed in Tariff Surcharge (hereafter referred to as FIT surcharge), followed by about 2 trillion yen from the gasoline tax. However, the FIT surcharge unit price was significantly reduced from 3.45 yen/kWh in fiscal year 2022 to 1.40 yen/kWh in fiscal year 2023, leading to an expected temporary decrease in collection amount to 1.1 trillion yen for that year, a reduction of 60%. This decrease in FIT surcharge price is attributed to the rise in avoidable costs due to Russia's invasion of Ukraine, indicating that electricity prices, including those derived from renewable energy, have risen more than expected. On the other hand, the FIT surcharge rate in 2024 reached a record high of 3.49 yen/kWh. This is attributed to the stabilization of fossil fuel procurement costs, which resulted in a decline in market electricity prices.

Taxpayer coverage varies by fuel type, and there is considerable debate over how much of the energy price can be passed on to the final consumer, but generally, a certain degree of tax burden is shifted to consumers.(6) As a result, the types of taxes and surcharges borne by households include the petroleum and coal tax, gasoline tax, light oil delivery tax, electric power development promotion tax, and renewable FIT surcharge. In the following section, these taxes and surcharges are collectively referred to as "taxes" for simplicity.

Table 2 Energy-Related Taxes and Revenue (in billion yen) for FY 2022

Item	Taxable Object	Taxpayer	Tax Rate	FY 2022 Revenue (billion yen)	Notes
Gasoline Tax	Gasoline	Manufacturers and importers from bonded areas	48,600 yen/kL (Basic tax rate: 24,300 yen/kL)	2,079	General revenue for the national government
Local Gasoline Tax	Gasoline	Manufacturers and importers from bonded areas	5,200 yen/kL (Basic tax rate: 4,400 yen/kL)	223	Entire amount allocated as general revenue for local governments (of which 222.5 billion yen is allocated to local governments)
LPG Tax	Auto LPG	Fillers and importers from bonded areas	17.5 yen/kg	10 (of which 5 billion yen is allocated to local governments)	Half of the tax revenue is allocated as general revenue for local governments
Petroleum and Coal Tax	Crude oil, petroleum products, natural gas, LPG, coal, etc.	Manufacturers, importers from bonded areas, miners	- Crude oil, petroleum products: 2,800 yen/kL (Basic tax rate: 2,040 yen/kL) - Natural gas, LPG: 1,860 yen/t - Coal: 1,370 yen/t	660	Revenue used for ensuring stable fuel supply and advancing energy supply-demand structure (Including 289 yen/t-CO2 for global warming countermeasures tax) (Basic tax rate: 1,080 yen/t) (Basic tax rate: 700 yen/t)
Aviation Fuel Tax	Aviation fuel	Aircraft owners	13,000 yen/kL (Basic tax rate: 26,000 yen/kL)	49	Revenue used for airport development and local airport countermeasures (of which 15.2 billion yen is allocated to local airport countermeasures; 4/13 of tax revenue)
Electric Power Development Promotion Tax	Electricity sold by general power transmission and distribution businesses	General power transmission and distribution businesses	375 yen/1,000 kWh	313	Revenue used for power source location measures, power use measures, and nuclear safety regulation
Light Oil Delivery Tax	Light oil	Persons taking delivery of light oil from special contractors or primary wholesalers (e.g., gas station	32,100 yen/kL (Basic tax rate: 15,000 yen/kL)	931	General revenue for local governments (Partially allocated to designated cities)
Renewable Energy FIT Surcharge	Electricity sold by general power transmission and distribution businesses	Retail electricity suppliers	3.45 yen/kWh (FY 2023: 11,133)	2,744	Used to cover part of the costs for electric companies to purchase renewable energy at a fixed price and period

Source: Compiled from materials from the Ministry of Finance, Ministry of Economy, Trade and Industry, and Ministry of the Environment.

3.2. Regional Tax Burden Estimation

Various taxes are imposed at different stages until energy is supplied to the final consumer, but what is the actual burden for final energy demand? To grasp the actual burden on households, it is necessary to understand the input fuels. For example, the petroleum and coal tax is imposed at the stage when crude oil and liquefied natural gas, which are raw materials for energy products, are imported or produced. These fuels are then converted to electricity in the power generation process and supplied to the final consumer through transmission lines if they are electric. Some of these fuels are also converted to city gas in the city gas manufacturing process and supplied through pipelines. With regard to crude oil, it is input into atmospheric distillation units and then converted to various petroleum products. Therefore, to accurately assess the actual amount of the petroleum and coal tax paid by households, it is essential to understand the quantity of fuel input in the energy conversion process. Addressing this aspect of the petroleum and coal tax, the per capita fuel input should be estimated. In this analysis, the final energy demand in "Region a" is used, along with supply losses (including power generation loss, in-house loss, transmission loss, gas product manufacturing loss, and petroleum product manufacturing loss), to estimate the per capita fuel inputs. For power generation, the input fuel amount (I_{ELa}) is calculated using formula (1). The gas product refining input fuel amount (I_{GSa}) is calculated using formula (2), and the petroleum product refining input fuel amount (I_{PPa}) is calculated using formula (3).

$$I_{ELa} = \sum_i^n \left(D_{ELa} S_{ELai} \Big/ \frac{TE_i \, TE_{EP}}{TE_{GP}} \right) \quad \cdots\cdots\cdots(1)$$

$$I_{GSa} = D_{GSa} \, RE_{GS} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(2)$$

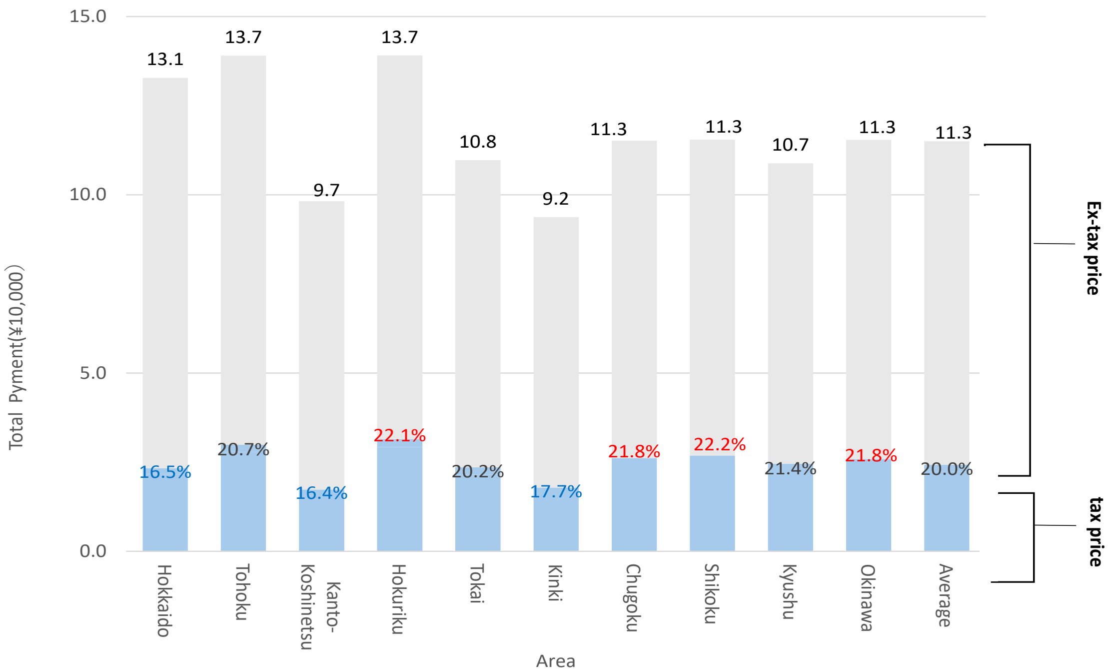
$$I_{PPa} = D_{PPa} \, RE_{PP} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(3)$$

Per capita energy demand in "Region a" is set as per capita power demand (D_{ELa}), per capita gas product demand (D_{GSa}), and per capita petroleum product demand (D_{PPa}). The proportion of fuel input "i" in the power source composition (S_{ELai}), the power generation efficiency of fuel "i" (TE_i), the overall power generation terminal efficiency (TE_{EP}), the overall receiving terminal efficiency (TE_{GP}), the gas product refining efficiency (RE_{GS}), and the petroleum product refining efficiency (RE_{PP}) are defined. The overall power generation terminal efficiency, overall receiving terminal efficiency, and refining loss rate are referenced from the Comprehensive Energy Statistics.(7) The power generation efficiency of various fuels is sourced from the Comprehensive Resource Energy Study Group Power Generation Cost Verification Working Group 2021 material.(8)

On the other hand, gasoline tax, light oil delivery tax, power source development promotion tax, and renewable FIT surcharge are calculated based on the sales volume to final demand, so the payment amount is estimated by multiplying the final energy demand amount by the tax rate/surcharge unit price. Additionally, tariffs at the fuel import stage and consumption tax at the final consumption stage are imposed, forming components of the overall tax burden on energy use.

Further, consumption tax is also imposed on the petroleum and coal tax and gasoline tax (so-called "Tax on Tax"). However, tariffs and consumption tax, which are not specifically taxed on energy demand and are commonly imposed on other consumer goods, are excluded from this analysis.

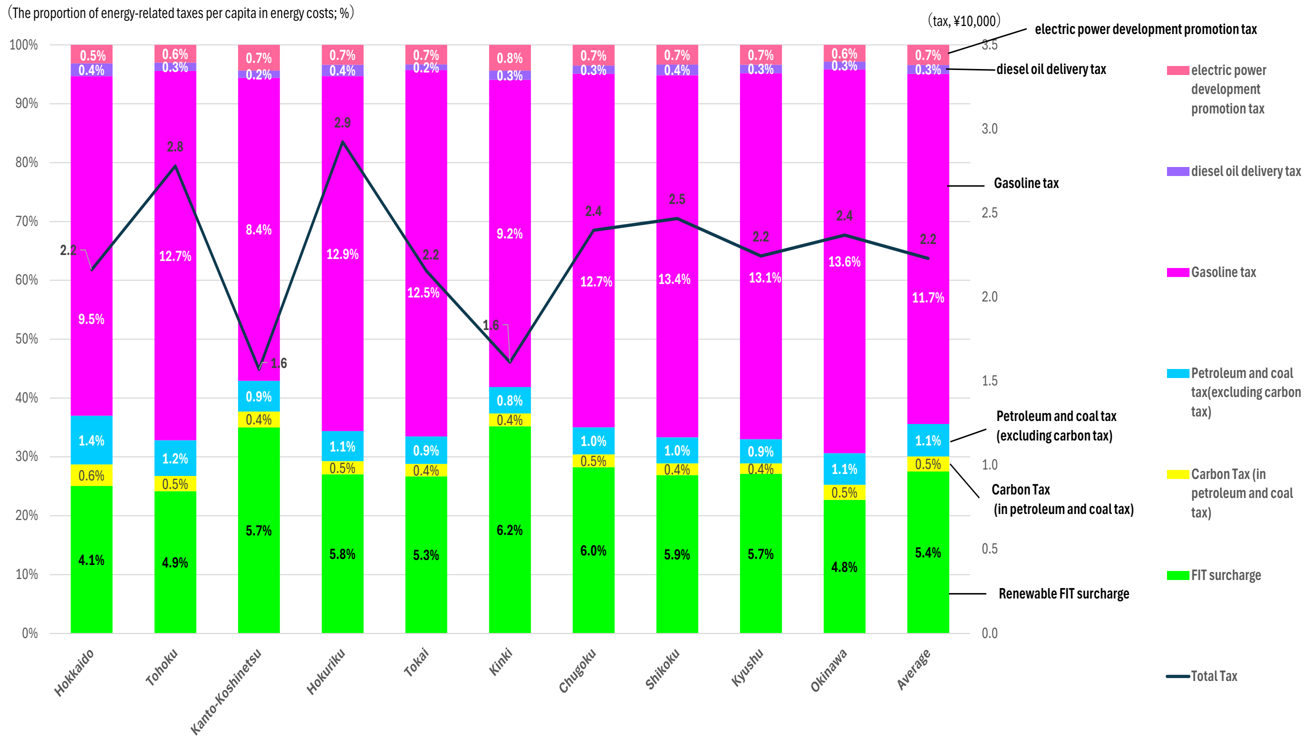
According to Figure 4, the region with the highest proportion of energy taxes in per capita utility costs in the residential sector is Shikoku, followed by Hokuriku, Okinawa, and Chugoku. On the other hand, Kanto-Koshinetsu, Hokkaido, and Kinki have the lowest proportions.



Source: Estimated from the Ministry of the Environment's Household CO_2 Statistics, Comprehensive Energy Statistics, and electricity business data, etc.

Figure 4: Per Capita Utility Costs and Tax Proportion in the Residential Sector (Annual, 2020)

Figure 5 shows a detailed breakdown of taxes and the per capita tax payment amount. Looking at the tax payment amounts, Hokuriku and Tohoku significantly exceed other regions, while Kanto-Koshinetsu and Kinki are at the lowest level. Hokkaido, one of the regions with the largest per capita energy consumption, has a relatively low tax payment amount, as the tax burden on kerosene is lower compared to the gasoline tax and FIT surcharge. In Okinawa, Kyushu, Shikoku, and Chugoku, despite the average level of per capita energy consumption (Figure 1), the tax amounts are higher than the average. This is due to regional characteristics where the proportion of gasoline demand, which is subject to a higher gasoline tax rate, is larger.



Source: Estimated from the Ministry of the Environment's Household CO_2 Statistics, Comprehensive Energy Statistics, and industry data.

Figure 5: Proportion of Taxes and Surcharges on Household Energy Demand (Annual, 2020)

4. Overview of Energy Tax Burden Regional Differences

In this analysis, the regional characteristics of energy demand and utility costs in Japan's residential sector, and the per capita amounts of energy-related taxes based on estimates of primary input fuels were clarified by using the "Household CO_2 Statistics." In addition, this analysis revealed that energy consumption patterns vary due to regional climate, population characteristics, and infrastructure conditions, and consequently, tax burdens also differ. Particularly, the analysis of the burden of utility costs on households indicated that households in rural areas or those with lower incomes tend to bear a heavier burden of utility costs, observing a 'regressivity' in utility costs. Therefore, it is suggested that the design of a carbon pricing system should take into consideration the specific regional characteristics of household energy demand.

Additionally, in light of the ongoing domestic discussions regarding the introduction of carbon pricing, the focus should shift to international examples. Specifically, examining the discussions surrounding the introduction of carbon pricing, identifying the major barriers, and analyzing consumer reactions can provide valuable insights and strategies for Japan to implement carbon pricing smoothly. Particularly, understanding the impact of rising energy prices on households and the social reactions to new tax burdens are crucial perspectives to consider in the design of Japan's carbon pricing policy.

5. Debate about the introduction of a carbon tax in major countries

In the United States, there have been several attempts to introduce energy taxes. However, as the impact of rising energy prices places a significant burden on households, especially in a car-dominated society, there has been historically strong opposition to increases in gasoline taxes and the introduction of a carbon tax. For example, in 1993, under the Democratic administration, the BTU tax (an energy tax) was nearly implemented. However, due to the strong regressive nature of the energy tax, public backlash, and industry lobbying, it was ultimately not introduced.(9) Reflecting this reality, the United States has refrained from implementing federal-level tax increases on energy. Consequently, gasoline prices and tax rates in the U.S. remain some of the lowest among major developed countries.(10) On the other hand, it is common in the United States for states to introduce individual policies. For example, a referendum was held in Washington State in 2016 that paired a reduction in sales tax with an introduction of a carbon tax. However, this referendum was defeated by a majority of 'no' votes. Furthermore, along with the midterm elections in November 2018, a revised proposal for a referendum that would allocate tax revenues to green subsidies was held, but it was again defeated by a majority of 'no' votes.(11)(12) Washington State is one of the most politically liberal states in the United States, with a Democratic governor and a legislature dominated by Democrats. Furthermore, many residents understand the necessity of addressing climate change. However, even in such a favorable context, the failure to introduce a carbon tax underscores the significant emotional and political challenges associated with implementing a carbon tax in the United States.

In addition to the case of the United States, the experiences from European countries are also instructive. For example, in the United Kingdom, the Conservative Party, which was the ruling party in 1993, announced that it would impose a standard VAT rate (8% at the time) on gas and electricity for households, which had previously been zero-rated, in order to secure revenue. However, the public backlash was stronger than anticipated, leading to intense debates. Ultimately, the government addressed the issue by coupling the tax increase with enhanced energy-saving subsidies for low-income households. This experience influenced subsequent policy discussions on the Climate Change Levy, resulting in the exclusion of the household sector from the tax base. The UK's Climate Change Levy was initially designed to target the industrial sector, but strong opposition from industry led to a compromise involving a lower-than-planned tax rate and significant relief measures (as of 2023, reductions of 80-90% are available under certain conditions).(13)

In France, the "Yellow Vest Movement" emerged in November 2018 as a reaction to the proposed increase in the carbon tax, leading to multiple large-scale demonstrations in Paris. This protest garnered widespread support across France. Consequently, the Macron administration decided to freeze the planned carbon tax increase.(14) Notably, the "Yellow Vest Movement" became the longest-lasting protest in France since World War II.(15)

Examining the cases of major countries, it becomes evident that energy, like food and water, is a vital lifeline for both everyday life and industry, leading to significant opposition to new financial burdens. The impact of rising energy prices on households, particularly the disproportionate effects on lower-income groups—known as the issue of "regressivity"—makes taxation on energy a difficult policy to garner social support for. This opposition has sometimes resulted in political instability. Therefore, when implementing policies that would increase energy prices, it is crucial to thoroughly explain the necessity, benefits, and impacts of such policies to the public. Moreover, it is essential to consider measures that ensure fairness and to actively work towards gaining public understanding and support.

6. Conclusion and Policy Implications

This analysis aimed to provide fundamental information for a consideration of the introduction of carbon pricing, a new policy initiative. Using the "Household CO_2 Statistics," the focus was on analyzing the regional characteristics of household energy demand and various energy-related taxes. Significant regional differences in household energy demand, utility costs, and tax burdens were revealed. These differences, influenced by local climate, demographic characteristics, and infrastructure development, suggest that a uniform application of carbon pricing policies is challenging. The burden of utility costs is particularly heavy on low-income households and rural areas, highlighting the regressive nature of such policies.

Furthermore, international case studies indicate that policies leading to increased energy prices carry risks of political turmoil and social resistance. The ongoing energy crisis has prompted the implementation of subsidy policies, akin to "reverse carbon pricing," in Japan and European countries to mitigate the impact on households. This situation underscores the need for cautious approaches to rising energy prices, even in regions actively pursuing climate change mitigation.

In the United Kingdom, Prime Minister Rishi Sunak acknowledged in a September 2023 speech(16) that the costs associated with the net-zero policy have been unnecessarily high and that there has been insufficient communication with the public regarding these costs. He emphasized that a future approach should prioritize realistic measures, cost transparency, and public consent.

In Japan, it is essential to conduct thorough examinations and provide careful explanations for any powerful policies that might increase energy costs or alter the way of life. Given these challenges, policymakers must first deeply understand the characteristics of household energy demand

and the burdens faced by the public. Second, policymakers should ensure thorough and transparent communication about the necessity, benefits, and impacts of policies that would increase energy prices. Finally, they should consider and implement measures that address the fairness of such policies, particularly for vulnerable populations. This approach not only mitigates the regressive impact but also helps secure broader social acceptance and political stability when introducing carbon pricing.

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Steps Toward Creation of a Carbon Market in India

Yi-chun Chen*, Miki Yanagi**

1. Overview of climate change policy

Prime Minister Modi declared that India aims to achieve net-zero emissions by 2070 at the United Nations Framework Convention on Climate Change (UNFCCC) COP26 (Conference of the Parties 26) meeting in 2021[1]. India's latest Nationally Determined Contributions (NDCs) strengthened ambitions compared with the NDCs submitted in 2015, reduction of greenhouse gas (GHG) emission intensity per unit of gross domestic product (GDP) by 45% compared to the 2005 level and realization of 50% of power generation capacity from non-fossil fuel power by 2030[2]. While India previously focused on promoting energy savings and expansion of renewable energy as core policy drivers, currently it has added the national hydrogen plan and other initiatives as new efforts too.

The Indian government realizes the importance of creating a market mechanism needed to reduce GHG emissions and developing a domestic carbon market in pursuit of the attainment of NDCs and other goals. Furthermore, it discusses the necessity of basing the creation of a carbon market on knowledge related to certificate trading for the PAT (Perform, Achieve and Trade) program, an existing economic method that promotes energy savings, and the RPO (Renewable Purchase Obligation) program[3].

2. Design of Emission Trading System (ETS)

2.1. Overview of the program

2.1.1. Policy direction related to the carbon market

According to the Indian Press Information Bureau, Minister of Power Singh mentioned the creation of a national carbon market framework aimed at promoting energy savings by companies and reducing CO_2 emissions in October 2021[4]. At the same time, the Ministry of Power's Bureau of Energy Efficiency (BEE) announced the "National Carbon Market: Draft Blue Print for Stakeholder Consultation," proposing a three-phase plan for transition from the PAT program to an ETS program[5] (refer to 2.1.3 for details). India started legal preparation for creation of a national carbon market at the end of 2022 (Table 1).

The Indian government revised The Energy Conservation Act (The Energy Conservation (Amendment) Act, 2022)[6], the foundational law for establishment of the carbon market, and issued a Notification of the Ministry of Power related to a Carbon Credit Trading Scheme (CCTS 2023; hereinafter, carbon market program) in June 2023[7] (refer to 2.1.4 for details). These actions offer an outline of the program, while program interpretation and details are likely to come in future disclosure of related rules and other measures. The legal preparation did not specifically discuss the method of transition from the above-mentioned PAT program to ETS or formation of a voluntary carbon market (VCM).

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1 Ministry of External Affairs (2021) National Statement by Prime Minister Shri Narendra Modi at COP26 Summit in Glasgow (November 2, 2021)
2 Press Information Bureau (2022b) Cabinet approves India's Updated Nationally Determined Contribution to be communicated to the United Nations Framework Convention on Climate Change (August 3, 2022). Additionally, India advocated a goal of "reducing GHG emission intensity per unit of GDP by 33-35% of the 2005 level by 2030" in the 2015 NDC.
3 BEE (Bureau of Energy Efficiency・Ministry of Power) (2021) National Carbon Market (Draft Blue Print for Stakeholder Consultation)
4 Press Information Bureau (2021) Power Minister calls for enhanced action on energy efficiency by States (October 22, 2021)
5 BEE (Bureau of Energy Efficiency, Ministry of Power) (2021)
6 Ministry of Law and Justice (2022) The Energy Conservation Act, 2001 (52 of 2001); Press Information Bureau (2022c) Creation of Carbon Markets (December 15, 2022)
7 Ministry of Power (2023) Gazette notification for Indian Carbon Market (June 28, 2023)

Table 1: Main policy trends related to the creation of the Indian carbon market

Oct. 2021	Ministry of Power's BEE announced "National Carbon Market: Draft Blue Print for Stakeholder Consultation"
Aug. 2022	Indian Parliament's Lower House (Lok Sabha) passed the revised Energy Conservation Act
Oct. 2022	Government conducted stakeholder consultation on the draft policy paper on Indian Carbon Market (ICM)
Dec. 2022	Indian Parliament's Upper House (Rajya Sabha) approved the revised Energy Conservation Act, the foundational law for establishment of the carbon market
Jun. 2023	Government announced an overview of the method for setting the target for GHG emission intensity in a Ministry of Power Notification
Nov. 2023	BEE announced a draft of "Detailed Procedure for Compliance Mechanism under CCTS"

Source: Compiled by the authors

2.1.2. Experience of market and certificate mechanisms: Trading schemes for energy saving certificates and renewable energy certificates

As explained above, India has two existing certificate trading systems aimed at promoting energy savings and deployment of renewable energies, and these programs have the potential to serve as the foundation of a carbon market. One is Energy Saving Certificates (ESCerts) under the PAT program that promotes energy savings, and the other is issuance and trading of Renewable Energy Certificates (RECs) under the RPO program.

In designing the carbon market, there was a discussion[8] of the need to leverage the experience with existing certificate trading and to review fungibility between the carbon market and the two certificate trading programs. The following description hence presents an overview of the two programs.

The PAT program is based on the revised Energy Conservation Act (Revised Energy Conservation Act 2010) and aims to curtail energy usage utilizing "energy intensity (toe/t)" and "baseline production volume (t)." It issues notification as an ordinance of the goal of "energy intensity" and "baseline production volume" to individual energy consumers (Designated Consumers, DCs). After completion of each regulatory cycle, reporting and verification of attainment of the energy intensity goals occur using forms stipulated in an ordinance, and the authority issues ESCerts (unit: toe (tonne of oil equivalent)) for the surplus portion to DCs. DCs have an obligation to undergo a verification once every three years by BEE-accredited verifiers as required in MRV (Monitoring, Reporting, Verification). If the energy intensity goal is not met, the specific DC either purchases ESCerts or pays energy costs for non-compliance volume or a penalty. ESCerts are traded on the Indian Energy Exchange (IEX) or Power Exchange India Limited (PXIL)[9].

According to the Indian Press Information Bureau, India is currently implementing the Seventh Cycle (fiscal years 2022–2025), and the regulations apply to 509 DCs with an energy saving effect of roughly 6 Mtoe[10]. This program applies to 13 industries: steel, aluminum, cement, chlor-alkali, fertilizer, oil refineries, petrochemical products, paper/pulp, railway, textiles, thermal-fired power plants, Power Distribution Companies (DISCOMs), and commercial buildings (hotels).

The RPO program, meanwhile, was rolled out to promote high-volume installations of renewable energy. It requires DISCOMs, autoproducers with no less than 1 MW of installed capacity, and electricity consumers with not less than 1 MVA who procure from conventional fossil fuels through open access[11] to acquire a certain percentage of power from renewable energy power. If obligations are not met, these entities must procure RECs (unit: MWh) issued to renewable energy power producers via the markets, i.e. IEX, PXIL, etc. REC trading takes place within the floor

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8 BEE (Bureau of Energy Efficiency, Ministry of Power) (2021)

9 For more details, Yanagi et al. (2013) compiled an overview of the PAT program focused on elimination of energy conservation barriers based on the Ministry of Power Notification (Yanagi, Miki, Fuyuhiko Noda, and Momoko Aoshima (2013) "Outline of the PAT (Perform, Achieve and Trade) scheme introduced in India and its contribution to overcome barrier to energy efficiency activities" Energy System, Economics, and Environment Conference Presentations 29). The Ministry of Law and Justice stores various revisions to The Energy Conservation Act 2001 and related ordinances, etc. (Ministry of Law and Justice (2022))

10 DCs and target sectors differ in each cycle. During the periods, the lowest number of DCs was 106, and the highest number was 621. Over 1,000 businesses are registered.

11 India's power sector reform made it possible for the power consumers who consume 1MW or more to select power suppliers in addition to purchasing power from DISCOMs. "Open access" means "non-discriminatory provision for the use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations." Additionally, "Green Open Access Rules 2022" notified on June 6, 2022 lowered the limit of open access trading of green energy from 1MW to 100kW and thereby enabled smaller consumers to also purchase renewable energy via open access. (Ministry of Law and Justice (2003) The Electricity Act, 2003; Press Information Bureau (2022a) Another Major Reform to promote Renewable Energy through Green Energy Open Access (June 7, 2022); Sharma, Nikhil (2019) Open access. New Delhi: Council on Energy, Environment and Water (CEEW).)

and forbearance prices decided by the Central Electricity Regulatory Commission (CERC)[12]. However, regulated industries are requesting flexibility in response to the recent sharp decline in renewable energy costs[13].

2.1.3. "National Carbon Market: Draft Blue Print for Stakeholder Consultation" – Creation of a voluntary carbon market

The "National Carbon Market: Draft Blue Print for Stakeholder Consultation" disclosed in October 2021 proposed a three-phase process for transition from the existing program to a voluntary carbon market. However, it is unclear to what extent it might affect the full-fledged program design in the future.

This document presents support in realizing the NDC through formation of a Voluntary Carbon Market (VCM) while also solving problems such as surplus issuance of certificates under the PAT program.

① Phase-1 (short term): Increasing demand in the VCM and conversion of ESCerts and RECs to emission reduction units

This phase seeks to expand the VCM to businesses without obligations in addition to DCs, increasing demand for certificates. It enables conversion of ESCerts and RECs to emission reduction units (ERUs; one ERU is equivalent to one metric tonne of CO_2 equivalent) for interchangeability of trading units for voluntary market buyers and sellers.

ERU (Nos) = Conversion factor of specific DC x ESCerts (Nos.)

Notes:
Conversion factor of a specific DCs (tonne of CO_2 equivalent emission per Mtoe)
= Annual CO_2 emissions by DCs in target year ÷ [(SEC[14] target – SEC actual in target year) x Production baseline year]
Annual CO_2 emissions by DCs in target year
=[{Emission factor of fuel 1 (tonne of CO_2 per tonne of fuel) x Quantity of fuel 1 consumed in target year (tonne)}
+ {Emission factor of fuel 2 (tonne of CO_2 per tonne of fuel) x Quantity of fuel 2 used in target year(tonne)}
+ {Emission factor of electricity used (tonne of Co2 per million units) x Quantity of electricity used in target year (million units)} ……
+ {Emission factor of fuel N (tonne of CO_2 per tonne of fuel) x Quantity consumed in target year (tonne)}

② Phase-2 (medium term): Increasing supply in the VCM

This phase aims to increase the supply volume of ERUs being traded by opening the VCM to sellers other than DCs too, and permitting the registration of emission reduction projects and issuing ERUs.

③ Phase-3 (long term): Transition to a Cap-and-Trade System

This phase involves setting GHG emission intensity for specific entities. The "business as usual (BAU)" emissions for the initial target period will be determined using the expected sectoral growth. To ensure alignment with the NDCs, it introduces an NDCs-alignment coefficient (NAC) as an index for reducing GHG emissions compared to BAU. The proposal assigns emission intensity goals to DCs without changing the fundamental structure or mechanism of the PAT program.

Furthermore, the BEE implemented a stakeholder consultation based on the draft policy paper on the Indian Carbon Market (ICM) on October 19, 2022[15].

2.1.4. Legal framework for the Indian carbon market

① The Energy Conservation (Amendment) Act, 2022 (December 2022)

The Energy Conservation (Amendment) Act, 2022 implemented at end-2022 incorporated the carbon market and carbon credit certificate.

This revised Act stipulates the following points: (1) assignment of carbon market design to the central government based on discussions with the BEE (Article 14), (2) enabling the government and authorities with jurisdiction to issue carbon credit certificates to businesses, and (3) enabling

[12] Ministry of New and Renewable Energy (nd) National Portal for Renewable Purchase Obligation (RPO); Singh and Chaturvedi (2023)
[13] Central Electricity Regulatory Commission (2022) Stakeholders commented on draft CERE (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) Regulations, 2022: Ministry of Power
[14] SEC refers to energy consumption intensity under the PAT program.
[15] Singh, Nishtha and Vaibhav Chaturvedi (2023) Understanding Carbon Markets: Prospects for India and Stakeholder Perspectives. New Delhi: Council on Energy, Environment and Water (CEEW)

registered businesses to purchase and sell carbon credit certificates (Article 14AA).

The Act also stipulates registered entities as "any entity, including designated consumers, registered for carbon credit trading scheme…" and that "any other person may also purchase energy saving certificate or carbon credit certificate on voluntary basis" (Article 14A). It hence widens market access by approving new market entrants in addition to the existing DCs under PAT program. Meanwhile, it simply lists "energy saving certificate" and "carbon credit certificate" and does not offer a detailed image of the program (Ministry of Power's Notification announced in June 2023 decided the roles of various organizations in the institutional framework of the carbon market in the following manner (Figure 1).

- The National Steering Committee for the Indian Carbon Market (hereinafter, Steering Committee) is a new organization formed by the central government that extends across ministries and agencies. Secretaries from the Ministry of Power and the Ministry of Environment, Forest and Climate Change (hereinafter, Ministry of Environment) shall serve as chairs. Other members include Joint Secretaries from various ministries and the Grid Controller of India Limited. The functions of the Steering Committee are governance and supervision of the carbon market. This scope covers recommending to BEE[16] for the "formulation and finalisation of procedures for institutionalizing the Indian carbon market," and "of the rules and regulations for the functions of Indian carbon market;" for the "formulation of specific greenhouse gases emission targets for the obligated entities," etc. (Article 4).
- The BEE is the Administrator and shall "identify sectors and potential for reduction of greenhouse gases emissions in such sectors and recommend to the Ministry of Power." Its roles include "developing trajectory and targets for the entities under compliance mechanism," "accrediting the agencies in accordance with the approved procedure for accredited carbon verification agency," and others (Article 5).
- The Central Electricity Regulatory Commission (CERC), which supervised REC trading, shall serve as the regulator that regulates trading activities for carbon credit certificates (Article 7).
- Grid Controller of India Limited is the carbon market registry and has data platform functions (Article 6). In addition to "undertaking registration of obligated or non-obligated entities" (Article 6(b)), it shall also "function as meta-registry," which serves "data management including Market Based Mechanisms and National Inventory Management Systems," and "transaction with features of establishing the linkages with any national or international registry of **any** market-based mechanism" (Article 2(j), 6(g), 6(h)). Section 2.3 below explains "**any** market-based mechanism" (Article 6; meta-registry definition based on Article 2) (emphasis added by the authors).

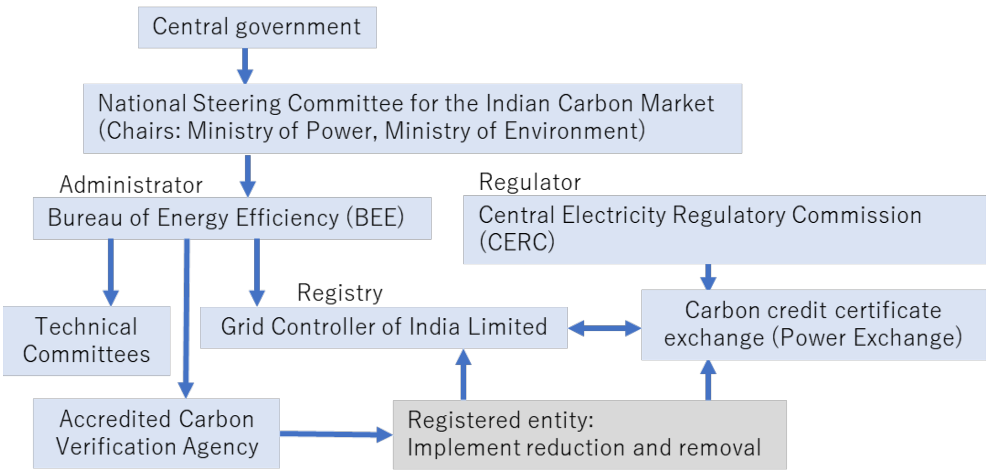

Figure 2: Image of governance for the Indian carbon market

Note: Image depicted by legislation at the current stage

Source: Prepared by the authors based on Ministry of Power (2023)

Preparations in setting goals for GHG emission intensity[17] and launching the system shall proceed in the following manner.

[16] "Bureau" in the original document.

[17] GHGs here refers to seven GHGs, including CO_2 and freon gases.

Setting goals for GHG emission intensity in the carbon market (Article 11):

① The Ministry of Power shall decide the sectors and obligated entities in accordance with the BEE's recommendation (BEE undertakes studies for recommending the targets "after taking into account all relevant aspects including available technologies and likely costs of their implementation"[18]).

② The Ministry of Power shall communicate the targets, which also factor in recommendations by the Steering Committee, to the Ministry of Environment.

③ The Ministry of Environment shall ultimately notify obligated entities and thereby create an obligation to comply with the targets. Furthermore, the Ministry of Power shall place obligations on obligated entities for non-fossil fuel energy consumption and energy intensity targets. The Ministry of Power may revise the Act.

④ Obligated entities shall receive the issuance of carbon credit certificates for exceeding the targets in accordance with the Steering Committee's recommendation[19]. Those who miss the targets shall purchase the carbon credit certificates from the carbon market.

The Act stipulates that further detailed procedures for operationalising the ICM, such as criteria for issuance of carbon credit certificate, validity, floor and forbearance prices, MRV, and other details shall take place in the future after discussions mainly by the Steering Committee (Article 12).

2.2. Allocation method (auction or free allocation)

The system adopts the target of intensity, not a scheme of allocating an emission allowance, which can be seen as affected by PAT and RPO programs. However, attention should be given to the central government and other authorities' power of issuing "carbon credit certificates" to entities.

2.3. Use of offset credits

It is currently unclear. However, it is worth noting that the Ministry of Power Notification arranges an international registry for operation of offset credits (all types of market-based mechanisms)[20] and allows any voluntary registered entities[21].

3. Conclusion: Implications for GX ETS of Japan

India has completed legislation that defines the institutional framework of the carbon market in the above-mentioned two laws following discussions with stakeholders. It widened access to the carbon market to voluntary entities too, in addition to obligated entities, and does not rule out possible use of offset credits. Furthermore, the initiative stands out in terms of considering technologies and setting reduction targets based on PAT program experience (2.1.4).

In November 2023, the Indian government disclosed a draft proposal[22] of the "Detailed Procedure for Compliance Mechanism under CCTS." It also presented a regulatory scope that covers not only direct emissions but also purchased electricity, steam, and other indirect emissions, setting reduction targets by intensity (tCO2e/production materials-t), and the ability to reserve excess carbon certificates to the next cycle (banking). Additionally, it appears to have postponed its stance on REC utilization and proposed placing REC outside of the CCTS reporting obligation[23].

Regarding the discussion of incorporating existing energy savings and renewable energy measures in the voluntary market, the current regulations are as discussed in 2.1.3.

Program details depend on progress in the discussion of the above-mentioned draft proposal from November. India is likely to proceed with preparations toward the creation of a domestic carbon market with explicit carbon pricing that factors in experience from existing programs as a

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[18] Since it conducted a review and analysis of Best Available Technology by sector for the PAT program too, this experience should be useful.

[19] The original text states "The obligated entities shall be issued carbon credit certificates."

[20] This appears to include response to corresponding adjustments (Article 6.2 Avoidance of double counting) in the Paris Agreement.

[21] In February 2023, the Indian government announced a list of 13 technologies (including green hydrogen, green ammonia, and sustainable airline fuel (SAF)) to be considered for the bilateral/cooperative approaches under Article 6.2 mechanism of the Paris Agreement. It anticipates collaboration with international players in rollout of innovative technologies (Press Information Bureau (2023) Activities finalised to be considered for trading of carbon credits under Article 6.2 mechanism to facilitate transfer of emerging technologies and mobilise international finance in India, February 17, 2023).

[22] BEE (Bureau of Energy Efficiency, Ministry of Power) (2023) Detailed Procedure for Compliance Mechanism under CCTS

[23] This document does not elaborate on the above-mentioned conversion and utilization of ESCerts.

response to the EU's carbon border adjustment measures (CBAM)[24] on track to begin CBAM certification charges in 2026.

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