Energy Consumption Down 40% in Fiscal 2050 by Economic Structural Changes

Energy Conservation Is a Growth Engine

Japan Center for Economic Research

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Since the Fukushima Daiichi Nuclear Power Plant accident in March 2011, there have been growing concerns over power shortages and increases in electricity costs. While industrial circles call for the “restart of nuclear power plants” as a measure to avoid electricity rate hikes, they are also, at the same time, making steady efforts to conserve energy and power. The business performance of Japanese companies is rapidly recovering due to the combined effects of the measures to stem the yen’s appreciation. This paper examines whether energy and power conservation will be a hindrance to growth.

<Summary>

1. The trend of energy and power saving is growing as rapidly as during the oil crises in the 1970s due to an increase in energy costs in the aftermath of the Fukushima Daiichi Nuclear Power Plant accident. It is expected that electricity rates will also be raised in the future and energy conservation based on price mechanisms will accelerate. By industry, there have been remarkable power efficiency improvements in major energy-consuming sectors except for steel, such as chemicals, pulp and paper, ceramics, stone and clay products. Leading export industries, such as machinery and automobiles, have hardly been affected by increasing energy costs. For the whole manufacturing industry, the advantage of the yen’s depreciation surpasses the burden of increasing costs. For the business operations and civilian sectors, such as office and store operations and households, the growing trend of energy conservation started in the mid-2000s and energy consumption is likely to decrease significantly from now on due to the combined effects of depopulation. It is conceivable that this is also true of the transportation sector.

2. When the oil crises hit Japan in the 1970s, the manufacturing industry used energy-conserving measures as a lever to noticeably boost its international competitiveness, which worked as a growth engine for Japan. This is because in addition to the acceleration of energy-conserving trends in each industry, the rise of high-tech and energy-conservation industries, especially electronics, drove the Japanese economy. Meanwhile, with living standards improving, energy consumption increased in the household and transportation sectors due to the wide use of domestic electric appliances and automobiles and the expansion of recreation. It cannot be ignored that in the 2000s,

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energy-conserving moves progressed in business operations and civilian and transportation sectors due to environmental regulations and the enhancement of the Act on the Rational Use of Energy in response to the Kyoto Protocol that required its member states to reduce greenhouse gas emissions. International commitments are effective for supporting energy-conserving moves.

3. The policy proposal “Vision 2050: Maintain Position as a First-tier Nation” which the Japan Center for Economic Research (JCER) drew up in February 2014, argues that if Japan realizes long-term economic growth (Growth Scenario), domestic energy consumption will be reduced by around 10% in fiscal 2050. If Japan shifts to economic structures based on the non-manufacturing industry in the future, domestic energy consumption will be reduced by around 40% in fiscal 2050. To realize a situation where the non-manufacturing industry is a growth leader and driver, productivity improvement in the financial and information and communications technology (ICT) sectors is definitely essential. The advancement and utilization of ICT is the key to realizing a balanced coexistence between energy conservation and industrial competitiveness improvements in every sector. That is why it is necessary to introduce an energy- and environment-friendly tax system and also to enact promotional measures for investment in knowledge capital rather than facilities and equipment.

**Figure 1: The Relationships between Economic Growth, Energy Efficiency, Energy Consumption and Fossil Fuel Prices**

**Note:** The improvement pace of energy efficiency is based on the assumption that the economic structure will change is almost equal to that during the oil crises. The improvement pace of energy efficiency without the assumption of economic structural changes is almost equal to the average figure of the period between the oil crises and fiscal 2010. The average growth rate by fiscal 2050 is 1.4%.

**Source:** 2014 Handbook of Energy & Economics Statistics in Japan compiled by the Institute of Energy Economics, Japan. Calculations based on the system of national accounts (SNA) and domestic corporate goods prices.
Figure 2: Challenges Concerning the Economic Situation and Energy Consumption by 2050

In case of steady growth (average growth of 1.4%, Growth Scenario)
- Living standards improve
- Energy consumption increases by 20% compared with the case of stagnation → Imports increase by about 10 trillion yen
- Realization of an energy conservation society is necessary due to economic structural changes (reform) → Current account deficits likely to expand
- Initiatives to urge economic structural changes
- Introduction of the environmental tax, promotion of knowledge capital investment

In case of stagnation (average growth of 0.2%)
- Living standards degrade
- Growth stagnation causes consumption to decrease by 30% compared with 2010
- Even if the national burden rate would increase significantly, a tax hike is necessary. → Financial failure may occur
- Measures to avoid financial failure
  - Significant consumption tax hike, increasing of social insurance costs

● The Acceleration of Energy Conservation in the Aftermath of the Fukushima Daiichi Nuclear Power Plant accident

After March 11, 2011, nuclear power plant operation was gradually stopped in Japan and no nuclear power plants have been operated since the fall of 2012. A portion of fossil fuel costs is passed on to electricity rates because of the alternative use of thermal power stations. Electricity rates have increased by 20 to 30% compared with the period before the nuclear accident. The energy and electricity efficiency of the whole Japanese economy began to improve in response to price increases. (Refer to Figure 3.)
Figure 3: The Acceleration of Energy Conservation by Price Increases after the Fukushima Daiichi Nuclear Power Plant accident

Changes in the improvement of power and energy efficiency

The rate of increase in electricity rates after the nuclear accident

Note: The final energy consumption figures for fiscal 2013 were calculated on the basis of the primary energy supply.


The energy efficiency obtained by dividing the final energy consumption by real GDP and the improvement rate of power efficiency obtained by dividing electricity sales volumes by real GDP are almost equal to those during the oil crises. (The average improvement rate of energy efficiency was 2.9% per year from fiscal 1973 to 1985, 2.7% per year from fiscal 2011 to 2013 and 1.7% per year during the decade before that.)

Fossil fuel prices began to rise in the early 2000s and the energy conservation trend began to progress slowly. However, power efficiency worsened. This is because there was a major shift from other energy sources to electricity. However, in fiscal 2011, it became impossible to depend on nuclear power as an electricity source base. Since then, power efficiency has rapidly improved. (The seemingly rapid improvement from fiscal 2009 to 2010 was due to the larger drop of power efficiency than that of real GDP amidst the recession triggered by the global financial crisis.)

Is it possible to wring out a “dry dust cloth” after the earthquake disaster?

With regard to energy and power saving, industrial circles had the deep-rooted belief that Japan’s energy conservation was at the world’s top level and that it was impossible to further squeeze a “dry dust cloth” before the nuclear accident occurred in Fukushima. However, data collected after the accident shows that energy- and power-saving moves are progressing. Figure 4 illustrates changes in power efficiency of the manufacturing industry. In fiscal 2013, the manufacturing industry increased production by 3.2% from the previous year, but power consumption increased only by 0.7% and power efficiency significantly improved. Reportedly, Komatsu, a leading construction machine and equipment manufacturer, succeeded in reducing
power consumption by half by saving energy and improving productivity at its new Awazu factory in the city of Komatsu, Ishikawa Prefecture. Komatsu reconstructed the factory itself, introduced energy-conserving air-conditioning, lighting systems and equipment and fundamentally reviewed production methods. Through these efforts, the corporation improved productivity and produced dramatic savings in energy. More specifically, Komatsu renovated two factory buildings into one, reduced the floor space by 30% and reinstalled power source and pipes, which had initially been installed on the floor, underground, allowing for free equipment arrangement. This enabled the company to increase its production capability 1.5-fold. Komatsu also utilized not electric power but underground water for air-conditioning and introduced many energy-conserving facilities to convert regenerative energy generated by stopping cranes into electric power. As a result, the company succeeded in reducing energy consumption by half. In addition, Komatsu utilized biomass power generation using excess local timber from forest-thinning and reduced electricity purchases from power companies by 90%. The company is planning to rebuild its factories one after another from now onward.\(^2\) It may be possible to say that the increase in electricity prices shortened energy conservation investment collection years and that restrained investments surfaced.

According to a *Nikkei* survey, companies are planning to reduce their electricity purchases by 7% in fiscal 2014.\(^3\) For some companies, even if they reduce their electricity purchases by 10%, they will have an increase of 30% in power cost. Although power conservation cannot resolve all cost increases, price increases are definitely prompting manufacturing companies to practice energy and power saving. In addition, because corporate measures for saving energy and power are expected to greatly contribute to improving productivity, they will also be effective for strengthening competitiveness.

Figure 4: Power Efficiency in the Manufacturing Industry Is Speeding up the Pace of Improvement

![Figure 4: Power Efficiency in the Manufacturing Industry Is Speeding up the Pace of Improvement](image)

**Sources:** Index of Industrial Production, Survey of Electric Power Statistics

Figure 5 illustrates power efficiency by industry. Power efficiency significantly improved after the Great East Japan Earthquake in the material industries such as chemicals, ceramics,


\(^3\) The July 31, 2014, morning edition of the Nikkei
stone and clay products, pulp and paper, and non-ferrous metals. Steel seems to have improved significantly in power efficiency from fiscal 2009 to 2010. This is primarily because electric furnace production stagnated due to the economic slowdown triggered by the Global Financial Crisis. Behind the seeming deterioration of power efficiency in and after fiscal 2011 is the recovery of electric furnace production amidst growing demand for restoration. In addition, for the food industry, it is conceivable that the use of electricity is structurally increasing amidst the growing popularity of processed and frozen foods. For the fiber industry, power efficiency seems to reflect the increasing percentage of materials whose production requires a large amount of electricity, such as carbon fiber. (The popularity of processed and frozen foods and the prevalence of carbon fibers are bringing users, such as households, the food service industry and the transportation industry, toward energy conservation, but these are not the subjects of analysis here.) Furthermore, the expansion of production led to the improvement of production efficiency (generally speaking, the closer a factory gets to full production, the greater its entire efficiency becomes), which accelerates the improvement of energy efficiency. However, power efficiency has been improving more than the rate of operation since fiscal 2011. In fiscal 2011 and 2012, electricity consumption decreased along with the decline of the rate of operation. In fiscal 2013, the rate of operation improved, but the increase in electricity consumption was below the rise in the rate of operation. (Refer to Figure 6.)

Figure 5: Changes in Power Efficiency by Industry

Sources: Index of Industrial Production, Survey of Electric Power Statistics
In addition, the effects of investments in energy conservation, maintenance and repairing operations are surfacing. According to the Development Bank of Japan Inc.’s survey on capital investment plans, maintenance and repairs hit the highest mark of 25.6% (fiscal 2013) on record for the manufacturing industry’s motivation for capital investment. For capital investment plans in fiscal 2014 as well, this rate will rise to 27.3%. Maintenance and repairs facilitate smoother management of facilities and equipment, which leads to improving energy efficiency. Moreover, for the manufacturing industry’s motivation for streamlining and labor saving, the percentage changed from 9.8% to 12.1% to 11.5% to 12.7% in fiscal 2011, 2012, 2013 and 2014 (planned), respectively, after the earthquake disaster. It is not easy to restart nuclear power plants. Electricity companies are more likely to carry out additional increases in rates. Fossil fuel prices are forecast to remain high. In this situation, the underlying tendency of energy conservation-related investments is speculated to be toward increasing.

To take a closer look at the current state of affairs, we examined the ratio of energy costs to production costs by industry with a focus on the comparison between 2010, when nuclear power plants were in operation, and 2012, when there were almost no nuclear power plants in operation. The percentages increased in the case of energy-consuming material industries (pulp and paper, chemicals, ceramics, quarrying, steel, non-metals and semiconductors). The largest margin of increase was 2.5 points (from 9% to 11.5%) with ceramics and quarrying. The second was 1.6 points with the steel industry. However, the margin of increase in the whole manufacturing industry was just 0.4 points in comparison between 2010 and 2012. This suggests that in the case of energy-consuming industries, the impact of price increases cannot be curbed even by the reduction of energy consumption through energy conservation. However, automobiles and machines, which are Japan’s leading export items, are almost free from the impact of energy cost increases. Data from 2012 shows that it is difficult to say that energy costs had a serious effect on Japan’s export competitiveness. (Refer to Figure 7.)
Now, we will take a further look at the effect of energy costs on export competitiveness. What was the state of affairs in fiscal 2013 when there were almost no nuclear power plants in operation? Although there are no industrial statistics data available, production growth in the whole manufacturing industry increased by 3.2% from fiscal 2012 and power consumption growth increased by 0.7% from fiscal 2012. Growth in the final energy consumption is estimated to be almost equal to that of electricity according to calculations based on primary energy supply and power consumption. Both power and energy efficiency can be considered to be further improving. Energy prices are rising, but the effect of production increase surpasses the rise in energy prices and operating profitability in the whole manufacturing industry is growing. There is a strong likelihood that the burden of energy costs is declining. Yen-based exported goods prices increased by around 10% in fiscal 2013 against the background of the yen’s depreciation. Even domestic corporate goods prices of industrial products increased by 1.3%. Looking at the whole manufacturing industry, it can be suspected to cover the increase in cost by improved profitability of exports (gains from the yen’s depreciation).

Figure 8 illustrates the relationships between the operating profitability rates of the manufacturing industry specified in the Financial Statements Statistics of Corporations by Industry of the Ministry of Finance and changes in foreign exchange rates and energy prices. As illustrated in the lower panel of Figure 8, the profitability rates of the manufacturing industry have little connection with energy prices. As noted above, the profitability rates of the manufacturing industry are linked significantly with changes in real foreign exchange rates.

Source: Industrial Statistics
through an increase (or a decrease) in export prices. Japanese companies have not increased the amount of units through price decreases but are enjoying gains from the yen’s depreciation in terms of price. As illustrated in the upper panel of Figure 8, the profitability rates of fiscal 2013 improved. The data suggest that the effects of the increase in energy costs in fiscal 2013 have eased from fiscal 2012. It can be said that the growth in cost triggered by energy price increases was within the level of being offset by gains from the yen’s depreciation.

Figure 8: The Relationships between the Operating Profitability Rates of the Manufacturing Industry, Foreign Exchange Rate (above) and Energy Prices (below).

Sources: Financial Statements Statistics of Corporations by Industry of the Ministry of Finance, Domestic Corporate Goods Price Index

Our calculations of the relationships between the operating profitability rates of the manufacturing industry, a change in real foreign exchange rates and a change in fossil fuel prices (on the contract currency basis) by the following formula show that the change in fossil fuel prices on the contract currency basis did not meet signal condition. (It is conceivable that the change in fossil fuel price is a proxy variable showing the state of the global economy.)
By industry, even energy-consuming industries, such as steel and chemicals, showed improvements in the rate of the operating profitability rates to net sales in fiscal 2013. It seems that the effect of gains from the yen’s depreciation surpassed the burden of the increase in energy cost. For multipurpose machines and automobiles (machines for transportation), the changes in energy cost and operating profitability rate had no relation and the trends of foreign exchange rate and the global economy had even greater impacts. In fiscal 2013, import volumes of fossil fuel reached their peak and hardly increased. The movement of international energy prices is the only conceivable factor that could have affected business conditions. It should be considered that the effect of nuclear halts on the manufacturing industry has almost ended. (Refer to Figure 9.)

Figure 9: Changes in the Ratio of Operating Profitability Rates to Net Sales in Major Manufacturing Industries

Sources: Financial Statements Statistics of Corporations by Industry of the Ministry of Finance, Index of Industrial Production, Trade Statistics of Japan

The above-mentioned case of Komatsu seems to offer some suggestions about the future outlook of industrial energy conservation. There are many superannuated factories nationwide that were constructed in response to the oil crises in the 1970s. If those factories are fundamentally renovated and rebuilt, there will be some room for revising energy-conserving machines and equipment and production processes. Komatsu has the prospect of reducing its energy use...
entire power consumption by half within a few years and this is true of other companies. By reviewing production processes, businesses can shorten the construction period and build a more efficient production structure, as well as gain energy-conserving effects, which would lead to effective reduction of the whole production cost. If companies address these revisions, the Japanese industry can never be said to be a “dry dust cloth.”

Komatsu estimates that the investment collection period will be ten years. The judgment of the corporate top management is an exceedingly important factor in determining whether the company can endure this investment collection period or not. The issue of how to cope with the increase in energy prices is likely to be linked with distinguishing between companies which can withstand investment collection risks and companies that cannot withstand the risks.

- The Trends of Energy Conservation in Business (office and store)
  Operations Accelerated in the mid-2000s

For energy conservation in office and store operations, energy conservation starting from the mid-2000s bears comparison with the energy-conserving period from the 1970s to around fiscal 1985. Or rather, energy conservation is progressing more today. This shows that environmental and energy conservation regulations have some effects. In response to the Kyoto Protocol (which went into effect in February 2005), which required developed nations to reduce greenhouse gas emissions, energy conservation regulations and assessment measures were introduced, including the Act on the Rational Use of Energy stipulating that mandatory notification of energy conservation measures should be applied to new buildings with an area of more than 2,000 square meters. Interviews with construction industry-related persons say that newly constructed buildings compatible with the new standards can reduce energy consumption by half compared with the period before they were rebuilt. Investments in energy-conserving technologies (thermal insulation, air-conditioning units, cooling and heating system and efficient lighting system) can be collected within five to seven years. Investments in light-emitting diode lighting, which is decreasing in price, can be collected within three to four years. If structures are approved for the conditions for their environmental and community contribution, their floor-area ratio is eased in urban areas. There are some cases in which profitability can be secured even if structures realize energy savings of 70%. Given the reconstruction of buildings for urban redevelopment and the decrease of area space due to depopulation, energy consumption in office and store operations is likely to naturally decrease by a significant amount. (Refer to Figure 10.)
Energy Conservation Has Also Taken Root in Households in the Same Way

The trend of energy conservation greatly progressed in industries from the 1970s to the early 1980s. However, energy consumption per household continued to rise along with the growing use of domestic electric appliances and cooling and heating devices. This situation was combined with the population increase, and the number of households and the whole household energy consumption rapidly increased. (Refer to the upper left figure of Figure 11.) The figure illustrates that energy consumption per household showed a continued growth trend until 1995 and energy consumption supported the improvement of material living standards during that period of time. From the 1970s to 1985, households came to own more than one air-conditioning system and color television, and refrigerators and washing machines increased in size. New home electric appliances, such as video recorders, appeared. In this situation, although energy conservation with individual products advanced, energy consumption for households was not restrained. It was in 2005 that domestic energy consumption began to show a downturn. (Refer to the upper right figure of Figure 11.)

In the 2000s, in addition to the energy conservation of individual home electric appliances, the prevalence of products became nearly saturated and energy consumption per household did not increase at all. Furthermore, the effects of depopulation appeared and the total amount of energy consumed started to decrease. (Refer to the lower figure of Figure 11)
A reason why the trend of energy conservation in households progressed in and after the 2000s is that the number of people per household gradually decreased. In addition, the trend was supported and driven by the enhancement of energy conservation regulations based on the Kyoto Protocol, just like the case of energy conservation in office and store operations. For housing, large-sized apartment buildings were required to abide by thermal insulation standards based on the Act on the Rational Use of Energy. In addition, top runner target product standards were introduced for domestic electric appliances and energy conservation measures specifying target fiscal years were required for refrigerators, air conditioners and lighting. A special labeling system was also put in place to show whether individual products met the standards or not. These measures have enabled consumers to choose energy-conserving products more easily, and energy conservation in households has naturally progressed along with the purchasing cycle of new products. It is certain that depopulation will directly lead to a decrease in the number of households in the future and the total energy consumption of households will continue to show a downward trend.

- Energy Consumption in the Transportation Sector Will Significantly Decrease by Low Growth

In fiscal 2012, the fuel efficiency of automobiles almost reached the level necessary to meet the fiscal 2020 standard of 20.3 km per liter on average for the automobile industry. In recent years, the fuel efficiency of automobiles has improved at an annual rate of 6 to 8%. This is
greatly influenced by the popularity of hybrid vehicles and light automobiles. In Japan, the ratio of next-generation vehicles to net passenger automobile sales has reached about 25%. The key to increasing the popularity of electric vehicles, which are attracting much attention, is improving storage cells. The current challenge is coping with their short life span and the long time required for recharges. Under the backing of the government, fuel cell vehicles are expected to be popularized in the 2020s. The significant challenge is reducing costs and building hydrogen refueling stations that cost about 500 million yen per unit.

Although there are challenges to the popularization of next-generation vehicles, traffic management and control supported by eco-driving oriented toward refraining from sudden starts and quick acceleration as well as ICT technologies, such as the spread and advancement of car navigation systems using GPS, will help further ease traffic congestion and drive improvements in fuel efficiency. Movement in the passenger sector is a typical representation of the relationship between living standards and energy consumption of the transportation sector. Just like the case of the household sector, where, even after fuel prices rose in the wake of oil crises, transportation volumes increased dramatically due to the widespread use of private automobiles and the expansion of recreation, and energy consumption expanded. (Refer to the upper left figure of Figure 12.) In the 2000s, young people started to avoid using automobiles and fuel efficiency improved (energy conservation progressed), as noted above. In this situation, energy consumption per transportation volume rapidly decreased. (Refer to the upper right figure and lower figure of Figure 12.) It is thought that transportation volumes will definitely decrease in the future due to depopulation just like the case of the household sector. Therefore, the total amount of energy consumed in the transportation sector is likely to decrease rapidly.
Structural Transformation Occurred within the Manufacturing Industry During the Oil Crises: Increased Presence of the Lever of Energy Conservation

Now, we will take a look at the relationship between energy conservation and economic growth from the time of the oil crises to the 2000s. Following the first oil crisis in the fall of 1973, the second oil crisis occurred from the end of 1978 to 1981, triggered by the Iranian Revolution. Japan was hit with a sharp rise in energy prices and its economy was thought to have been devastated. However, the average growth rate from 1973 to 1985 was 4%. In the 1980s, Japan showed a decrease in energy consumption while achieving a growth rate of 3%. Along with a rapid increase in fossil fuel price, energy efficiency dramatically improved in and after 1973. However, this suggests that if fossil fuel prices go down and low energy prices continue, energy conservation will not progress. After fossil fuel prices had risen again due to the rapid growth of emerging economies, such as China, from the early 2000s, energy conservation began to progress again. (Refer to Figure 13.)
After the oil crises, individual Japanese industries made an all-out effort to conserve energy. In addition, Japan’s economic structure itself underwent a dramatic transformation. For the manufacturing industry, which consumes more energy than the tertiary industry, the focus shifted from the heavy material industry to the high-tech industry represented by electronics, automobiles and machinery. From 1970 to 1985, the whole manufacturing industry realized an average growth of about 5%. For the whole manufacturing industry, the rate of the machine industry (including electronics and automobiles) expanded and achieved an annual average growth of about 10%. The Japanese economy peaked around 1990. This was based on the country’s industrial transformation “from heavy to small” in the aftermath of the oil crises. What should not be overlooked is that the material industry, such as steel and chemicals, also made efforts to conserve energy, supported by the prosperity of the machine industry, and achieved a growth of more than 4% and was able to expand its scale. As a result, the ratio of the whole manufacturing industry to the economy grew. (Refer to the upper figure of Figure 14.)

The figure clearly illustrates that the rise of new industries (including electronics) propelled by the crisis drove other industries as well. In addition, the rate of the manufacturing industry to the whole economy did not decline amidst structural changes to the industry and the trend of energy conservation. The percentage of the non-manufacturing industry was growing along with economic development, but it was energy-related industries that contracted due to energy conservation. Meanwhile, a focus on the period from 2000 to 2012 shows that the percentage of energy-related industries hardly decreased by 2010. The rate of energy-related industries to real GDP was stably 4% until 2010 before the major earthquake and nuclear accident occurred in 2011. However, the rate dropped by 1% in just two years after the earthquake disaster. It can be said that the earthquake-triggered rise in electricity rates brought the level of energy conservation to that of the time of oil crises. (Refer to the
lower figure of Figure 14.)

**Figure 14:** The Energy Industry Did Not Contract in the 2000s (the figure below, the rate of the industry to real GDP) Compared with the Time of Oil Crises (the figure above)

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**Note:** Oil and coal products are excluded from the manufacturing industry. Electricity, gas and water are excluded from government services. We used rates on a real basis to examine the relationships with energy consumption.

Source: Annual Report on National Accounts of 2014

- **If Japan’s Economic Structure is at the U.S. Level, There Will Be Room for Further Energy Conservation.**

  The research paper “Vision 2050: Maintain Position as a First-tier Nation” which the Japan Center for Economic Research drew up in February 2014, presented an outlook on Japan’s energy consumption. Our growth stagnation scenario (an average growth of 0.2% until 2050) shows that energy consumption will decrease by 30% compared with fiscal 2010. However, our growth scenario (an average growth of 1.4% until 2050) shows that energy consumption will decrease by about 10% compared with fiscal 2010. (Energy consumption will increase by 20% over the stagnation scenario.) The growth scenario postulates that the average improvement rate of energy efficiency will continue in the same way from the oil crises to the
most recent period due to energy conservation investments in the sectors of industry, office and store operations, transportation and households. For the economic structure, the growth scenario postulates that the most recent trend will continue and changes will stop in fiscal 2050. Based on these assumptions, we offset downward factors of energy consumption due to depopulation and upward factors of energy consumption due to the increase in growth rate.

Generally speaking, efforts to conserve energy in the cases of the oil crises are considered to be difficult to make in terms of the “dry dust cloth theory.” However, there is a strong likelihood that Japan will shift to U.S.-style economic structures based on the non-manufacturing industry. In the sector of information and communications technology (ICT), where there is tough competition through the latest technology, a key source of competitiveness is not the amount of energy consumed but analyses of information and data on customers and markets. If such area makes up a larger share of the whole economy, it will directly lead to the establishment of an energy-conserving society. Energy consumption will decrease by 40% in fiscal 2050 compared with fiscal 2010. The growth scenario specified on the left figure of Figure 15 shows a case in which individual industrial sectors make the utmost effort to conserve energy and the scenario does not assume that economic structures will change significantly. The estimate in the right figure, which is based on the assumption that economic structures will change, shows that the rate of industrial sectors (primarily the manufacturing and construction sectors) to the whole economy will decrease from 27% to 19% (the level of the United States in 2012) by fiscal 2050. The energy efficiency of operations primarily in the non-manufacturing industry and government services is ten times as large as the industrial sectors. If the rate of industrial sectors decreases by 6% and this portion shifts to the operational sector, energy consumption will decrease significantly even in the case of sustained growth.

We postulated that the transportation sector will be reduced by half, considering the trend of depopulation. Experts in the automobile industry estimate that they will be able to reduce energy consumption by 25% in fiscal 2020 from the level of fiscal 2005 due to the combined effects of actions for resolving traffic congestion. Considering that depopulation will accelerate starting from 2025, this scenario is quite likely to become a reality. We calculated the household sector on the basis of the 2013 energy-conservation standards and the discussion by “Mid-and Long-term Roadmap for Global Warming Measures”. Houses that meet the 2013 energy-conserving standards have greater thermal insulation effectiveness than houses built before 1980 and their cooling and heating systems consume only 40% of the energy of houses built before 1980. The standards will be applied to all new houses as well in 2020. According to a scenario presented by the environmental ministry’s subcommittee, if the current level of energy conservation continues in households, home energy consumption will have decreased by 15% in 2050 compared to 1990. Housing manufacturer experts think that this scenario is valid and we have used this estimate.
Figure 15: Economic Structural Changes Have a Decisive Impact on Energy Consumption

Note: The average growth rate by 2050 is 1.4%.

Sources: Estimate based on data from the Institute of Energy Economics, Japan, system of national accounts (SNA), data from the U.S. Department of Commerce

In addition, Figure 16 illustrates an estimate of fossil fuel import prices in the growth scenario of the research paper “Vision 2050: Maintain Position as a First-tier Nation” on the basis of a 2013 crude oil price forecast from the International Energy Agency (IEA). The figure on the left shows a scenario that is not based on the assumption that major economic structural changes will occur. Suppose that energy increases in the growth scenario are covered by fossil fuel imports, fossil fuel prices will annually exceed 10 trillion yen in fiscal 2050. Fossil fuel consumption will decrease in fiscal 2050 in comparison with fiscal 2010 through energy-conserving efforts, but fossil fuel import prices will rise due to the price increases. As of fiscal 2050, fossil fuel prices will have reached 50 trillion yen, more than double the level of fiscal 2012. (This estimate is based on the premise that Japan will completely abolish nuclear power plants and replace them with the latest natural gas and thermal power generation.)
Figure 16: If Japan’s Economic Structure Changes at U.S. Level, Fossil Fuel Price Increase Can Be Covered by Energy Conservation

In Case of No Economic Structural Change

- For addition by the economic growth
- fossil fuel imports (BaU)

In Case of Major Economic Structural Change

- For addition by the economic growth
- fossil fuel imports (BaU)
- Total

Note: Fossil fuel prices are based on the assumption that a barrel of crude oil will be 235 dollars in 2035 and will level off afterward. Fossil fuel prices are based on an exchange rate of one dollar to 100 yen.

Sources: Trade Statistics of Japan, data from the Institute of Energy Economics, Japan, system of national accounts (SNA)

The right figure in Figure 16 illustrates that in addition to offsetting fossil fuel import prices by conserving energy, import prices will start to reduce in the 2030s and lead to resolving a trade deficit. This is because the estimation is based on the assumption that crude oil prices will level off in or around 2035. Even if crude oil prices rise at the same pace as the period until 2035, the increase due to growth can be offset.

- Productivity Improvement in the Non-Manufacturing Industry is Key

A significant point in evaluating the validity of the above-mentioned estimate results is whether labor productivity can be maintained or not if Japan’s economic structure will transform into one based on the non-manufacturing industry, like the United States. Figure 17 illustrates comparisons of productivity in major non-manufacturing industries between Japan and the United States. Our country is surpassed by the United States. The per capita GDPs by economic activity in highly profitable financial, insurance and information and communications industries show particularly remarkable disparities. In addition, the United States is higher by more than double in the profitability of services including highly profitable consultancy for supporting corporations. Japan Center for Economic Research presented a policy proposal titled “Tokyo Financial City Vision: Vitalizing Japan’s Financial and Capital Markets as a Pillar to the New Growth Strategy” for the strengthening of competitiveness in the Japanese financial industry. Financial enhancement leads to the realization of a rich energy-conserving society. The differences in competitiveness between non-manufacturing industries are particularly notable.

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4 This was a joint proposal between the Daiwa Institute of Research and the Mizuho Research Institute.
Japan and the United States can also be seen in the information and communications technology (ICT) industry. The development of the ICT and financial industries can be considered to be connected. ICT is also indispensable for the productivity improvement of services. ICT is the key technology to support efficiency improvement (including things other than energy conservation) in every industry, operations, households and the transportation sector. It is essential to boosting Japan’s growth capabilities by accelerating the progress and utilization of ICT. JCER organized a research group in October 2014. We are planning to conduct analyses and proposals for the enhancement of competitiveness.

Figure 17: Productivity of the Non-Manufacturing Industry in Japan and the United States (nominal GDP by economic activity/number of employees)

Note: GDP by economic activity in 2012. Based on an exchange rate of one dollar to 105 yen (2012, OECD’s PPP rate)

Full utilization of ICT requires not only investment in facilities and equipment but also the education of human resources who can use facilities and equipment and a fundamental review of specific operations. Investment in knowledge capital is indispensable. The government is currently considering corporate tax cuts. This is more about encouraging investments in knowledge capital than about reducing tax on investments by conventional special taxation measures.

- Integrated Measures Consisting of Energy, Environment and Economy Are Necessary

The yen’s depreciation caused by a market-oriented economic policy called Abenomics, combined with the increase in fossil fuel price, brought about the rise in domestic energy prices and consequently led to the great progress in energy conservation. (There is a strong

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5 The Research Group of Economy and Society Transformed by Information and Communications Technology (chaired by Kazumasa Iwata)
probability that the additional monetary easing the Bank of Japan decided to carry out at the end of October will also cause further weakening of the yen and prompt energy conservation through the increase in energy prices.) A particular look at Abenomics in terms of environmental policy shows that it can be said to have enacted environmental measures fully dependent on price mechanisms, not conventional regulation-centered environmental measures, although these developments may have been unexpected. While the effectiveness of measures using price mechanisms is now being verified, there remain some concerns.

Firstly, there are concerns over the return to coal and thermal power generation. In the current situation in which full nuclear utilization is impossible for the years ahead, it is not impossible to understand that industrial circles hope for a “shift to inexpensive coal and thermal power generation” as a short-term measure out of fear of a decline in their export competitiveness due to an energy price increase. However, the United States and China are showing a positive attitude toward setting targets for reducing greenhouse gas emissions and the European Union (EU) is also committed to reducing greenhouse gas emissions by 40% by 2030 compared with 1990. Amidst this situation, it is inevitable that Japan will be required to tackle global environmental issues in the future. The expansion of coal use without considering the social costs, such as greenhouse gas emissions reduction and disposal of coal ash, should be carefully carried out. It may be conducive to the improvement of power generation efficiency to think about the popularization of the latest highly efficient coal gasification power generation and natural gas power generation. “Irresponsible and thoughtless measures to decrease energy prices” without considering social costs could lead to the loss of perfect opportunities to drive economic structural innovation.

Secondly, there are concerns over how Japan should tackle global warming. Conventionally, long-term energy consumption projections are conducted with the setting of a national goal for the reduction of greenhouse gas emissions. For example, crude steel production is often exogenously given on the basis of fixed, existing economic structures. This approach does not consider the Japanese economy’s capability to cope with external environmental changes and may stunt growth. JCER’s latest projection suggests that the transformation of economic structures will be a significant variable for the national survival and prosperity of Japan and making existing structures a sacred cow could be detrimental to our country. The Tokyo metropolitan government introduced the greenhouse gas emissions trading system for large-scale enterprise offices in fiscal 2010 and was able to reduce greenhouse gas emissions by more than 20% in fiscal 2012 in comparison with the benchmark year. Tokyo’s action shows the possibility that an approach using price mechanisms, such as greenhouse gas emissions trading and the environmental taxes, will realize a transformation into economic structures that can “flexibly” handle global warming and energy restraints.

Sohei Nakayama, the then-advisor to the Industrial Bank of Japan, who worked energetically to elaborate plans to cope with the Oil Crisis of 1973 from the standpoint of industrial circles, recognized the necessity of transforming economic structures and shifting to an energy-conserving society with a focus on the international division of labor. As is
symbolized by the disappearance of the aluminum refineries that consumed a large amount of electricity from Japan in the aftermath of the oil crisis, the rise in energy price is likely to directly lead to the waxing and waning of particular industries. However, it will not necessarily lead to the decline of the whole Japanese economy. If society moves toward the promotion of energy conservation again, it is highly likely to be a source of growth and international competitiveness. JCER suggested in this May that the time is just around the corner in which the linkage between energy consumption and economic growth can be cut off through the pursuit of the 4Ss (Safety, Security, Sustainability and Smart). To realize sustainable growth in an era with energy restraints, it is indispensable to implement a policy based on a harmonious balance between energy, environment and economy. A major transformation of economic structures is inevitable.

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