**THE INSTITUTE OF ENERGY ECONOMICS, JAPAN**

# Economic and Energy Outlook of Japan through FY2016

*Japanese economy on its way for recovery with help from oil prices.*
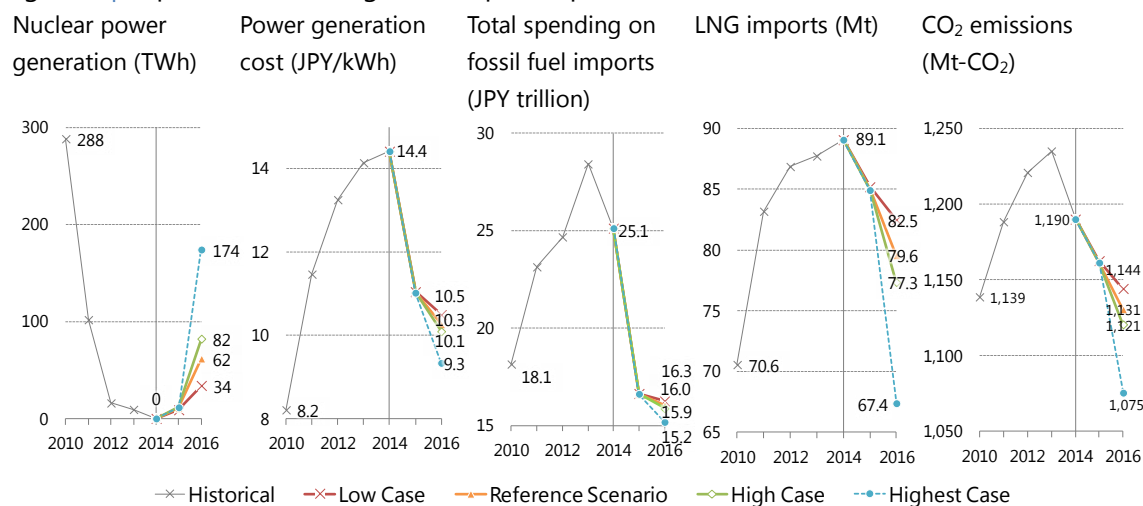*Appropriate domestic energy policy measures are required.*

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## Executive summary

### Nuclear power generation | Restart under new control rules is under way

▌ In November 2015, the #2 unit of the Sendai Nuclear Power Station has restarted its commercial operations. It is the second unit to restart under the new regulation standards, following the #1 unit, which restarted last September. This paper analyses the influences on the 3Es (Economy, Energy Security, and Environment) of four cases of different levels of nuclear power units approval and restart by the end of FY2016.

▌ The [Reference Scenario] assumes the restarts of three more nuclear power units to proceed in FY2015. By the end of FY2016, 12 units will have restarted, on average at the pace of approximately one unit every second month. They will be in service on average for only seven months during FY2016, for a total electricity generation reaching 61.8 TWh, which is 21% of the pre-earthquake FY2010 level. Compared to FY2010, total spending on fossil fuel imports decreases by JPY2.1 trillion because of energy saving and lower fossil fuel prices, while the average power generation cost rises by about JPY2,100/MWh. Relative to the same period, the self-sufficiency rate remains lower by 6.1% point at 11.7%.

▌ In the [High Case], which assumes a total of 18 units to restart by the end of FY2016, total fossil fuel imports spending decreases by JPY0.4 trillion relative to the [Low Case] where only six units are assumed to restart. In this comparison, the average power generation cost is lowered by about JPY400/MWh, the self-sufficiency rate improves by 2.1% point and the energy-related $CO_2$ emissions decrease by 24 Mt-$CO_2$ (2.1%) whilst GDP increases by JPY0.3 trillion (0.05%).

▌ The hypothetical [Highest Case] assumes that 25 units for which applications for conformity tests have been submitted, excluding Oma Power Station which is under construction, do generate electricity with a capacity factor of 80% in FY2016. Under this Case, compared to the [Low Case], total fossil fuel imports spending decreases by JPY1.1 trillion, the average power generation cost is lowered by about JPY1,200/MWh, the self-sufficiency rate is improved by 6.2% point and the energy-related $CO_2$ emissions are decreased by 69 Mt-$CO_2$ (6.0%) with GDP increases by JPY0.8 trillion (0.14%).

▌ The restart of Sendai Nuclear Power Station is only the first step of the reutilisation of nuclear power. There are many issues ahead to be addressed in order to realise a balanced energy mix.

Figure 1 | Impacts of restarting nuclear power plants

| Nuclear power generation (TWh) | Power generation cost (JPY/kWh) | Total spending on fossil fuel imports (JPY trillion) | LNG imports (Mt) | $CO_2$ emissions (Mt-$CO_2$) |
|---|---|---|---|---|



Historical — Low Case — Reference Scenario — High Case — Highest Case

## Lower oil price and its positive impacts | Lower energy burden for households and boosts for business

▌ Lower crude oil price brings benefits for households. During the period of higher crude oil prices, households of colder climate regions spent twice as much on energy as those of warmer climate regions. The discrepancy diminishes to 1.8 times in FY2016. As the future of crude oil prices is uncertain, colder climate regions should remain alert against the risk of higher oil prices.

▌ If the oil and LNG prices become lower by $10/bbl and by $1.4/MBtu, respectively, they will contribute to a positive growth cycle for consumption and investment and Japan's GDP will increase by 0.4% (JPY1.9 trillion). The virtuous influence will reach domestic demand type industries that do not consume much in terms of fossil fuels, such as oil, and will increase the total production value by JPY3.4 trillion and employment by 220,000 persons. On the other hand, all this is vulnerable to a possible hike of oil and LNG prices. In order to prepare for such eventuality, the promotion of an appropriate economic growth strategy, distribution policies and energy policies is needed.

## Executive summary of outlook through FY2016 [Reference Scenario]

## Macro economy | Japanese economy grows by 0.9% and 1.5% due to improvements of domestic demand

▌ Japan sees its economic recovery strengthening towards the latter part of FY2015 with the economy growing on average at 0.9% during the period. Private consumption gradually recovers due to improved employment status and higher wages; private investment improves supported by higher corporate profits induced by lower oil prices; and exports benefit from the yen's depreciation. For FY2016, the economic expansion continues and GDP grows at 1.5% for the period, led by a strong domestic demand.

## Energy supply and demand | In FY2015, energy use decreases to below 470 Mtoe (first time in 25 years) and it will continue to decrease in FY2016

▌ Total primary energy supply in FY2015 decreases due to the slow recovery in domestic production of the manufacturing sector. Because of a continued economic expansion and return of electricity

demand, the decline of energy supply of FY2016 will slow down with the level slightly less than the previous year despite the continuing energy saving. The restart of nuclear power plants will sharply reduce the oil and natural gas consumption for power generation.

▌ In FY2016, final consumption increases in buildings sector by 0.4% due to economic recovery and temperature effect. Industry sector's consumption decreases because of continued energy conservation and reduced production in energy-intensive petrochemical industry. Transport sector consumes less due to improved fuel efficiency and the effect of the previous leap year. The overall consumption will mark six consecutive years of decrease.

## Energy sales | City gas and electricity grow. Fuel oil declines after respite

▌ Electricity sales by utilities decrease slightly in FY2015, because of stumbling production, slow economic recovery, cooler summer and warmer winter. In FY2016, sales for lighting services, mainly to households, increase for the first time since the Great East Japan Earthquake. This is because of a return to normal temperatures and a relaxed consciousness towards electricity savings. Sales for power services, mainly large-scale power users, increase, reflecting better economic conditions.

▌ City gas sales in FY2015 slightly decrease because of a delayed production recovery in the manufacturing sector. In FY2016, sales to industry will increase reflecting the recovery of production activities and fuel switching while all the sales except for electric utilities will also increase. The temperature factor will also push the sales up. The overall sales will renew the highest-level marked five years ago.

▌ Despite lower oil prices and the additional effect of a leap year, total fuel oil sales show an overall decrease in FY2015, primarily in response to a huge decline in the use of Type C fuel oil for power generation. In FY2016, sales for Type A and Type C fuel oil products will decrease because of fuel switching and the use of naphtha will decrease because of a reduced ethylene production. Consequently, this leads to overall sales to be less than 180 GL, the lowest level in 47 years.

## Renewable power generation | Operational capacities will reach 60 GW. The cumulative cost burden could be JPY55 trillion

▌ The rapid expansion for renewable power generating capacity of the last few years, supported by a generous Feed-in Tariff (FIT) system, is slowly subsiding due to the cancellation of approval for contracts/permits without secured land and/or facilities, setup grid connection-ready capacities or strengthened power control. Despite such situation, the operating capacity by the end of FY2016 will reach 60 GW.

▌ Coincidently, the unavoidable burden expands also. The cumulative cost burden for 20 years could be JPY55 trillion if all of the approved 87.7 GW (of which 82.1 GW is solar PVs) by the end of July 2015 become operational. This is equivalent to an increase of JPY3,200/MWh above the rates in place just before FIT started – an increase of 14% for household and 19% for industrial consumers.

## $CO_2$ emissions | Reduce for three consecutive years, FY2016 lower than FY2010 level

▌ Energy-related $CO_2$ emissions reached a historical high of 1,235 Mt-$CO_2$ in FY2013 but will decrease for three consecutive years through FY2016. The restart of nuclear power plants combined with the increase in renewable energy and energy conservation will considerably diminish oil and natural gas

consumption, lowering the emission amount down to 1,131 Mt-$CO_2$ in FY2016. $CO_2$ emissions will be 8.5% less than in FY2013 and 0.7% less than before the earthquake (FY2010).

Table 1 | Summary of Reference Scenario

| | | Historical | | | | Projections | | Year-to-year changes | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Eenrgy | Primary energy supply (Mtoe)[1] | 513.3 | 483.6 | 488.5 | 473.1 | 469.0 | 468.6 | -3.2% | -0.9% | -0.1% |
| | Oil[2] (GL) | 232.3 | 242.8 | 234.5 | 217.6 | 212.2 | 203.6 | -7.2% | -2.5% | -4.0% |
| | Natural gas[2] (Mt of LNG equiv.) | 73.3 | 88.6 | 90.1 | 90.5 | 86.7 | 81.8 | 0.4% | -4.1% | -5.7% |
| | LNG imports (Mt) | 70.6 | 86.9 | 87.7 | 89.1 | 85.0 | 79.6 | 1.5% | -4.5% | -6.4% |
| | Coal[2] (Mt) | 184.7 | 183.4 | 194.6 | 190.0 | 189.6 | 190.2 | -2.4% | -0.2% | 0.3% |
| | Nuclear (TWh) | 288.2 | 15.9 | 9.3 | 0.0 | 10.6 | 61.8 | -100% | .. | 484% |
| | Renewables excl. large hydro (TWh) | 22.8 | 67.9 | 76.0 | 87.6 | 102.8 | 115.7 | 15.2% | 17.3% | 12.6% |
| | Final energy consumption (Mtoe) | 339.4 | 321.7 | 321.3 | 312.7 | 311.6 | 309.0 | -2.7% | -0.4% | -0.8% |
| | Industry[3] | 158.3 | 148.4 | 151.0 | 147.3 | 146.6 | 145.0 | -2.4% | -0.5% | -1.1% |
| | Buildings | 98.0 | 92.9 | 90.9 | 88.2 | 87.6 | 87.9 | -2.9% | -0.8% | 0.4% |
| | Transport | 83.1 | 80.4 | 79.5 | 77.1 | 77.4 | 75.9 | -3.0% | 0.3% | -1.9% |
| | Petroleum products | 176.2 | 165.5 | 163.9 | 157.9 | 157.4 | 153.3 | -3.7% | -0.3% | -2.6% |
| | Natural gas and city gas | 34.3 | 34.9 | 34.4 | 34.3 | 34.1 | 34.6 | -0.3% | -0.5% | 1.4% |
| | Coal and coal products | 35.9 | 34.3 | 35.5 | 34.9 | 34.7 | 34.8 | -1.6% | -0.8% | 0.5% |
| | Electricity | 89.8 | 84.6 | 84.5 | 82.7 | 82.5 | 83.3 | -2.1% | -0.3% | 1.0% |
| | Electricity sales (TWh) | 926.6 | 870.9 | 871.5 | 851.4 | 849.3 | 857.9 | -2.3% | -0.2% | 1.0% |
| | City gas sales[4] (Billion m³) | 39.28 | 40.33 | 39.82 | 40.16 | 40.01 | 40.53 | 0.9% | -0.4% | 1.3% |
| | Fuel oil sales (GL) | 196.0 | 197.8 | 193.6 | 183.0 | 180.9 | 175.1 | -5.5% | -1.1% | -3.2% |
| | Energy-related $CO_2$ emissions (Mt) | 1,139 | 1,221 | 1,235 | 1,190 | 1,162 | 1,131 | -3.6% | -2.4% | -2.7% |
| | (FY2013=100) | 92.2 | 98.9 | 100.0 | 96.4 | 94.1 | 91.5 | .. | .. | .. |
| Prices | Crude oil, import, CIF ($/bbl) | 84 | 114 | 110 | 89 | 52 | 53 | -19.0% | -41.4% | 0.9% |
| | LNG, import, CIF ($/t) | 584 | 866 | 837 | 800 | 433 | 382 | -4.5% | -45.8% | -11.7% |
| | ($/MBtu) | 11.3 | 16.7 | 16.1 | 15.3 | 8.3 | 7.3 | -4.5% | -45.8% | -11.7% |
| | Steam coal, import, CIF ($/t) | 114 | 127 | 108 | 93 | 76 | 76 | -14.2% | -17.7% | 0.3% |
| | Coking coal, import, CIF ($/t) | 175 | 173 | 135 | 109 | 89 | 88 | -19.6% | -18.0% | -1.0% |
| Economy | Nominal GDP (JPY trillion) | 480.5 | 474.4 | 482.4 | 489.6 | 501.0 | 511.3 | 1.5% | 2.3% | 2.1% |
| | Real GDP (JPY2005 trillion) | 512.7 | 519.5 | 529.8 | 524.7 | 529.3 | 537.1 | -1.0% | 0.9% | 1.5% |
| | Industrial production (2010=100) | 99.4 | 95.8 | 99.0 | 98.5 | 98.3 | 99.8 | -0.5% | -0.2% | 1.5% |
| | Exchange rate (JPY/$) | 86.1 | 82.6 | 100.0 | 109.2 | 122.1 | 124.8 | 9.3% | 11.8% | 2.2% |

Notes:

1. Mtoe = $10^{13}$ kcal

2. Conversion factors for Oil: 9,126 kcal/L; Natural gas: 13,043 kcal/kg; Steam coal: 6,139 kcal/kg; Coking coal: 6,928 kcal/kg until FY2012.
   Conversion factors for Oil: 9,145 kcal/L; Natural gas: 13,141 kcal/kg; Steam coal: 6,203 kcal/kg; Coking coal: 6,877 kcal/kg since FY2013.

3. Industry includes non-energy use.

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

# Introduction

The Japanese economy has begun to indicate signs of recovery against the backdrop of continued weakness of oil prices and the yen, and government fiscal, monetary and tax cut policies. In 3Q2015, the Japanese economy posted an annualised growth rate of 1.0%, the first positive growth in two quarters. As for private consumption, wage hikes and employment improvements through the shrinking supply-demand gap in the labour market are expected to make consumers less thrifty. Non-residential investment is improving, supported by robust corporate earnings. Exports are also recovering moderately.

Regarding the international energy situation, the Brent crude price sank to $37.92 per barrel briefly in December 2015, the lowest since December 2008, just after the Lehman Shock. The liquefied natural gas price for Northeast Asia fell to $6.45 per million British thermal units. Oil and LNG prices are likely to remain weak. In Japan, Kyushu Electric Power Co. restarted commercial operations for the No. 1 unit of the Sendai Nuclear Power Station in September and for the No. 2 unit in November.

The energy situation and the government's economic policies are working to benefit the Japanese economy. If oil prices rise back under the weak yen, however, it may bring about heavy damage to the Japanese economy. The government has just begun to review its renewable energy promotion policy contributing to raising electricity costs.

Based on the abovementioned perception of the present situation, we have projected the Japanese economy and energy supply and demand through FY2016 and analysed various implications of the projection.

# Major assumptions in the Reference Scenario

### World economy

We assume that the world economy will shift from deceleration to recovery. The U.S. economy, though undergoing the impact of monetary policy normalisation after the ultra-easy policy, will be supported by private consumption growth accompanying oil price falls and growing employment. The European economy will recover moderately thanks to weak oil prices, the euro's depreciation and low interest rates. Though its growth is decelerating now, the Asian economy will avoid any substantial deceleration and keep on growing at an annual rate of 5% or more. The world economy as a whole will grow by 2.8% in FY2015 and by 3.0% in FY2016.

### Oil, LNG and coal import CIF prices

The Organization of the Petroleum Exporting Countries again left its crude oil production quotas unchanged at its general meeting in December. We assume Japan's oil import price at $52/bbl in FY2015 and $53/bbl in FY2016 as the supply-demand balance is likely to remain loose. The LNG price is assumed at $8.3/MBtu in FY2015 and $7.3/MBtu in FY2016. The coal supply-demand balance is likely to tighten somewhat. The steam coal price is assumed at $76 per tonne both in FY2015 and FY2016. The coking coal price is assumed at $89/t in FY2015 and at $88/t in FY2016.

### Exchange rate

We have assumed the average yen/dollar exchange rate at JPY122/$ for FY2015 and JPY124.8/$ for FY2016.

### Tax

We assume that the VAT will be raised to 10% in April 2017. The petroleum and coal tax is assumed to increase in April 2016. The tax is assumed to rise by 10% to JPY2,800/kL for crude oil and petroleum products, by 16% to JPY1,860/t for gaseous hydrocarbon and by 20% to JPY1,370/t for coal.

## Nuclear power generation

Given the progress in the assessment of nuclear power plants' conformity with new regulatory standards, we assume that, following two plants at the Sendai Nuclear Power Station, others will restart one after another. The number of nuclear power plants restarted in FY2015 will reach five, with the average operation period coming to three months for a total of 10.6 terawatt-hours of electricity generated. By the end of FY2016, a total of 12 plants will have been restarted. The average operation period in the year will come to seven months, with electricity generated at 61.8 TWh.

## Electricity supply and demand

Based on discussions at the government's Electricity Supply-Demand Verification Subcommittee, we assume that each electric utility will secure a reserve capacity rate of at least 3% in its service area.

## Temperature

Based on the three-month weather forecast by the Japan Meteorological Agency, we assume a warmer winter (+0.3°C) in FY2015 than in the previous year, lowering space-heating demand. Normal weather is assumed for FY2016, including a warmer summer (+0.4°C) and a colder winter (-0.5°C) than in the previous year.

# Macro economy

**The Japanese economy in FY2015 will grow by 0.9%, the first positive growth in two years. Nominal GDP will exceed JPY500 trillion for the first time in eight years.**

Among private demand components, private consumption will increase due mainly to a drop in the unemployment rate. Non-residential investment will also expand in line with improvements in corporate earnings. Overall private demand will contribute to boost GDP by 0.7%. Among public demand components, public investment will continue falling. But government expenditure will expand. Overall public demand will contribute to expand GDP by 0.2%. Exports' expansion will decelerate. Imports will increase despite a drop in fossil fuel imports, as other imports increase. External demand will contribute to increase GDP by 0.0%. Fossil fuel imports will decline to JPY16.6 trillion, with the trade deficit shrinking substantially from JPY9.1 trillion in the previous year to JPY1.5 trillion. The income balance will improve, leading the current account to have a surplus of JPY17.3 trillion, the largest since the Great East Japan Earthquake. The consumer price rise will slow down to 0.1%.

**The economy will grow by 1.5% in FY2016, led by private demand including consumption and non-residential investment, as well as an extra demand increase before the next VAT hike.**

Among private demand components, private consumption will increase as a further fall in the unemployment rate and wage hikes are coupled with an extra demand rise before the next VAT hike set for April 2017. Non-residential investment will substantially expand as manufacturing industries grow bullish in addition to non-manufacturing industries. Residential investment, though falling short of restoring the level just before the latest VAT increase, will expand. Overall private demand will contribute to boost GDP by 1.3%. Among public demand components, government expenditure, including social security spending, will increase, while public investment will decline further. Overall public demand will contribute to expand GDP by 0.2%. Exports will rise in line with the yen's continued weakness and the brisk U.S. economy. Although fossil fuel imports will decrease due to the restart of nuclear power plants, overall imports will expand thanks to a rise in other imports amid a domestic demand increase. External demand will thus contribute to reduce GDP by 0.0%. The trade deficit will slightly increase to JPY1.8 trillion. The current account surplus will expand to JPY17.6 trillion, with the expansion decelerating. Consumer prices will rise by 0.9% on a shrink in the GDP gap. Nominal GDP will exceed JPY510 trillion.

Table 2 | Macroeconomic indicators

| | Historical | | | | Projections | | Year-to-year changes | | |
|---|---|---|---|---|---|---|---|---|---|
| | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Real GDP (JPY2005 trillion) | 512.7 | 519.5 | 529.8 | 524.7 | 529.3 | 537.1 | -1.0% | 0.9% | 1.5% |
| Private demand | 377.1 | 390.4 | 399.1 | 391.2 | 394.0 | 400.2 | -2.0% | 0.7% | 1.6% |
| Private consumption | 299.7 | 309.2 | 316.2 | 307.1 | 308.1 | 312.7 | -2.9% | 0.3% | 1.5% |
| Private residential investment | 12.5 | 13.7 | 14.9 | 13.1 | 13.6 | 14.1 | -11.7% | 3.4% | 3.9% |
| Private non-residential investment | 64.9 | 68.6 | 70.7 | 70.7 | 71.8 | 74.2 | 0.1% | 1.5% | 3.4% |
| Public demand | 118.5 | 120.8 | 124.5 | 124.1 | 125.0 | 125.6 | -0.3% | 0.7% | 0.5% |
| Government consumption | 97.9 | 100.6 | 102.2 | 102.3 | 103.3 | 104.4 | 0.1% | 1.0% | 1.0% |
| Public investment | 20.7 | 20.3 | 22.4 | 21.8 | 21.6 | 21.2 | -2.6% | -0.6% | -1.9% |
| Net exports of goods and services | 17.2 | 8.6 | 7.3 | 11.3 | 11.7 | 12.3 | 55.9% | 3.1% | 5.4% |
| Exports of goods and services | 83.9 | 81.4 | 85.0 | 91.7 | 92.7 | 96.8 | 7.8% | 1.1% | 4.3% |
| Imports of goods and services | 66.8 | 72.9 | 77.7 | 80.3 | 81.0 | 84.4 | 3.3% | 0.9% | 4.2% |
| Nominal GDP (JPY trillion) | 480.5 | 474.4 | 482.4 | 489.6 | 501.0 | 511.3 | 1.5% | 2.3% | 2.1% |
| Balance of trade (JPY trillion) | 5.3 | -8.2 | -13.8 | -9.1 | -1.5 | -1.8 | -33.5% | -83.8% | 19.3% |
| Exports | 67.8 | 63.9 | 70.9 | 74.7 | 76.7 | 79.8 | 5.4% | 2.7% | 4.0% |
| Imports | 62.5 | 72.1 | 84.6 | 83.8 | 78.1 | 81.5 | -0.9% | -6.8% | 4.3% |
| Fossil fuels | 18.1 | 24.7 | 28.4 | 25.1 | 16.6 | 16.0 | -11.6% | -33.8% | -3.5% |
| Oil | 12.3 | 16.2 | 18.7 | 15.2 | 10.2 | 10.2 | -18.4% | -32.9% | 0.4% |
| LNG | 3.5 | 6.2 | 7.3 | 7.8 | 4.5 | 3.8 | 5.9% | -42.7% | -14.4% |
| Current account (JPY trillion) | 18.3 | 4.2 | 1.5 | 7.9 | 17.3 | 17.6 | 439% | 118% | 1.7% |
| Domestic corporate goods price index (2010=100) | 100.2 | 100.5 | 102.4 | 105.3 | 102.1 | 102.5 | 2.8% | -3.0% | 0.4% |
| Consumer price index (2010=100) | 99.9 | 99.5 | 100.4 | 103.4 | 103.5 | 104.4 | 2.9% | 0.1% | 0.9% |
| GDP deflator (2005=100) | 93.7 | 91.3 | 91.1 | 93.3 | 94.6 | 95.2 | 2.5% | 1.4% | 0.6% |

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

# Industrial production

## Crude steel production will be limited to 105 Mt in FY2015 and to 106 Mt in FY2016 due to global oversupply.

In FY2015, crude steel production will decline by 4.1% from the previous year to 105 million tonnes, the lowest since FY2009 after the Lehman Shock, due to prolonged inventory adjustment and China's massive exports to the Asian market. In FY2016, domestic demand, including steel for automobiles and housing, will recover. But exports, accounting for 40% of crude steel production, will be affected by China's continued oversupply. Crude steel production will thus be limited to 106 Mt, up 0.8% from the previous year.

## Ethylene production will be brisk in FY2015, totalling 6.76 Mt. In FY2016, ethylene production will fall to 6.38 Mt, even with ethylene plants operating at full capacity.

In FY2015, ethylene production will increase by 1.0% from the previous year to 6.76 Mt as exports expand on the weakness of the yen and oil prices, with routine plant checks reduced despite a production capacity cut. In early FY2016, one plant will be shut down to lower production capacity. Although ethylene plants will continue to operate at full capacity, production in the year will fall by 5.6% to 6.38 Mt.

## Cement production will slip below 60 Mt in FY2015 and will be limited to 60.6 Mt in FY2016 despite an extra demand rise before the VAT hike.

In FY2015, cement production will fall by 2.3% from the previous year to 59.7 Mt due to slack production in the first half before a moderate year-on-year increase in the second half. In FY2016, cement production will be limited to 60.6 Mt (up 1.5%) as public investment is cut for the second straight year, despite a domestic demand expansion including non-residential

and residential investment recovery and an extra demand rise before the VAT hike.

## Paper and paperboard production in FY2015 will remain unchanged from the previous year as paper production fails to grow. In FY2016, paper and paperboard production will increase for the first time in three years due primarily to an extra demand expansion before the VAT hike.

In FY2015, paper production will remain affected by a demand decline attributable to decreasing population and less demand for newspaper and New Year's postcards amid a shift from paper to electronic media, while paperboard production will increase on improvements in freight traffic. Paper and paperboard production in FY2015 will thus decrease by 0.8% from the previous year. In FY2016, paperboard production will increase thanks to steady demand from processed food and beverage producers as well as an extra demand rise before a VAT increase. Paper production will slightly fall, despite a rise in demand for sanitary paper. Paper and paperboard production will score a 0.3% increase, the first rise in three years, led by brisk paperboard production.

## Automobile production will be sluggish at 9.15 million in FY2015 and will be limited to 9.4 million despite a rebound in domestic and overseas demand in FY2016.

In FY2015, domestic demand declined substantially due to the revision of mini-vehicle and eco-friendly vehicle taxes. Despite a slight export increase, production in the year will decrease by 4.6% from the previous year. FY2016 will see a private consumption recovery and an extra demand increase before a VAT hike, which may not be as significant as the latest one. Even under the weak yen, export growth will be limited due to Japanese automakers' shift to

overseas production. Production in the year will    increase by 2.8% to 9.41 million units.

Table 3 | Industrial activities

| | | Historical | | | | Projections | | Year-to-year changes | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Production | Crude steel (Mt) | 110.8 | 107.3 | 111.5 | 109.8 | 105.4 | 106.2 | -1.5% | -4.1% | 0.8% |
| | Ethylene (Mt) | 7.00 | 6.26 | 6.76 | 6.69 | 6.76 | 6.38 | -1.1% | 1.0% | -5.6% |
| | Cement (Mt) | 56.1 | 59.5 | 62.4 | 61.1 | 59.7 | 60.6 | -2.0% | -2.3% | 1.5% |
| | Paper and paperboard (Mt) | 27.3 | 25.7 | 26.7 | 26.3 | 26.1 | 26.2 | -1.4% | -0.8% | 0.3% |
| | Automobiles (Million) | 8.99 | 9.55 | 9.91 | 9.59 | 9.15 | 9.41 | -3.2% | -4.6% | 2.8% |
| Production indices | Mining and manufacturing (2010=100) | 99.4 | 95.8 | 99.0 | 98.5 | 98.3 | 99.8 | -0.5% | -0.2% | 1.5% |
| | Food | 98.2 | 96.7 | 98.9 | 96.2 | 102.4 | 103.4 | -2.7% | 6.4% | 0.9% |
| | Chemicals | 99.7 | 96.5 | 98.3 | 95.3 | 96.2 | 96.5 | -3.1% | 1.0% | 0.2% |
| | Non-ferrous metals | 98.9 | 96.6 | 97.3 | 97.9 | 96.1 | 98.5 | 0.6% | -1.8% | 2.4% |
| | General and electrical machinery, etc. | 101.3 | 93.2 | 97.6 | 100.0 | 100.6 | 102.2 | 2.4% | 0.6% | 1.6% |
| Tertiary industry activity index (2005=100) | | 99.9 | 102.0 | 103.2 | 102.1 | 103.3 | 103.8 | -1.1% | 1.2% | 0.5% |

Note: Chemicals include chemical fibre.

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

# Primary energy supply

**Primary energy supply in FY2015 will decline due to energy conservation, weather factors and slow economic activities. In FY2016, a drop will slow down due to an electricity demand rise.**

Primary energy supply in Japan in FY2015 will decline by 0.9% from the previous year due to slow production and economic activities and weather factors, slipping below 470 million tonnes of oil equivalent for the first time in 25 years. In FY2016, primary energy supply will fall for the third straight year, but the decline will be limited to 0.1% as production and economic activities and electricity demand rebound despite further progress in energy conservation.

Oil in FY2015 will decrease by 2.5% from the previous year as heavy fuel oil C for power generation declines despite an upturn in gasoline. Heavy fuel oil C for power generation will decline further in FY2016 as nuclear power plants are restarted one after another. Naphtha will fall on an ethylene production cut. Fuel for transport will decrease again. Overall oil in FY2016 will fall by 4.0%, with oil's share of total primary energy supply slipping below 40% for the first time in 55 years.

Natural gas in FY2015 will decline by 4.1% from the previous year, the first drop since the Great East Japan Earthquake as for both power generation and city gas decreased. Natural gas in FY2016 will decrease by 5.7% for the second straight year of decline as for power generation decreases substantially on the restart of nuclear power plants, despite an increase in demand for city gas. Even with the decline, natural gas in FY2016 will still be up more than 12% from FY2010 before the Great East Japan Earthquake.

Coal in FY2015 will post a slight decline of 0.3% from the previous year as industrial use decreases, despite an increase in coal-fired power generation. Coal in FY2016 will score a small increase of 0.3% as industrial consumption expands on steel and cement production recovery. The restart of nuclear power plants will have little impact on coal-fired power generation.

Following the No. 1 and 2 units at the Sendai Nuclear Power Station, three more nuclear power plants are expected to restart within FY2015, but nuclear power generation in the year will be limited to 10.6 terawatt-hours. By the end of FY2016, a total of 12 plants will have restarted. However, the year's nuclear power generation will total only 61.8 TWh, about one-fifth of the level for FY2010 that ended in March 2011 when the Great East Japan Earthquake occurred. Nuclear's share of primary energy supply will be limited to 2.7%.

Renewables will follow an upward trend due primarily to the rapid spread of solar photovoltaics, boosting its share of total primary energy supply in Japan to 8.1% in FY2016.

Japan's energy self-sufficiency rate will rise back to 11.7% in FY2016, but the level will still be 6.1 percentage points lower than the pre-earthquake FY2010 level of 17.8%.

Energy-related carbon dioxide emissions will decline in FY2016 for the third straight year after peaking at 1,235 million tonnes in FY2013. As oil and natural gas declines in line with energy conservation, the restart of nuclear power plants and an increase in renewables, $CO_2$ emissions in FY2016 will fall to 1,131 Mt, down 8.5% from FY2013 and 0.7% from the pre-earthquake FY2010 level.

Table 4 | Primary energy supply

| | Historical | | | | Projections | | Year-to-year changes | | |
|---|---|---|---|---|---|---|---|---|---|
| | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Primary energy supply (Mtoe) | 513.3 | 483.6 | 488.5 | 473.1 | 469.0 | 468.6 | -3.2% | -0.9% | -0.1% |
|   Coal | 119.2 | 117.7 | 126.1 | 124.4 | 124.1 | 124.4 | -1.3% | -0.3% | 0.3% |
|   Oil | 212.0 | 221.6 | 214.5 | 199.0 | 194.0 | 186.2 | -7.2% | -2.5% | -4.0% |
|   Natural gas | 95.7 | 116.2 | 118.4 | 118.9 | 114.0 | 107.5 | 0.4% | -4.1% | -5.7% |
|   Hydro | 17.2 | 15.7 | 16.2 | 17.1 | 18.4 | 18.4 | 5.9% | 7.4% | 0.2% |
|   Nuclear | 60.7 | 3.4 | 1.9 | 0.0 | 2.2 | 12.8 | -100% | .. | 484% |
|   Geothermal, new energies, etc. | 8.7 | 9.2 | 11.4 | 13.7 | 16.3 | 19.3 | 19.8% | 19.3% | 18.6% |
| Self-sufficiency rate | 17.8% | 6.9% | 7.0% | 7.4% | 8.8% | 11.7% | 0.5p | 1.4p | 2.9p |
| Energy intensity (FY2005=100) | 94.0 | 87.4 | 86.5 | 84.6 | 83.2 | 81.9 | -2.2% | -1.7% | -1.5% |
| Energy-related $CO_2$ emissions (Mt) | 1,139 | 1,221 | 1,235 | 1,190 | 1,162 | 1,131 | -3.6% | -2.4% | -2.7% |
|   (FY2013=100) | 92.2 | 98.9 | 100.0 | 96.4 | 94.1 | 91.5 | .. | .. | .. |

Note: New energies include solar, wind, biomass, small and medium-scale hydro, etc.

    Heat contents have been revised since FY2013.

# Final energy consumption

**Final energy consumption in the industry and buildings sectors will slightly decrease in FY2015. Total will also post a small fall in the year. In FY2016, final energy consumption will decline in the industry and transport sectors and in total.**

Final energy consumption in FY2015 will decline by a mere 0.4% from the previous year. The industry sector will reduce energy consumption due to a delay in production recovery. The buildings sector will drop on a cooler summer and a warmer winter, but the transport sector will expand consumption in reaction to a drop caused by bad weather in the previous year and the leap-year effects. In FY2016, total final energy consumption will decrease by 0.8%. In the industry sector, energy conservation will make further progress, while production will grow more brisk. The transport sector will decline due to a reaction to leap-year effects in the previous year and the further spread of fuel efficient vehicles. The buildings sector will slightly increase due primarily to the normal temperature assumed for the year.

In the industry sector, final energy consumption in FY2015 will fall by 0.5% on a delay in recovery in automobile and industrial materials production, despite a rebound in some home electric appliances and some other production. Electricity, city gas and natural gas will slightly drop. Petroleum products, including heavy fuel oil, will decrease. In FY2016, energy consumption will drop by 1.1% due to progress in energy conservation, despite recovering production. Petroleum products will be further affected by an ethylene product cut. However, electricity, and city and natural gas will increase along with coal supported by recovering crude steel and cement production.

In the residential sector, final energy consumption in FY2015 will decrease by 0.8% from the previous year due to a cooler summer and a warmer winter, as well as an energy-saving trend for lighting equipment and electrical home appliances. In FY2016, the sector's energy consumption will increase by 0.3%, the first rise since the Great East Japan Earthquake, due to the normal temperature, income improvements through wage hikes and an unemployment rate fall, and the public's fading consciousness of electricity and energy conservation. Kerosene and other petroleum products will decrease as consumers switch to electrical home appliances and to city gas.

In the commercial sector, final energy consumption will narrow its year-on-year decline to 0.8% in FY2015 due to a slowdown in electricity conservation and in switching to energy-saving equipment as well as leap-year effects. Electricity and city gas will slightly fall. Petroleum products will decrease. In FY2016, energy consumption will expand by 0.7% due to more brisk economic activities and a temperature change, despite further energy conservation, but energy consumption trends will differ from source to source. While electricity and city gas will increase, petroleum products will continue to decrease.

In the transport sector, final energy consumption in FY2015 will increase by 0.3% from the previous year, the first rise in five years, with the increase concentrating in passenger transport, as a reaction to bad weather in the previous year and leap-year effects are coupled with drops in gasoline and diesel oil retail prices. In FY2016, energy consumption will decline by 1.9% due to a shift away from automobiles, improvements of vehicle fuel efficiency through the spread of hybrid and next-generation vehicles as well as mini-vehicles, lighter truck bodies and transport efficiency improvements regarding transport routes and load factors.

Table 5 | Final energy consumption

| | Historical | | | | Projections | | Year-to-year changes | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Final energy consumption (Mtoe) | 339.4 | 321.7 | 321.3 | 312.7 | 311.6 | 309.0 | -2.7% | -0.4% | -0.8% |
|    Industry | 158.3 | 148.4 | 151.0 | 147.3 | 146.6 | 145.0 | -2.4% | -0.5% | -1.1% |
|    Buildings | 98.0 | 92.9 | 90.9 | 88.2 | 87.6 | 87.9 | -2.9% | -0.8% | 0.4% |
|       Residential | 54.7 | 51.6 | 50.1 | 48.8 | 48.4 | 48.5 | -2.7% | -0.8% | 0.3% |
|       Commercial | 43.4 | 41.3 | 40.7 | 39.5 | 39.1 | 39.4 | -3.1% | -0.8% | 0.7% |
|    Transport | 83.1 | 80.4 | 79.5 | 77.1 | 77.4 | 75.9 | -3.0% | 0.3% | -1.9% |
| Coal and coal products | 35.9 | 34.3 | 35.5 | 34.9 | 34.7 | 34.8 | -1.6% | -0.8% | 0.5% |
| Petroleum products | 176.2 | 165.5 | 163.9 | 157.9 | 157.4 | 153.3 | -3.7% | -0.3% | -2.6% |
| City and natural gases | 34.3 | 34.9 | 34.4 | 34.3 | 34.1 | 34.6 | -0.3% | -0.5% | 1.4% |
| Electricity | 89.8 | 84.6 | 84.5 | 82.7 | 82.5 | 83.3 | -2.1% | -0.3% | 1.0% |
| Others | 3.2 | 2.5 | 3.0 | 2.9 | 2.9 | 2.9 | -3.8% | -0.5% | 0.5% |

Note: Industry includes non-energy use.

# Electricity sales and power generation mix (electric utilities)

**In FY2016, electricity sales for the industry and commercial sectors will increase on an economic recovery. Those for the residential sector will expand further.**

In FY2015, electricity sales for lighting services will decline by 0.5% from the previous year due to a cooler summer and a warmer winter. Sales for power services with large industrial users will post a slight drop of 0.1% despite a small recovery for chemical and machinery manufacturers. Overall electricity sales will fall by 0.2%, but indications are that a downward trend might come to a halt.

In FY2016, electricity sales for lighting services will score a 0.7% increase, the first upturn after the Great East Japan Earthquake, helped by wage hikes making consumers less thrifty and a temperature change, despite further progress in energy conservation for lighting equipment and electrical home appliances. Sales for power services will increase by 1.1% as production and economic activities recover with an extra demand increase arising before the next VAT hike. Sales for power services with large industrial users will expand by 0.9% as those for many industries, including general and electric machinery, increase. Overall electricity sales will rise by 1.0%, the first effective upturn after the Earthquake.

Table 6 | Electricity sales (electric utilities)

| | Historical | | | | Projections | | Year-to-year changes | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Total (TWh) | 926.6 | 870.9 | 871.5 | 851.4 | 849.3 | 857.9 | -2.3% | -0.2% | 1.0% |
| Lighting services | 304.2 | 286.2 | 284.3 | 273.1 | 271.9 | 273.8 | -4.0% | -0.5% | 0.7% |
| Power services | 622.4 | 584.7 | 587.2 | 578.3 | 577.5 | 584.1 | -1.5% | -0.1% | 1.1% |
| of which: Large-scale industrial users | 283.2 | 267.4 | 269.3 | 266.8 | 266.5 | 269.0 | -1.0% | -0.1% | 0.9% |
| Mining and manufacturing | 234.4 | 221.3 | 222.8 | 220.4 | 219.1 | 221.5 | -1.1% | -0.6% | 1.1% |
| Chemicals | 28.1 | 26.3 | 26.6 | 26.3 | 26.6 | 26.8 | -1.1% | 1.1% | 0.9% |
| Iron and steel | 36.3 | 36.0 | 37.3 | 36.6 | 34.9 | 35.3 | -1.9% | -4.7% | 1.0% |
| Machinery | 74.6 | 69.0 | 69.2 | 69.0 | 69.4 | 70.4 | -0.4% | 0.7% | 1.4% |

Note: Power services and total include specified-scale demand.

**Nuclear power plants will restart one after another. Fossil fuel-fired power generation's share in FY2016 will fall to 77%, the lowest after the Earthquake.**

In FY2015, three nuclear power plants will restart in addition to No. 1 and 2 units at the Sendai Nuclear Power Station, but nuclear power generation's share will be limited to 1.1%. The share for new energy will expand by 1.6 percentage points on the strength of the feed-in tariff system. Fossil fuel-fired power generation's share will drop by 3.1 points to the still high level of 84%.

In FY2016, nuclear power generation's share will expand by 5.3 points to 6.4%. The share for new energy will also increase by 1.5 points, but fossil fuel-fired power generation's share will decline by 6.7 points to 77%, the lowest since the Earthquake. Particularly, the share for liquefied natural gas will post a large fall of 4.8 points, but the fossil share will still be 15 points higher than before the Earthquake. Despite fuel price drops, electric utilities' fossil fuel import costs will not be negligible.

Table 7 | Power generation mix (electric utilities)

| | Historical | | | | Projections | | Year-to-year changes | | |
|---|---|---|---|---|---|---|---|---|---|
| | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Electricity generated and purchased (TWh) | 1,028 | 962.7 | 963.5 | 936.2 | 933.3 | 943.4 | -2.8% | -0.3% | 1.1% |
| Share | | | | | | | Year-to-year changes | | |
| Hydro | (9%) | (8%) | 8% | 9% | 9% | 9% | +0.4p | +0.4p | -0.1p |
| Fossil fuel-fired thermal | (62%) | (88%) | 88% | 87% | 84% | 77% | -0.9p | -3.1p | -6.7p |
| Coal | (25%) | (28%) | 30% | 30% | 31% | 30% | +0.5p | +0.4p | -0.3p |
| Natural and city gases | (29%) | (43%) | 44% | 46% | 44% | 39% | +2.4p | -2.4p | -4.8p |
| Oil, etc. | (8%) | (18%) | 14% | 11% | 9% | 8% | -3.8p | -1.2p | -1.5p |
| Nuclear | (29%) | (2%) | 1% | 0% | 1% | 6% | -1.0p | +1.1p | +5.3p |
| New energies and others | (1%) | (2%) | 2% | 3% | 4% | 6% | +1.1p | +1.6p | +1.5p |

Note: Only for general electric utilities until FY2012.

Components may not add up to 100% as others are not shown.

# City gas sales (gas utilities)

**In FY2015, city gas sales will fall slightly. In FY2016, city gas sales will hit an all-time high, led by those for general industrial use.**

City gas sales in FY2015 will decrease by 0.4% from the previous year to 40 billion cubic metres due to the stagnant economy, a cooler summer and a warmer winter, despite leap-year effects. In FY2016, city gas sales will increase particularly on strong sales for general industrial use as recovering production and economic activities are coupled with an extra demand increase before the April 2017 VAT hike. Total sales will expand by 1.3% to an all-time high of 40.5 Bcm.

City gas sales to the residential sector in FY2015 will decline by 0.9% from the previous year despite leap-year effects as a drop in water- and space-heating demand under warmer winter weather is combined with the spread of highly efficient water heating machines. In FY2016, city gas sales will post a small increase of 0.5% due to a colder winter, the relaxation of energy conservation consciousness amid wage hikes and employment growth, and growing power generation demand amid the spread of stationary fuel cells.

City gas sales to the commercial sector (for commercial and "other" users) in FY2015 will decline (by 0.5% for commercial users and 0.6% for "other" users) despite the spread of micro gas engines and gas heat pumps as the improvement of efficiency for gas-using equipment coincides with a cooler summer and a warmer winter, as is the case with the residential sector. In FY2016, sales to the sector will increase (by 1.0% for commercial users and 1.1% for "other" users) due to cooling and heating demand growth under warmer summer and colder winter weather than in the previous year, an increase in new equipment amid corporate earnings growth and fuel switching for existing equipment. Experiences with rolling blackouts just after the Great East Japan Earthquake and requirements for environmental measures will encourage hospitals, schools and other public facilities to switch from grid-based electricity and diesel engines to small- and medium-sized gas engines and city gas cogeneration systems.

City gas sales to the industry sector in FY2015 will fall by 0.1% due to stagnant industrial production. Those to general industrial users will drop by 0.2% on the stagnant capacity utilisation rate, but those to electric utilities will post a small increase of 0.4%. In FY2016, city gas sales to the industry sector will increase by 1.7% as economic improvements are coupled with an extra demand rise toward the next VAT hike. Sales to general industrial users will expand by 2.0% due to robust food and beverage production under recovering private consumption and a production rebound for vehicles and industrial materials, including chemicals. Sales to electric utilities will post a small fall of 0.3% due to a drop in operations of existing gas-fired power plants. City gas sales to the whole of the industry sector will hit a new high of 23.1 Bcm. The industry sector's share of total city gas sales will expand to 57% in FY2016 from 26% in FY1990.

Table 8 | City gas sales (gas utilities)

| | Historical | | | | Projections | | Year-to-year changes | | |
|---|---|---|---|---|---|---|---|---|---|
| | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Total (Billion m$^3$) | 39.28 | 40.33 | 39.82 | 40.16 | 40.01 | 40.53 | 0.9% | -0.4% | 1.3% |
| Residential | 9.79 | 9.80 | 9.55 | 9.58 | 9.50 | 9.55 | 0.3% | -0.9% | 0.5% |
| Commercial | 4.75 | 4.52 | 4.49 | 4.34 | 4.32 | 4.36 | -3.4% | -0.5% | 1.0% |
| Industrial | 21.61 | 22.92 | 22.20 | 22.74 | 22.71 | 23.10 | 2.5% | -0.1% | 1.7% |
| For general industries | 20.18 | 21.03 | 20.26 | 20.07 | 20.03 | 20.43 | -0.9% | -0.2% | 2.0% |
| For electric utilities | 1.43 | 1.89 | 1.94 | 2.68 | 2.69 | 2.68 | 37.9% | 0.4% | -0.3% |
| Others | 3.13 | 3.09 | 3.58 | 3.50 | 3.48 | 3.51 | -2.2% | -0.6% | 1.1% |

Notes: Converted at 1 m$^3$ = 41.8605 MJ (10,000 kcal)

# Fuel oil and LPG sales and crude oil throughput

**The decline in fuel oil sales will decelerate on the oil price plunge in FY2015. In FY2016, fuel oil sales will slip below 180 GL for the first time in 47 years, affected by a sharp fall in heavy fuel oil sales.**

The year-on-year decline in fuel oil sales in FY2015 will narrow to 1.1% on the oil price plunge and leap-year effects. In FY2016, demand for heavy fuel oil C for power generation will decline in line with an increase in the number of operating nuclear power plants. Heavy fuel oil C consumption for other use and heavy fuel oil A demand will fall under requirements for environmental measures, while fuel switching will make progress. As a result, total fuel oil sales in the year will decrease by 3.2%, slipping below 180 billion litres for the first time in 47 years.

Gasoline sales in FY2015 will increase by 0.7% from the previous year, the first rise in five years, due to leap-year effects, a reaction to bad weather in the previous year and falling retail prices. In FY2016, gasoline sales will decrease by 1.9% on the further spread of fuel efficient vehicles, including hybrid and other next-generation vehicles as well as mini-vehicles.

Naphtha sales are sensitive to the ethylene production trend and less vulnerable to energy conservation and fuel switching than other petroleum products. In FY2015, naphtha sales will increase by 0.9% in response to an ethylene production rise. In FY2016, however, they will drop by as much as 2.1 GL or 4.7% in line with an ethylene production cut.

Kerosene sales in FY2015 will decrease by 1.2% due mainly to warmer winter weather. In FY2016, they will decline by 1.5% despite a heating demand rise amid a colder winter than in the previous year as fuel switching from

kerosene to electricity and city gas makes further progress.

Diesel oil sales in FY2015 will post a small fall of 0.3% on stagnant freight traffic. In FY2016, they will increase by 0.1% on growing transport demand despite continued improvement of transport and fuel efficiency and a drop in demand for diesel oil for industrial use through fuel switching.

Heavy fuel oil A sales will decrease by 6.1% in FY2015 and 2.7% in FY2016 as demand for agricultural and shipping use declines and fuel switching makes progress for industrial and commercial use under environmental measures.

Heavy fuel oil B and C sales for industrial use will decline due to fuel switching and energy conservation. Those for power generation will also decrease in line with an increase in the number of operating nuclear power plants. Overall heavy fuel oil B and C sales will fall by 9.5% in FY2015 and 13.3% in FY2016, the largest declines among fuel oil sales. These sales in FY2016 will drop below the FY1960 level of 15.97 GL.

Liquefied petroleum gas, used mainly for water heating and cooking, has attracted new attention as a distributed energy source independent from electric grids and pipelines since the Great East Japan Earthquake. However, growing switching from LPG to electricity and city gas has forced LPG sales to continue a downward trend. LPG sales will decrease by 1.6% in FY2015 and 0.3% in FY2016.

Crude oil refining capacity may be reduced to 3.55 million barrels per day at the end of FY2016 in response to the second notice under the Energy Supply Sophistication Act. Crude oil throughput will decline to 183 GL (3.16 Mb/d) due to a domestic demand fall, although petroleum product exports will remain high. A remaining challenge will be how to maintain the refinery capacity utilisation rate at a certain level.

Table 9 | Fuel oils and LPG sales, and crude oil throughput

| | Historical | | | | Projections | | Year-to-year changes | | |
|---|---|---|---|---|---|---|---|---|---|
| | FY2010 | FY2012 | FY2013 | FY2014 | FY2015 | FY2016 | FY2014 | FY2015 | FY2016 |
| Fuel oils (GL) | 196.0 | 197.8 | 193.6 | 183.0 | 180.9 | 175.1 | -5.5% | -1.1% | -3.2% |
| Gasoline | 58.2 | 56.2 | 55.5 | 53.0 | 53.3 | 52.3 | -4.5% | 0.7% | -1.9% |
| Naphtha | 46.7 | 43.2 | 45.7 | 43.9 | 44.3 | 42.2 | -4.0% | 0.9% | -4.7% |
| Jet fuel | 5.2 | 4.0 | 5.1 | 5.3 | 5.3 | 5.4 | 5.7% | 0.0% | 0.3% |
| Kerosene | 20.4 | 18.9 | 17.9 | 16.7 | 16.5 | 16.2 | -7.0% | -1.2% | -1.5% |
| Diesel oil | 32.9 | 33.4 | 34.1 | 33.6 | 33.5 | 33.5 | -1.5% | -0.3% | 0.1% |
| Heavy fuel oil A | 15.4 | 13.8 | 13.4 | 12.4 | 11.6 | 11.3 | -8.0% | -6.1% | -2.7% |
| Heavy fuel oils B and C | 17.3 | 28.4 | 21.9 | 18.1 | 16.4 | 14.2 | -17.3% | -9.5% | -13.3% |
| For electric utilities | 7.7 | 19.4 | 14.4 | 10.8 | 9.4 | 7.5 | -25.3% | -12.5% | -20.5% |
| For other users | 9.7 | 9.0 | 7.5 | 7.3 | 7.0 | 6.7 | -1.8% | -5.3% | -3.5% |
| LPG (Mt) | 16.5 | 16.6 | 15.5 | 15.4 | 15.1 | 15.1 | -0.7% | -1.6% | -0.3% |
| Crude oil throughput (GL) | 208.9 | 197.6 | 200.4 | 189.0 | 188.0 | 183.3 | -5.7% | -0.5% | -2.5% |

# Renewable energy power generation

## Cumulative costs for approved renewable power generation capacity under the feed-in tariff system would be as much as JPY55 trillion.

As three-and-a-half years have passed since the feed-in tariff system started for renewable energy power generation, such power generation has spread rapidly. At the same time, grid operation and other technical problems as well as economic and other problems have emerged.

Renewable power generation capacity has increased too rapidly, resulting in a fast cost expansion. The rapid increase in approved renewable power generation capacity has been restricted due to the cancellation of the approval for projects without secured land and equipment, electric utilities' establishment of grid connection limits, the expansion of the scope for projects subject to output control, the enhancement of output control and other FIT system revisions. By the end of July 2015, however, approved renewable power generation capacity totalled 87.7 gigawatts (including 82.1 GW in solar photovoltaic power generation and 2.3 GW in wind power generation). If all approved capacity is put into operation, cumulative costs for consumers for 20 years, including those for capacity for transition[1], will reach as much as JPY55 trillion[2]. Costs for lighting services mainly for the residential sector will total about JPY900 billion, close to about JPY1 trillion in VAT cuts for food. The sum

would call for an electric rate hike of JPY3.2/kWh – 14% for residential use and 19% for industrial and other use.

Particularly, the rapid expansion of solar photovoltaic power generation subject to higher purchasing prices has boosted the costs. As approved mega-solar systems are completed and put into operation, costs will further increase. The maximum expansion of renewable power generation must be balanced with restriction of costs for consumers. A government panel is now discussing how to reform renewable energy promotion systems.

Figure 2 | Cumulative burden of FIT over 20 years
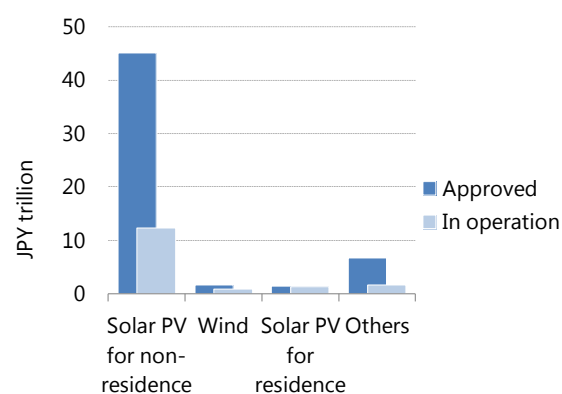


Note: As of July 2015.

## Renewable power generation capacity in operation will reach 60 GW.

Renewable power generation excluding large-scale hydro capacity in operation will reach 60.4 GW at the end of FY2016 on completion of facilities under construction, although some approved non-residential solar PV projects (including mega-solar projects) are expected to drop out. Particularly, non-residential solar PV capacity in operation will expand to 33.3 GW at the end of FY2016, accounting for more than 50% of FIT-approved capacity in operation. Meanwhile, wind power generation capacity in operation will still be limited to 4.1 GW at the end of FY2016 as it takes wind power generation projects some five years to start generation.

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[1] The capacity for transition represents facilities that were built before the FIT system introduction and subjected to the system after its introduction.

[2] A residual period for electricity purchases from the capacity for transition is taken into account. The marginal avoidance cost has been computed at JPY10.9/kWh, based on "Renewable Energy FIT System" on the website of the Agency for Natural Resources and Energy. The operating rate is assumed at 20% for wind power generation, 12% for solar PV, 70% for geothermal generation, 45% for hydro generation and 70% for biomass generation.

Figure 3 | Installed capacity in operation of renewable power generation
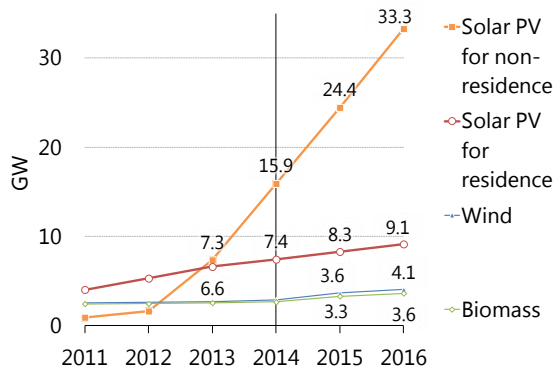


As of the end of fiscal year. Excludes small and medium-scale hydro, etc.

Due to the rapid completion of renewable power generation facilities, renewable power generation in FY2016 will expand to 115.7 TWh (including 44.6 TWh in solar PV generation, 38.2 TWh in small- and medium-scale hydro power generation, 22.1 TWh in biomass power generation, 7.1 TWh in wind power generation and 3.7 TWh in geothermal power generation), accounting for a little more than 10% of Japan's total power generation.

# Impacts of nuclear power plant restart

**In November 2005, the Sendai Power Station's No. 2 unit became Japan's second plant to restart commercial operations under new regulation standards. The timing for restarting other plants for which screening has been completed will become the new focus of attention.**

In November 2015, the No. 2 unit of the Sendai Nuclear Power Station restarted commercial operations. After the station's No. 1 unit put an end to the absence of nuclear power generation in Japan, which lasted for about two years, the No. 2 unit became the second nuclear power plant to restart under the new regulation standards. Japan's energy system thus made another step forward toward ending an emergency situation after the Great East Japan Earthquake. Nuclear energy use is indispensable for Japan's energy policy, as suggested in last July's long-term energy supply and demand outlook by the Ministry of Economy, Trade and Industry.

This chapter analyses the impacts of different nuclear power plants restart scenarios on the so-called three Es – economy, energy and environment. We developed four scenarios for restarting nuclear power plants in consideration of progress in regulatory screening, the presence or absence of large-scale construction and the timing of applications filed for screening, depicting the FY2016 situation in each scenario.

In the [Reference Scenario], three units are assumed to restart toward the end of FY2015 in addition to the two units that have already restarted. Five units will be in operation at the end of FY2015. They will be in service for three months on average, with 10.6 TWh of electricity

generated. Later, one unit is assumed to restart about every two months. At the end of FY2016, a total of 12 units will be in operation under the new regulation standards. They will operate for seven months on average. The restarted 12 units will not necessarily operate throughout the year. Therefore, their power generation will be limited to 61.8 TWh or 21% of the pre-earthquake FY2010 level.

The [High Case] makes no major difference from the Reference Scenario for FY2015, assuming that a total of five units will have restarted by the end of the year. In FY2016, when the process for restarting will be rationalised, one unit is assumed to restart every month on average. By the end of FY2016, a total of 18 units will have restarted. They will operate for six months on average in the year, generating 82.2 TWh, about 30% more than in the Reference Scenario.

In the [Low Case], only one will restart by the end of FY2015 in addition to the two units of the Sendai Nuclear Power Station that have already restarted. The number of units that will have restarted by the end of the year will thus be limited to three. As many units are assumed to restart in FY2016. By the end of FY2016, a total of six units will have restarted. They will be in service for eight months on average in the year, generating 34 TWh, 55% less than in the Reference Scenario.

In the hypothetical [Highest Case], 25 units subject to past applications for screening, excluding one unit of the Oma Nuclear Power Station now under construction, will have restarted by the end of FY2016, operating at 80% of their full capacity in the year (the restarts in FY2015 will be the same as in the Reference Scenario).

Figure 4 | Assumption of restarting nuclear power plants (cumulative)
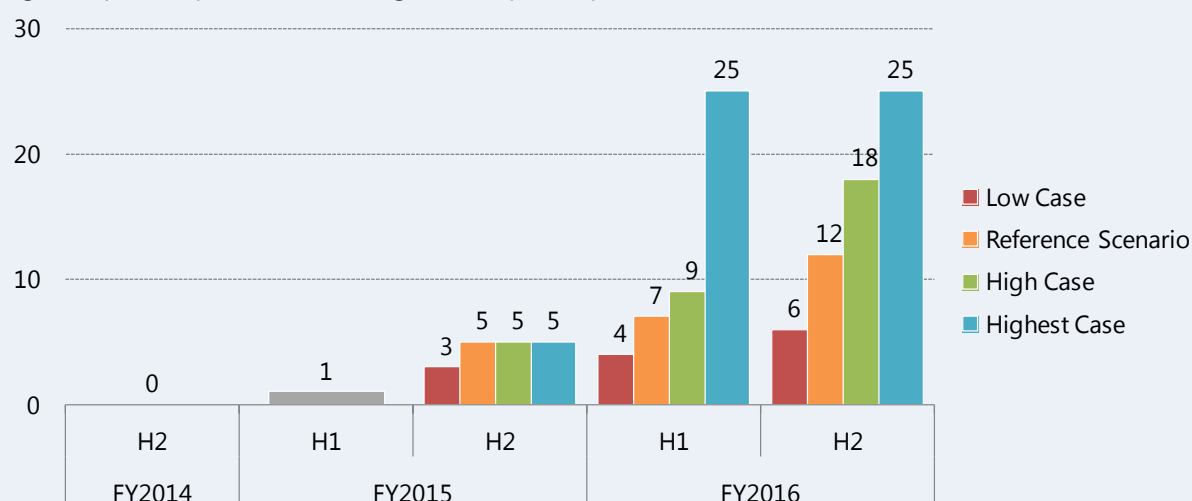


In the Reference Scenario, fossil fuel imports in terms of value in FY2016 will decline by JPY2.1 trillion from FY2010 due to energy conservation and fossil fuel price drops. However, power generation costs will rise by JPY2.1/kWh, while the energy self-sufficiency rate will drop by 6.1 percentage points.

From the Low Case to the High Case, fossil fuel imports in value in FY2016 will decline by JPY0.4 trillion. The power generation cost will fall by JPY0.4/kWh. Gross domestic product will expand by JPY0.3 trillion or 0.05%. The energy self-sufficiency rate will rise by 2.1 percentage points. $CO_2$ emissions will decrease by 24 Mt or 2.1%.

From the Low Case to the Highest Case, fossil fuel imports in value in FY2016 will decline by JPY1.1 trillion. The power generation cost will decrease by JPY1.2/kWh (by 9.0% from the Reference Scenario). GDP will expand by JPY0.8 trillion or 0.14%. The energy self-sufficiency rate will rise by 6.2 points. $CO_2$ emissions will decrease by 69 Mt or 6.0%.

Since the Fukushima Daiichi Nuclear Power Station accident, the international community has grown more interested in pursuing higher safety of nuclear power generation. Under the situation, the Japanese government broadly agreed with India to conclude a bilateral nuclear cooperation agreement. It is significant for Japan to take advantage of lessons from the accident at home and abroad.

The restart of the Sendai Nuclear Power Station represented only the first step in Japan's long-awaited resumption of nuclear energy use. Future courses are still uncertain for 23 plants that have been subjected to applications for screening and have yet to restart. Discussions are underway on old plants approaching the 40-year service limit and on the Monju fast breeder reactor. Japan has a mountain of problems that must be resolved for a balanced energy mix.

Table 10 | Impacts of restarting nuclear power plants

| | FY2010 | FY2016 | | | |
|---|---|---|---|---|---|
| | | Low Case | Reference Scenario | High Case | Highest Case |
| Cumulative number of restarted nuclear reactors[1] [FY2015] | .. | [3] | [5] | [5] | .. |
| FY20016 | .. | 6 | 12 | 18 | 25 |
| Average period for operation (months) | .. | 8 | 7 | 6 | .. |
| Electricity generation by nuclear (TWh) | 288.2 | 34.0 | 61.8 | 82.2 | 174.1 |

| | | FY2010 | FY2016 (changes from **FY2010**) | | | | FY2016 (changes from **the Low Case**) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Low Case | Reference Scenario | High Case | Highest Case | Reference Scenario | High Case | Highest Case |
| Economy | Power generation cost[2] (JPY/kWh) | (8.2) | +2.3 | +2.1 | +1.9 | +1.1 | -0.2 | -0.4 | -1.2 |
| | Total fossil fuel imports (JPY trillion) | 18.1 | -1.9 | -2.1 | -2.3 | -3.0 | -0.2 | -0.4 | -1.1 |
| | Oil | 12.3 | -2.0 | -2.0 | -2.1 | -2.3 | -0.1 | -0.1 | -0.4 |
| | LNG | 3.5 | +0.4 | +0.3 | +0.2 | -0.3 | -0.1 | -0.3 | -0.7 |
| | Trade balance (JPY trillion) | 5.3 | -7.3 | -7.1 | -6.9 | -6.3 | +0.2 | +0.4 | +1.0 |
| | Real GDP (JPY2005 trillion) | 512.7 | +24.2 | +24.4 | +24.5 | +25.0 | +0.2 | +0.3 | +0.8 |
| | Gross national income (JPY trillion) | 493.8 | +41.1 | +41.3 | +41.4 | +41.9 | +0.2 | +0.3 | +0.8 |
| Energy | Primary energy supply | | | | | | | | |
| | Oil (GL) | 232.3 | -27.1 | -28.8 | -30.1 | -35.6 | -1.8 | -3.0 | -8.5 |
| | Natural gas (Mt of LNG equivalent) | 73.3 | +11.4 | +8.4 | +6.2 | -3.7 | -2.9 | -5.2 | -15.1 |
| | LNG imports (Mt) | 70.6 | +11.9 | +9.0 | +6.8 | -3.2 | -2.9 | -5.2 | -15.1 |
| | Self-sufficiency rate | 17.8% | -7.3p | -6.1p | -5.2p | -1.2p | +1.2p | +2.1p | +6.2p |
| Environment | Energy-related $CO_2$ emissions (Mt-$CO_2$) | 1,139 | +6 | -8 | -18 | -63 | -14 | -24 | -69 |
| | Changes from FY2013 | [-7.8%] | [-7.3%] | [-8.5%] | [-9.3%] | [-12.9%] | .. | .. | .. |

Reference Scenario: Commercial operation resumes in autumn 2015, followed by one unit restarting
about every second month.
Low Case: Commercial operation delayed compared to the Reference Scenario, with the other units
to restart about one year later.
High Case: Commercial operation resumes in autumn 2015, followed by one unit restarting about every month
(thanks to a more efficient assessment process).
Highest Case: A hypothetical case where 25 units generate electricity with an 80% capacity factor.
1. Thirty-nine reactors operated at the end of 2010.
2. Power generation cost in FY2010 is for the general electric utilities, estimated based on
their profit-and-loss statements.

# Impacts of lower oil price on households and industry

## Low oil prices benefitting households

Household energy spending had been rising in Japan due to oil price spikes coupled with other factors, such as the Asian premium on LNG prices and the limited operations of nuclear power plants since the Great East Japan Earthquake. In FY2014, however, two-or-more-member households' average gasoline spending fell by JPY5,000 from the previous year due to international oil price plunges in the second half. Their kerosene spending also decreased by JPY4,000. Electricity spending increased by JPY5,000 in the absence of nuclear power generation. City gas spending also expanded by JPY2,000 because of a delay in the reflection of oil price plunges for city gas. As a result, overall average household energy spending in FY2014 fell only by JPY1,000 to JPY297,000.

In the April-September first half of FY2015, household energy spending declined by 4.5% year on year due to the big effects of continued oil price weakness. Household energy spending will decrease by JPY30,000 or 10% in the whole of FY2015 and by JPY15,000 or 5.6%.
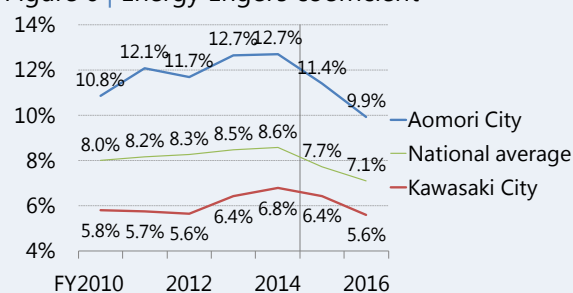
Figure 5 | Energy spending by average household
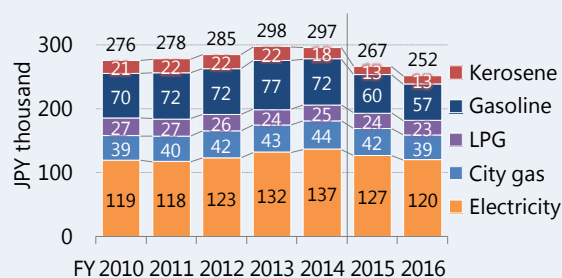


## Narrowing energy cost gaps between cold and warm regions

Oil price plunges can contribute to narrowing energy cost gaps between regions. In the present season for heating, we pay attention to a gap between cold and warm regions. Between the

cold city of Aomori and the warm city of Kawasaki, the energy Engel's coefficient[3] gap ranged from a factor of 1.9 to 2.1 between FY2011 and 2014. In FY2016, the gap will narrow to a factor of 1.8, with the indicator of effective household energy costs being 9.9% for Aomori and 5.6% for Kawasaki.

Figure 6 | Energy Engel's coefficient



Average household energy spending will fall by JPY38,000 from JPY264,000 in FY2014 to JPY226,000 in FY2016 in Kawasaki and by JPY66,000 from JPY361,000 to JPY295,000 in Aomori. This is because kerosene consumption that is less in Kawasaki and more in Aomori due to the heating demand gap reflects oil price plunges sensitively. Prices for other energy sources for household consumption change more moderately.

## Cold regions should make regional efforts to reduce heating demand

Given that energy for heating is indispensable in cold regions plagued with severe winter weather, energy spending in cold regions is inevitably more than in warm regions. However, cold regions may have to make appropriate regional efforts, including the promotion of super-insulated housing equipment and highly efficient heating systems, to increase energy efficiency, the introduction of community energy management systems, and the expansion of safety-net heating subsidies for low-income people.

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[3] Energy spending divided by consumption expenditure

## Oil price plunges benefiting Japan

The global oil glut has continued due to growing global supply and demand growth deceleration accompanying an economic slowdown in emerging countries. This outlook through FY2016 assumes any rise in oil prices to be limited. Our institute projects that oil prices will turn upward on falling production in the United States and some other countries and recovering demand in oil-consuming countries over a medium term. At present, however, there is much news indicating further falls in oil prices, including the results of December's general meeting of the Organization of the Petroleum Exporting Countries.

Resources price drops lower expected inflation rates, exert downward pressure on stocks in the United States where mining's economic weight is higher than in Japan, and bring about an economic slowdown in resource-rich countries, imposing adverse impacts on the Japanese economy. As far as the real economy is concerned, however, resources price drops are expected to bring about favourable results for the Japanese economy. In a bid to assess the favourable results, we conducted a sensitivity analysis for an assumed Lower Price Case in which the oil price in FY2016 will be $10/bbl lower than in the Reference Scenario, with the LNG price linked to the oil price being $1.4/MBtu lower.

In the Reference Scenario, a favourable employment situation and improved corporate earnings are expected to lead to wage hikes supporting consumption. Oil and LNG price drops will enhance this trend. Costs of many goods and services, including energy, will decline, pushing up corporate earnings. Corporate earnings growth will induce wage hikes, while falls in prices of consumer goods, including energy, will contribute to expand private consumption (by JPY980 billion or 0.3%). Earnings improvement and sales growth will have a positive impact on business confidence, leading to an increase of JPY840 billion (0.8%) in non-residential investment. Net exports will also expand by JPY70 billion as lower resource prices benefit the United States, Chinese, the European Union, Korean and other foreign economies. As a result, real GDP will grow by JPY1.89 trillion (0.4%).

The final demand growth will boost industrial production by JPY3.44 trillion. Given great domestic demand growth, non-manufacturing industries will expand production by JPY2 trillion accounting for a majority of the industrial production growth. Particularly, production growth will be as high as JPY370 billion for commerce, JPY350 billion for construction and JPY210 billion for business services.

Figure 7 | Increases in domestic production by lower oil and LNG prices
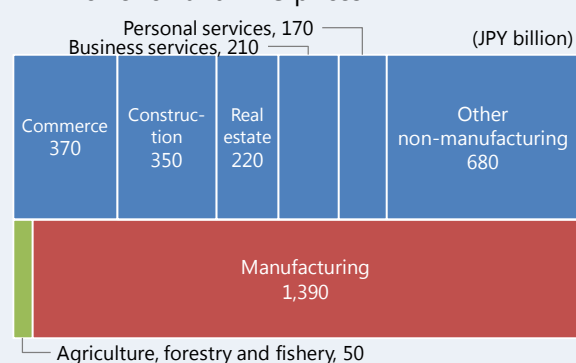


Invigorated production will support employment, increasing overall employment by 225,000 persons including 150,000 in non-manufacturing industries. Given that commerce, construction and personal services sectors, ranked high in production value growth, represent labour-intensive industries, their growth will bring about a great increase in labour demand. At present, however, these sectors are plagued with manpower shortages. How to secure labour may become a serious problem for them.

Figure 8 | Increases in employee by lower oil and LNG prices
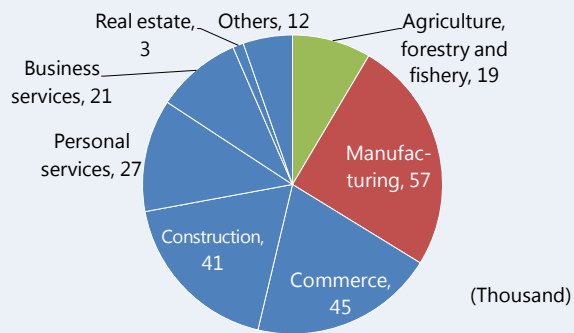


## Japan should not be complacent with the present situation but should manage the risk of rising oil prices

Oil and LNG price falls will benefit the Japanese economy, but this entails a great risk of an upturn in oil and LNG prices. An unexpected OPEC policy turnabout or large-scale supply interruptions could reverse the market trend, leading to an upturn in oil prices. Such development is conceivable. Such event will reverse the abovementioned virtuous circle, damaging the whole of the Japanese economy, including sectors that do not directly consume massive oil. In order to remain unshaken by oil and LNG price fluctuations and achieve autonomous, stable economic growth, Japan should develop appropriate economic growth strategies, distribution policies and energy policies.

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