14th June 2011

Economic losses Could Hit ¥7 Trn if All Nuclear Plants Cease

Current Account Deficit from FY2017 through the Substitution of Thermal Power

JCER Medium-Term Economic Forecast Team*

How might the shape of the Japanese economy change over the next decade in the wake of the Great East Japan Earthquake? We have updated our 37th Medium Term Forecast for the Japanese economy released in February in order to account for factors such as electric power shortages, as well as damage and reconstruction demand resulting from the tsunami. Following serious accidents at the Fukushima Daiichi nuclear power plant, the safety of nuclear power stations is being subjected to very severe scrutiny. In the event that nuclear stations are shut down as they come due for regular safety inspections, power shortages could cause production capacity to fall by 1.2% per year on average from 2012 through fiscal year 2020 (April 2020–March 2021), resulting in economic losses of ¥7 trillion. On the demand side, growth will receive a lift from factors such as rebuilding of infrastructure in the Tohoku region, but maintaining production will require that thermal power generation be substituted for nuclear. In turn, fossil fuel imports will increase sharply, giving rise in the future to a chronic deficit in Japan's trade and services balance. The nation's current account balance will fall into the red from fiscal year 2017 (April 2017–March 2018) onward. Japan's CO_2 emissions, of which reduction is critically important to combat the greenhouse effect, will likely rise by about 14% over 1990 levels by FY2020, making it extremely difficult for the nation to achieve its international greenhouse gas emission targets.

In addition to reconstruction spending, lower tax revenues associated with the slump in growth will further worsen government finances, and the outlook is increasingly inevitable for tax increases if a government default is to be avoided.

Main Points

(1) A shutdown of all nuclear power stations would cut supply-side capacity (potential GDP) over the long term (1.2% per year on average between FY2012–2020, with a ¥7.2 trillion loss in wealth per year).

(2) Chronic deficit in trade and services balance, with current account deficit from FY2017.

(3) Government fiscal deficit to rise sharply, with unavoidable rise in tax burden and spike in greenhouse gas emissions .

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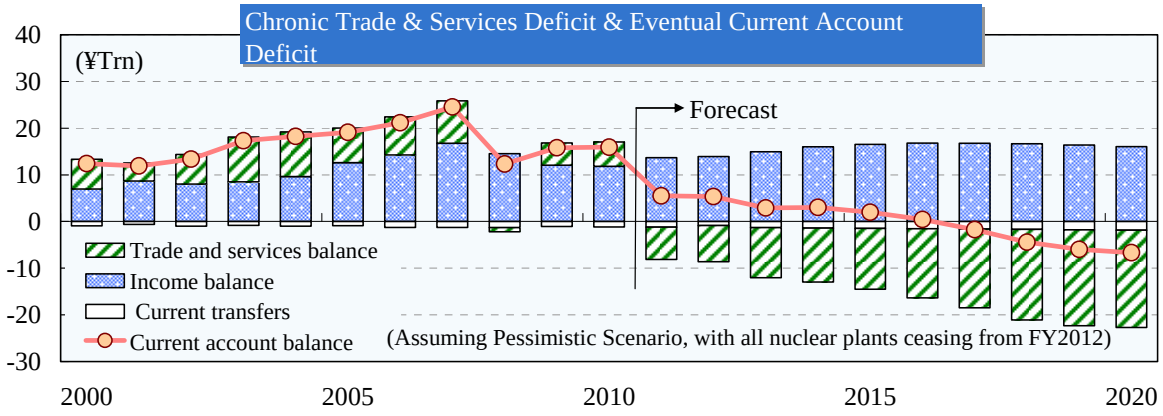


Source : JCER forecast based on Ministry of Finance and Bank of Japan, *Balance of Payments Statistics*.

1. Introduction

The Great East Japan Earthquake of March 11, 2011, together with the associated tsunami and nuclear power station accidents, brought with it significant damage and other consequences for Japan. Even as earthquake aftershocks continue, the accidents at the nuclear power stations remain unresolved. With the peak summer demand just around the corner, power shortages are becoming an issue, but that does not mean they will be resolved within this year. Rather, the impact will continue several years into the future. Massive spending will also be necessary for reconstruction and recovery, but in view of how dire the state of Japan's government finances was even before the earthquake, increases in spending could hasten the speed of deterioration, pushing up interest rates via the risk premium and thereby constraining business and government activity.

In response to these concerns, we have updated our Medium Term Forecast released in February of this year, focusing mainly on the supply-side constraints caused by power shortages, the damage to the capital stock, and on reconstruction-related demand, taking into account the conditions following the earthquake disaster.[1] The present update is based on limited information available at the present time, and in order also to focus on the impact on supply-side constraints and government finances, we have avoided making an overall update which would include the influences on industry and other areas. Readers interested in comprehensive forecasts based on detailed data should refer to our "38th Medium-Term Economic Forecast" due for release in December 2011.)

2. Principal Assumptions

Of decisive importance in the present update is the manner in which the forecasts estimate the various constraints arising from the earthquake disaster, the corresponding fiscal expenditures and other factors.

2.1. Supply-side constraints associated with power shortages: Power shortages to persist as late as FY2020 if all nuclear plants shut down.

[1] In formulating a description of the future, we have based our analysis on values forecasted through our macroeconomic model. This model is based on the JCER Environmental Economics Macroeconomic Model (please refer to JCER Discussion Paper No. 127 of April, 2010, "Impact of a Carbon Tax as Analyzed by the JCER Environmental Economics Macroeconomic Model"), incorporating equations relating mainly to SNA distribution categories. It comprises 306 equations (93 of which are estimation formulas) and 166 exogenous variables. Moreover, the outlook for FY2011 and FY2012 set forth in our forecasts for Japan is basically in line with our revised Short-Term Forecast No. 146, "Quarterly Forecast of the Japanese Economy" released on June 10, 2011.

The present task is how to reflect in our outlook the inevitable contraction that must take place in production and business activity due to power shortages. Of the factors defining the supply-side capacity (or potential GDP) of the Japanese economy, the present update perceives those which are not based on the theoretical reserves of the factors of production (i.e., labor and capital) as total factor productivity (TFP). This is what we assume will be subject to downward pressure owing to the electric power shortage.

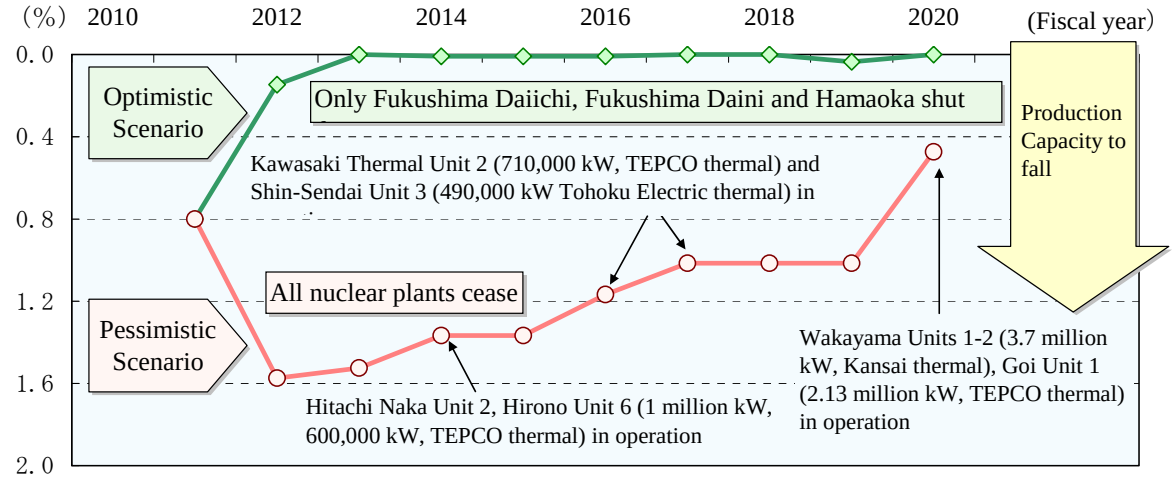
First, we have assumed that, without the impact of the power shortage, TFP would grow at 0.9%, the average annual rate prevailing over the years 1991 through 2007. We then gauge how this value is likely to be affected by power shortages due to the shutdown of nuclear power plants. The next question therefore concerns the extent to which nuclear power plants will remain in operation. In the present forecast, we consider two scenarios. The first is a Pessimistic Scenario, under which those nuclear power plants coming due for regular safety inspections will remain shut down due to a longer time period being required to complete tsunami and earthquake safety checks. The second is an Optimistic Scenario under which it will be possible to bring nuclear plants successively back into operation from FY2012 onward.

Under the Pessimistic Scenario, all nuclear power stations will be shut down in FY2012, with production activity subject to constraints mainly in the summer. The extent of the constraints will depend on such factors as the system peak load by region and the degree of dependency on nuclear power generation. If estimates are made taking account of the linkage (elasticity) between electric power and production and the size of the economies in each region, the rate of supply-side constraints nationwide would be about -1.6% in FY2012[2]. From FY2013, thermal plants now under construction would successively be put into operation, and the constraints would gradually ease. In FY2020, the remaining constraint rate would be -0.5%.

The rate of constraint under the Optimistic Scenario, meanwhile, will be -0.1% in FY2012. From FY2013 onward, only TEPCO's Fukushima Daiichi and Daini nuclear power plants (with a combined output of 9.1 million kilowatts) and Chubu Electric's Hamaoka nuclear station (3.62 million kilowatts) would be shut down, with the remaining nuclear power plants gradually reactivated. We have also assumed that those nuclear power stations in service for over forty years by FY2020 will be decommissioned.

[2] For details, see Supplement 1.

Figure 1. Supply-side constraints from Closure of Nuclear Plants (negative impact on potential GDP, %)



Note: Estimated based on Prefectural Accounts and Electric Power Statistics. Since new thermal power is expected to come into operation even under the Pessimistic Scenario, the supply constraint ratio will still decline. Indicated in the diagram are the principal thermal power stations expected or scheduled to be activated. For details, please see "Supplement 1".

Optimistic Scenario
Only the Fukushima Daiichi, Fukushima Daini and Hamaoka nuclear power stations remain shut down.
- Government works out provisional safety guidelines.
- Nuclear power plants in service for forty years or more are decommissioned.

Pessimistic Scenario
All nuclear power plants due for regular safety inspections are ceased.
- Extended time required to work out new safety standards.
- Increasing thermal power generation capacity goes ahead on schedule.

The present analysis will focus mainly on the Pessimistic Scenario.

At the present time, the standards for restarting nuclear power stations that have come due for regular inspections have not been released; it is not yet certain that it will be possible to avert a situation in which the nuclear stations will be successively shut down. In the present update, therefore, we will focus our analysis on the Pessimistic Scenario. With regard to consumption, we also take account of the impact of increases in electricity utility rates. However, we have not taken into consideration the impact which the shortage of electric power might have in negatively affecting consumer sentiment through any further downward pressure on consumption from and after FY2012.

2.2. Population, labor and capital: ¥18 trillion in damage to capital stock from earthquake disaster.

The factors of production which determine supply-side capacity also suffered massive damage from the recent earthquake disaster. Our estimates of this damage are set forth below.

2.2.1. Population: We estimate that about 22,000 people aged fifteen and above lost their lives in FY2010 owing to the earthquake disaster. We have assumed an annual average impact of about -0.0% in the first half of our forecast period (2011-2015) and an annual

average impact of -0.2% in the second half of our forecast period (2016-2020).

2.2.2. Labor force participation rate: The labor force participation rate by sex and age will remain unchanged from recent levels (FY2010).

2.2.3. Damage to capital stock (FY2010): Referring to estimates by the Development Bank of Japan, we have estimated the nationwide capital stock damage (on a gross basis) at about ¥18 trillion.[3] The values as itemized are: about ¥9.1 trillion for public capital, about ¥2.6 trillion for private residential housing and about ¥6.3 trillion for private business facilities (For details, please refer to Supplement 2).

2.3. Reconstruction demand: Estimating reconstruction demand over five years from FY2011.

As for the portion corresponding to the estimated ¥18 trillion in damage to capital stock, we anticipate a rise in investment for stock recovery in private business facilities, private housing and public total fixed capital formation. Given the fact that the damage to capital stock resulting from the Great East Japan Earthquake exceeds the amount of damage to capital stock resulting from the Great Hanshin Earthquake (which was about ¥9.6 trillion), we surmise that five years will be required for recovery (compared to about three years in the case of the Great Hanshin Earthquake).

2.4. Government finance: Raising consumption tax no easy matter.

2.4.1. Restoration costs: Our estimates are about ¥1.3 trillion for government consumption expenditures in FY2011-12 (for the removal of debris), about ¥1.2 trillion in income transfers to households (in the form of unemployment compensation and employment adjustment subsidies) and about ¥2.8 trillion in transfers to corporations (in the form of loans to small and medium-sized companies, compensation for loss caused by the earthquake including blows to business caused by unfounded rumors or misinformation). With regard also to the expense of dealing with the nuclear power plant accidents and the problem of “dual loans” (in which new debts are incurred by business and individual disaster victims who must also bear mortgage payments on properties destroyed in the disaster), we have not taken into account expenditures that may arise in the case that the government bears the costs of such issues[4].

2.4.2. Reconstruction spending: We assume that only the portion corresponding to the public capital stock damaged by the earthquake disaster (about ¥9.1 trillion) will be expended between FY2011 and FY2015.

2.4.3. Expenditures other than restoration and reconstruction spending: As for social welfare expenditures, those associated with the aging of the population will rise, with social

[3] “Regarding Estimates of Damage to Capital Stock from the Great East Japan Earthquake,” DBJ News of April 28, 2011. There is also a government estimate of the capital stock damage (¥16-¥25 trillion), but for present purposes we have opted to refer to the Development Bank of Japan’s estimates, which make it possible to use itemized values upon estimating reconstruction demand.

[4] With regard to the expense of cleaning up the nuclear power plant accidents, we estimated, in our April 25 policy proposal “Impact to last Decade or more if Existing Nuclear Plants Shut Down,” that the total expense of buying up land within 20 kilometers of the Daiichi nuclear power station, paying income compensation and paying for the decommissioning of the nuclear reactors will amount to between ¥5.7-¥20 trillion.

welfare spending and general expenditures other than that for reconstruction rising in line with increases in the price level.

2.4.4. The consumption tax rate: We have assumed the consumption tax rate will remain at 5%, with no increases being made.[5]

2.5. Overseas economies: We assume the oil prices will reach $141 per barrel in FY2020. Our current projections for overseas economies are generally in line with our February forecasts, but crude oil prices have risen since our previous outlook. Hence, one major point of contrast with our previous forecast is that we have set our estimates for the price of oil on the high side. We have also assumed that, in the event of supply-side constraints, exports will be adversely affected.

2.5.1. Growth rate: Our present forecast remains in line with our February forecast. Our forecast for the world growth rate (measured as the weighted average of Japan's export markets) reflecting the actual performance through 2010 is 5.0% for the first half of the forecast period and 4.4% for the latter half, which is essentially in line with our February forecasts.

2.5.2. Yen/dollar rate: Our forecast for the yen/dollar rate is based on purchasing price parity. In nominal terms, the price level is rising at a slower pace within Japan than it is overseas, so we expect the dollar to remain basically unchanged in the ¥80-¥90 range (with the yen weakening somewhat in real terms).

2.5.3. Fossil fuel prices: The price of West Texas Intermediate (WTI) crude oil is trading about 10% higher than it was at the time of our February forecast and has continued to do so recently. Taking this into account, we see it rising to $141 per barrel by 2020 (versus $129 according to our February forecast), with the prices of other fossil fuels also rising at the same pace.

2.5.4. Exports: With the emergence of supply-side constraints due to power shortages, we anticipate that exports will decline.[6]

3. Forecasts regarding the Macro-Economy and Government Finances

3.1. Electric power shortages and rising fossil fuel costs: Direct linkage between falling exports and consumer restraint.

First, let us formulate a clear conceptual picture of the consequences arising from the power shortages. As indicated in the above section, “2. Principal Assumptions,” if there is a

[5] We will use the scenario involving no consumption tax increase when making comparisons with our February forecasts hereafter. Please refer to section “I.1.7 Simulation: Impact of a consumption tax increase” of our February 2011 “37th Medium-Term Economic Forecast”).

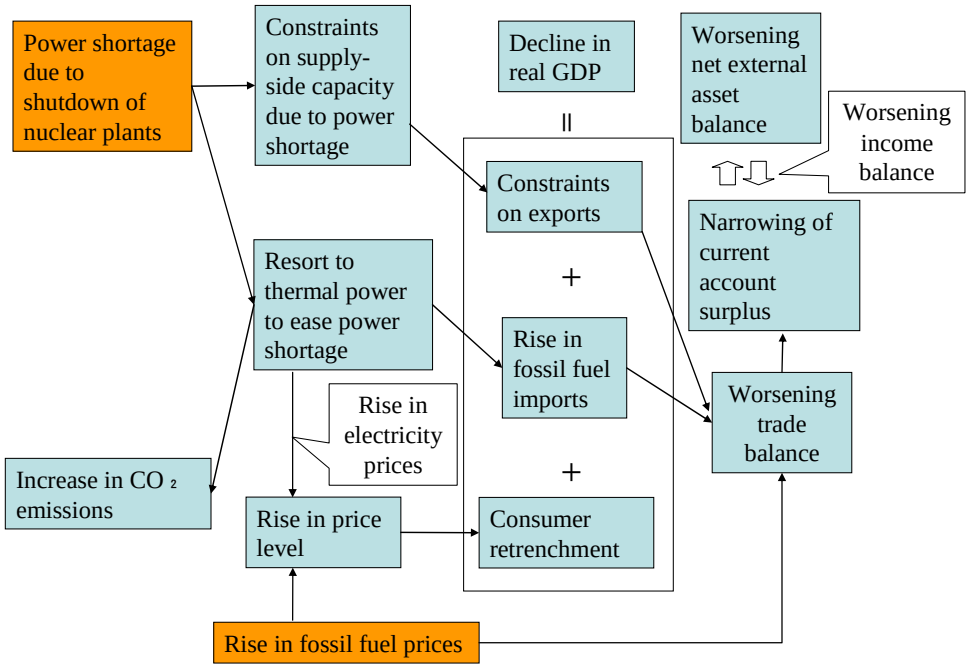
[6] We have assumed that supply-side constraints of a given degree will result in a proportional reduction in exports. It is also conceivable that business firms will move production facilities overseas to avoid location risk and power shortages. There is some danger that a move by highly productive companies (or groups) overseas could undermine supply-side capacity, but we do not incorporate such factors into our present estimates. With regard to the impact on the demand side, however, export of investment goods could conceivably rise in the short term, or even in the medium to long term they could boost exports of parts to their production bases. We have therefore adopted a neutral stance regarding these factors in the present forecast.

shortage of electric power, production will be impossible despite the availability of labor and capital. For this reason, power shortages will put constraints on supply-side capacity and therefore cause potential GDP to fall. Since supply-side capacity will be constrained, moreover, it is conceivable that exports precipitated by brisk external demand will also be subject to constraints.

It will be possible to ease the electric power shortage by boosting imports of fossil fuels and turning to thermal power in place of nuclear power generation. However, this will raise power generation costs, and in turn, push up electricity prices. With the addition of higher fossil fuel prices, the price level will increase, causing consumption to dampen. In this way, exports will decline, fossil fuel imports will rise and consumption will erode, causing real GDP to fall. Owing to the rise in the nominal value of imports, Japan's trade balance will deteriorate, narrowing the margin of surplus in the nation's current account balance.

Since the above chain of events will cause Japan's net external assets to decline, the erosion of the nation's balance on income will further undermine the margin of surplus in the current account. CO_2 emissions will also rise (Figure 2).

Figure 2. Economic Impact of Power Shortage and Rising Fossil Fuel Prices



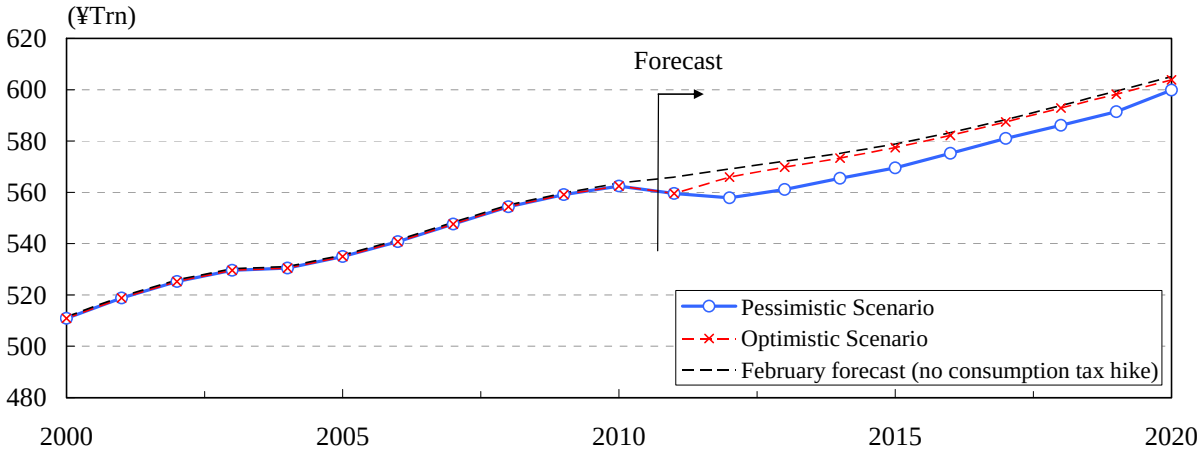
3.2. Growth rate: Average growth rate to decrease, with potential GDP falling at an average of 1.2%.

What, then, is Japan's growth path over the middle to long term? A look at the consequences on the supply-side indicates that there will be some degree of damage to the capital stock in the near term. However, since investments will be forthcoming to rebuild the capital stock, the impact of the damage caused is likely to diminish over time. Rather, electric power shortages will have a conceivably greater impact. Under the Pessimistic Scenario, all of the nuclear power plants due for regular safety inspections will be ceased from and after FY2012, and despite the expected increase in supply from newly installed thermal power generation, supply-side capacity would be subject to constraints ranging

from 0.5% to 1.6%.[7] Potential GDP will be pulled down by about 1.2% on average between FY2011 and FY2020, with a possible loss in monetary terms of ¥7.2 trillion each year.

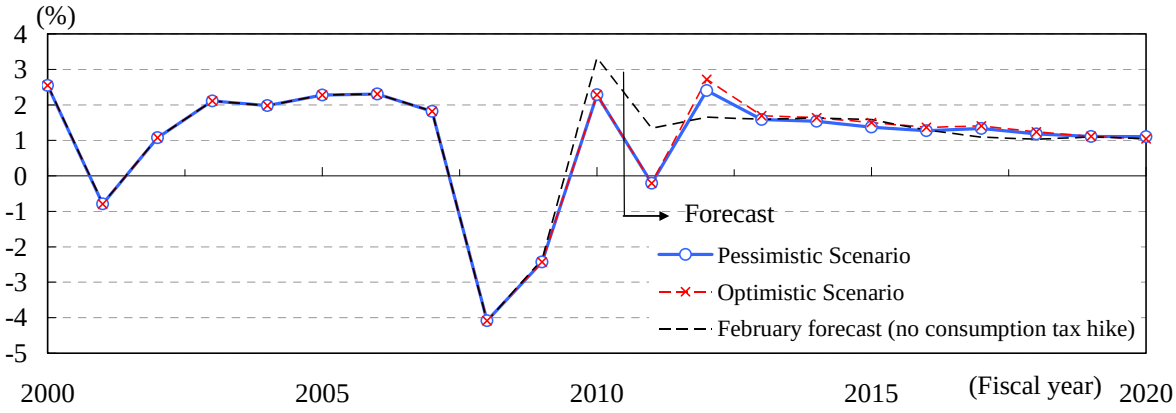
On the demand side, our outlook for overseas economies remains basically unchanged from our February forecast. However, constraints on the supply-side capacity will cause exports to fall, while the shift from nuclear power to thermal power generation will cause an increase in fossil fuel imports. In addition, rising prices on imports (including fossil fuels) and higher electricity prices will cause consumption to stall. As a result, despite the expected reconstruction-related demand in the first half of our forecast period, we believe that the average growth rate of the Japanese economy will be slower than we anticipated in our February forecast (1.27% rather than 1.34%).

Figure 3. Potential GDP (three-year moving average)



Source: JCER estimates.

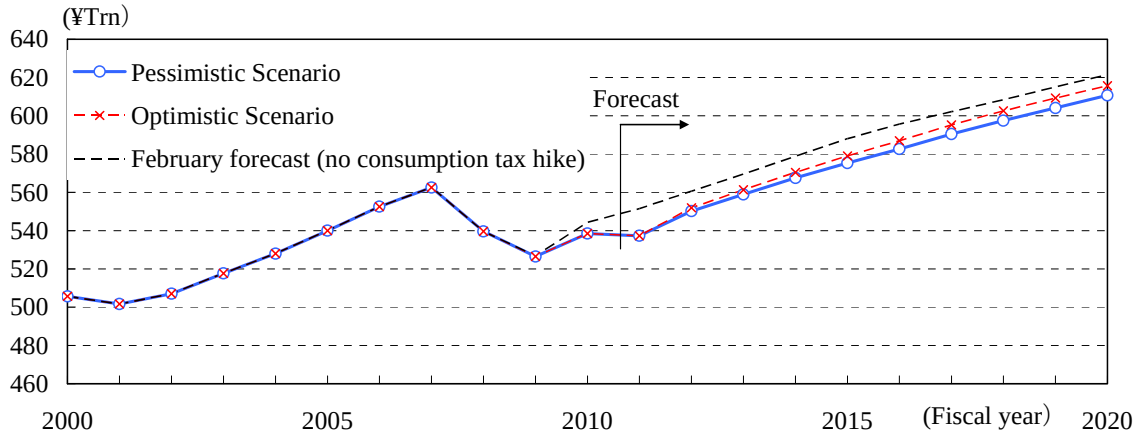
Figure 4-1. Real Growth Rate



Source: Cabinet Office, *National Accounts.*

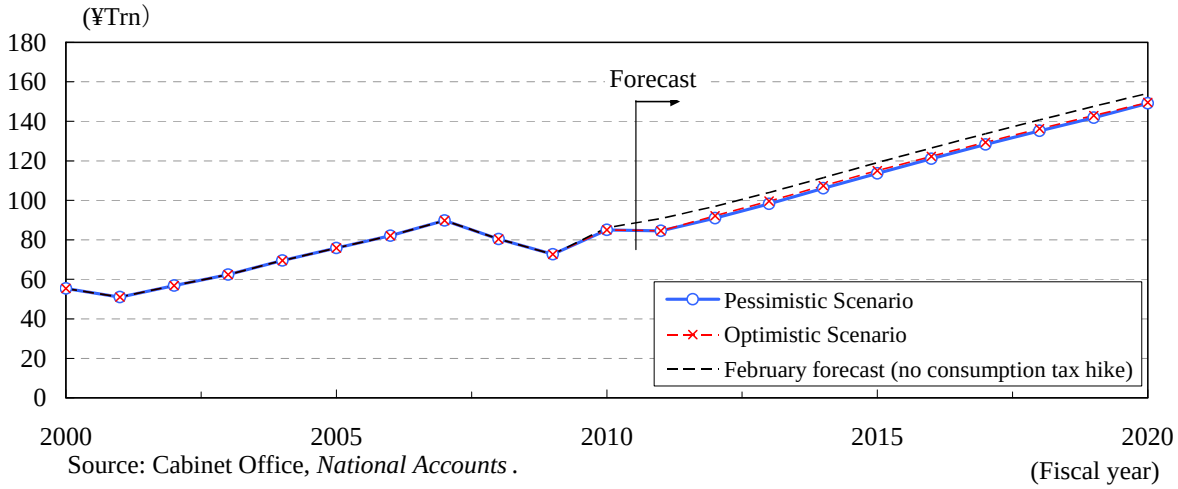
Figure 4-2. Real GDP

[7] With regard to this point, please refer to the discussion in our April 25 report, "Impact to last Decade or more if Existing Nuclear Plants Shut Down."



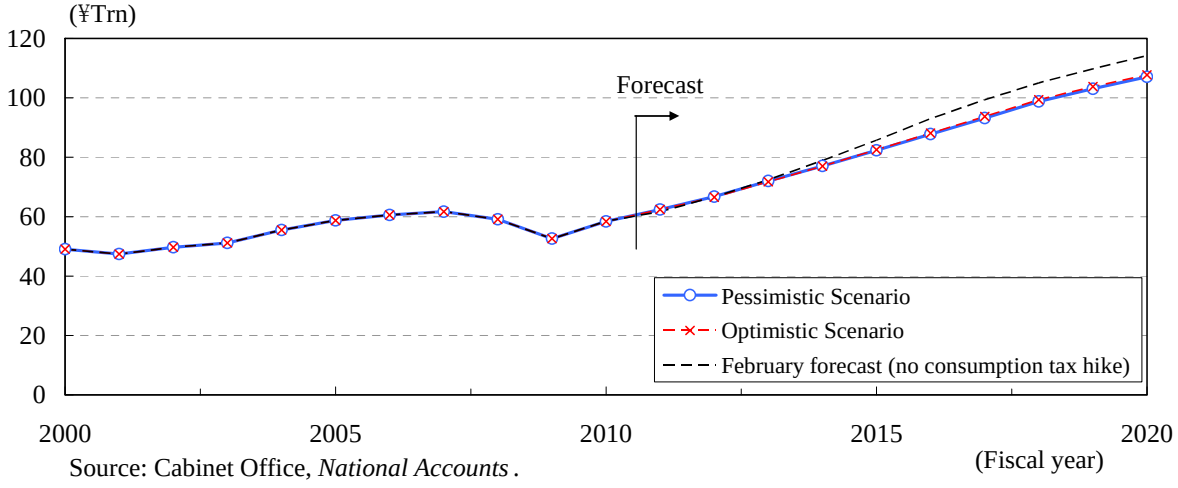
Source: Cabinet Office, *National Accounts.*

Figure 5. Real Exports, Etc.



Source: Cabinet Office, *National Accounts* .

Figure 6. Real Imports, Etc.



Source: Cabinet Office, *National Accounts* .

Figure 7. Real Private Final Consumption Spending

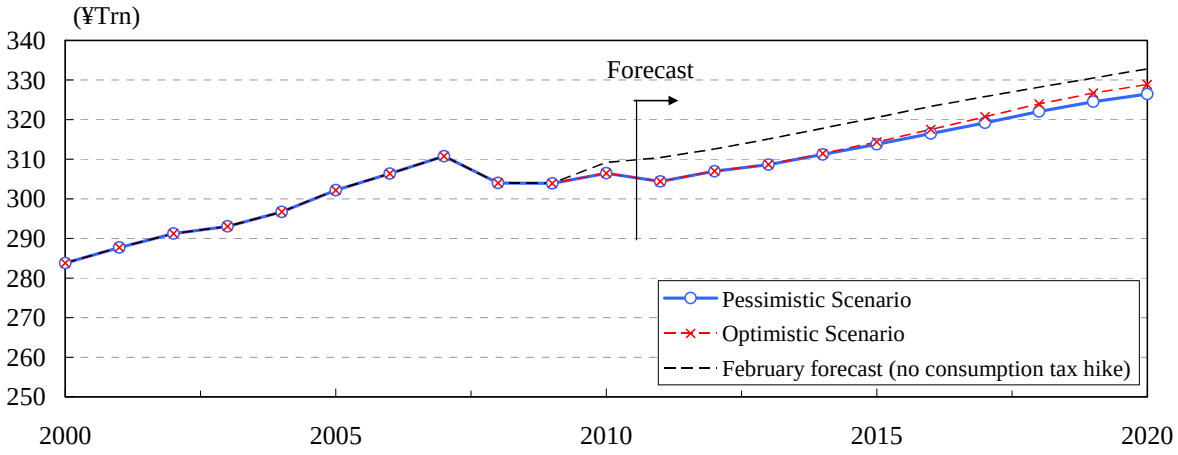
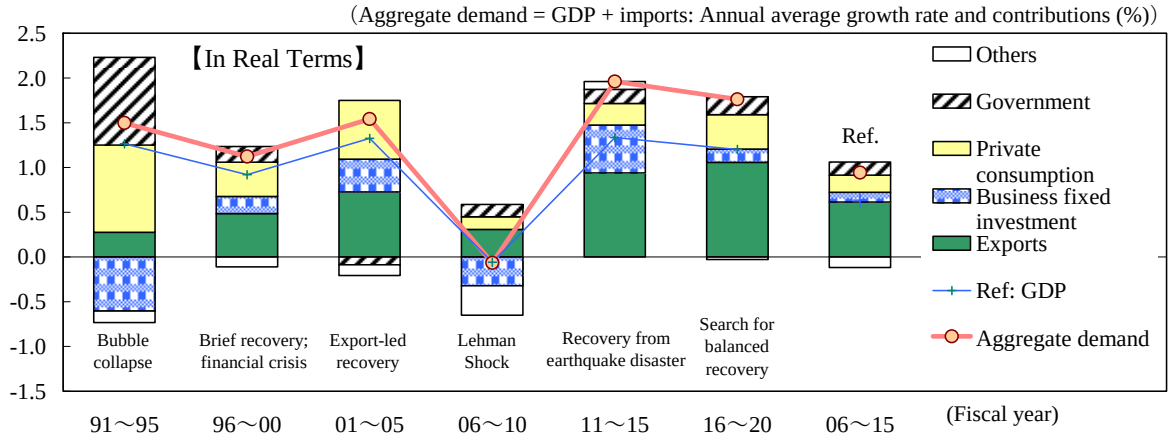


Figure 8. Aggregate Real Demand Growth and Components: Pessimistic Scenario



Constraints on supply-side capacity as well as reconstruction-related demand will likely cause the GDP gap to turn positive in FY2014. Reflecting the weakness on the demand side, however, the unemployment rate will be slow to improve and wages will remain under pressure.

Figure 9. Potential Growth Rate, Real Growth Rate, GDP Gap: Pessimistic Scenario

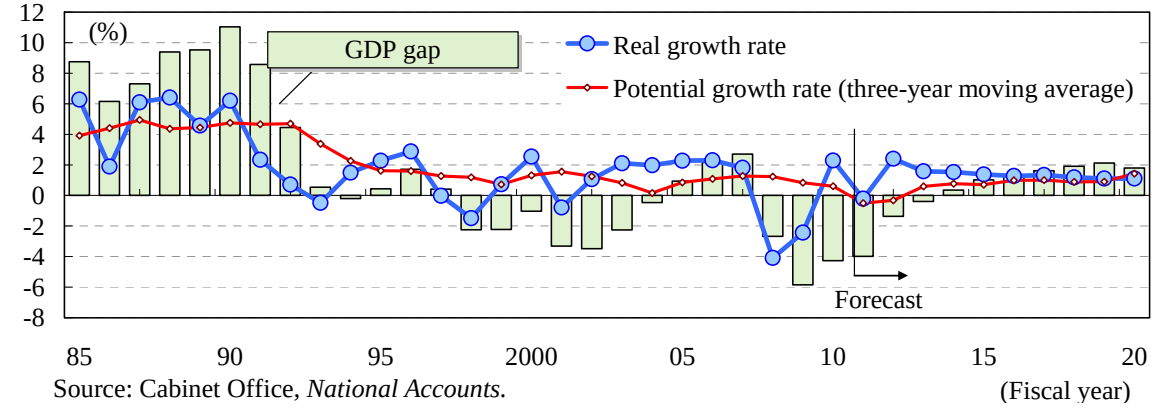
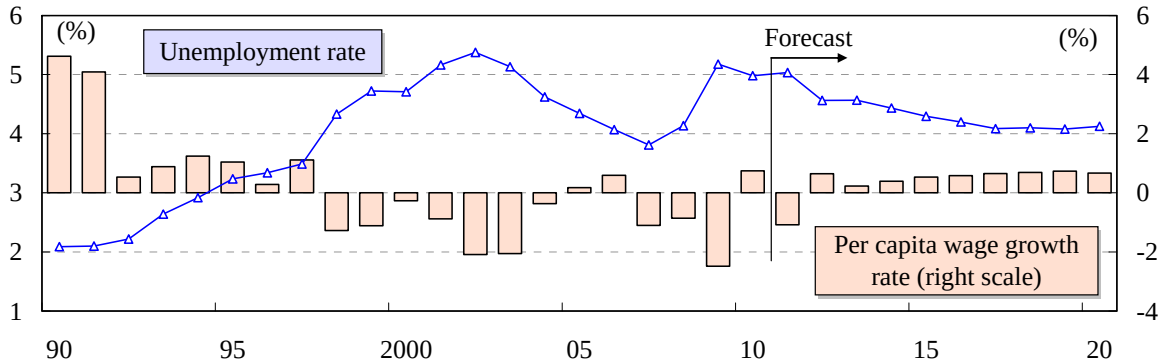


Figure 10. Unemployment rate, Wage Growth Rate: Pessimistic Scenario



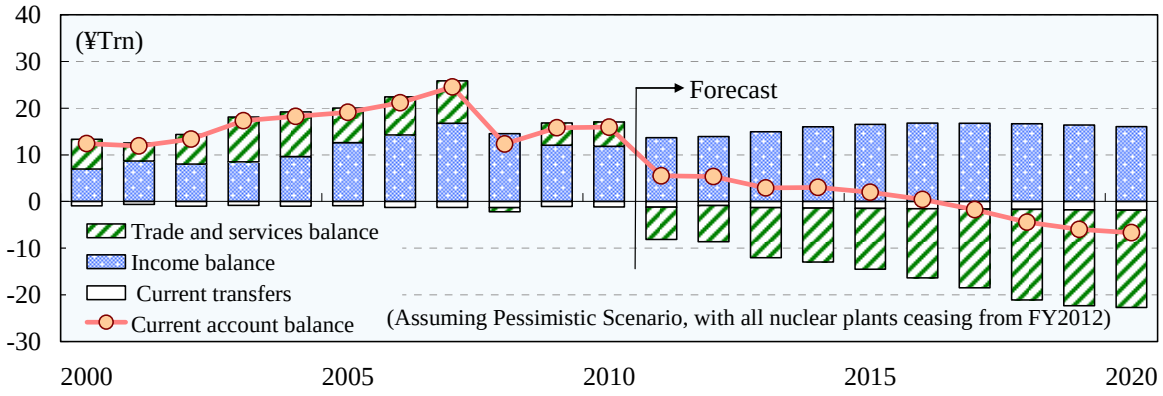
Source: Cabinet Office, *National Accounts* . ;
Ministry of Internal Affairs and Communications, *Labor Force Survey* .

Under the Optimistic Scenario, the revision of safety standards will make it possible for nuclear power plants to successively come back into operation from FY2012. Thus, although there will be constraints on supply-side capacity in FY2011 and FY2012, the electric power shortage will for the most part be resolved from that point. It will be possible, in average terms through FY2020, to achieve a potential growth rate essentially equal to as it would have otherwise been even if there had been no electric power shortage. The average growth rate would only decline by a modest degree.

3.3. Current account deficit, rising prices and increasing CO2: three grave challenges

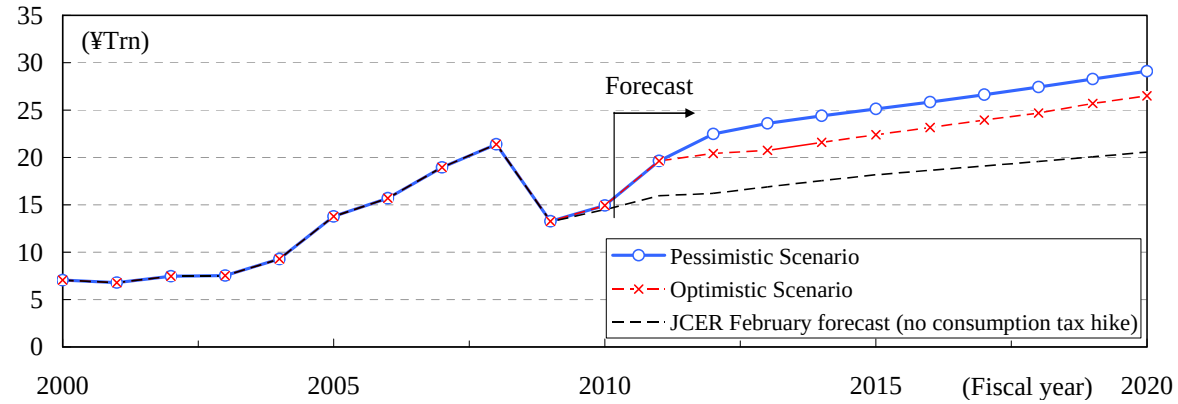
If all nuclear power plants were to be shut down, the resulting constraints on electric power supply, real exports and a rise in import prices including those on fossil fuels and increased fossil fuel imports of using thermal power to offset the loss of nuclear power would lead to a chronic deficit in the nation's balance in trade and services. As a result, although Japan would continue to show a surplus in its income balance, the margin of surplus in its current account balance would gradually narrow, ultimately moving into the red in the latter half of the present decade. Even if it is possible to bring nuclear power plants successively back in operation, that would serve only to somewhat delay the point at which Japan would fall into the red in its current account balance and would not alter this basic trend. Since a deficit in the current account balance would lead to the erosion of domestic savings, it would also leave less room to mobilize domestic savings in financing the general government debt (national and local). In addition to the rise in fossil fuel and other import prices, the cost of increased imports will be passed on in the form of higher electricity prices, resulting in an unhealthy rise in the price level. Increased substitution of thermal power generation for nuclear will also cause Japan's CO_2 emissions to rise.

Figure 11. Balance in Trade & Services, Current Account: Pessimistic Scenario



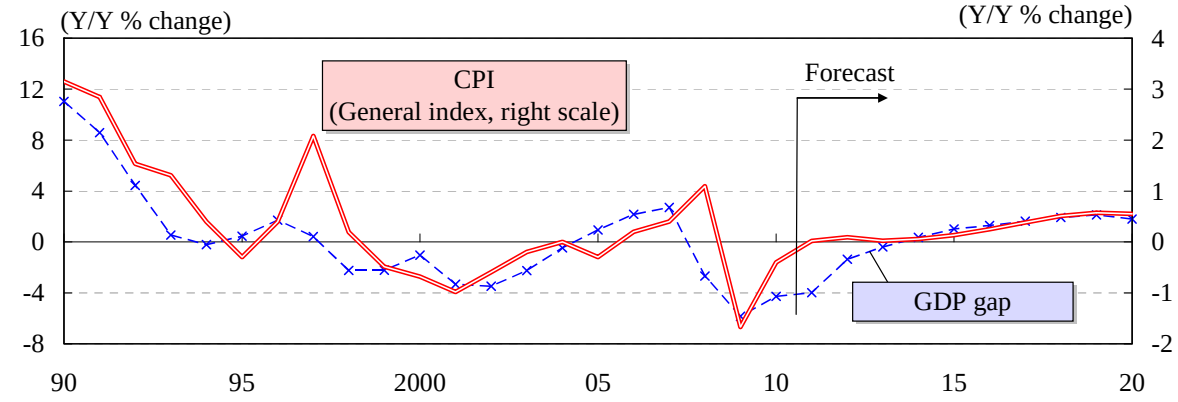
Source : JCER forecast based on Ministry of Finance and Bank of Japan, *Balance of Payments Statistics*.

Figure 12. Nominal Fossil Fuel Imports



Source: JCER estimates.

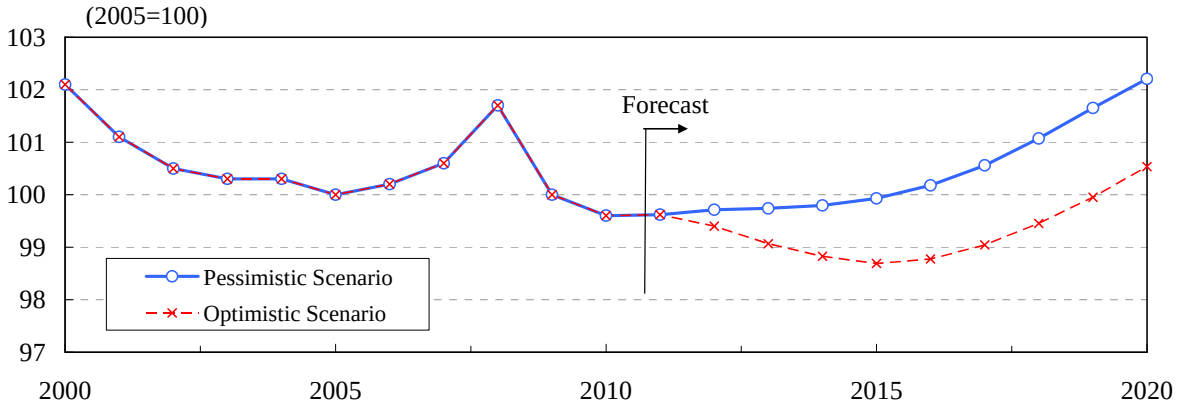
Figure 13. GDP Gap, Inflation Rate[8]: Pessimistic Scenario



Source: Ministry of Internal Affairs, *Consumer Price Index.* ; Cabinet Office, *National Accounts.*

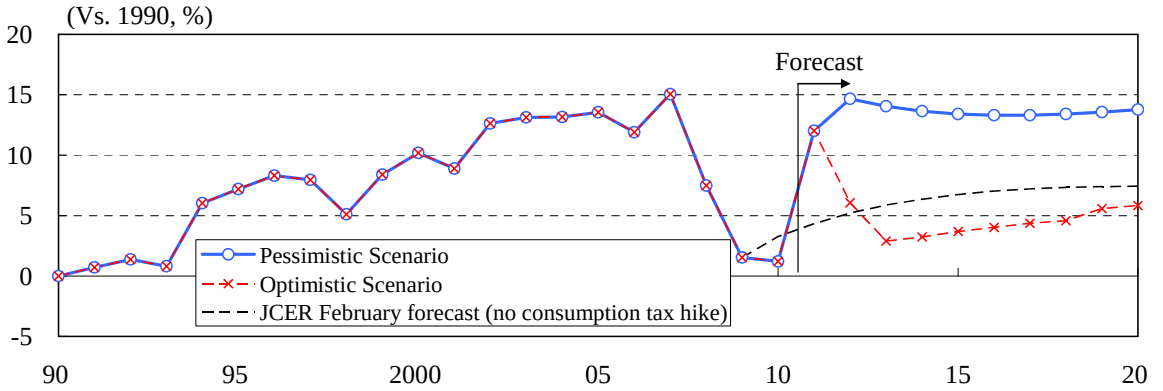
Figure 14. Consumer Price Index (General Index)

[8] Our forecast for the consumer prices index (CPI) takes into account the impact of the base revision scheduled for August 2011. We expect that backward revision will result in a downward adjustment of the year-on-year growth rate by 0.5 percentage points.



Source: Ministry of Internal Affairs, *Consumer Price Index.*

Figure 15. CO_2 Emissions



Source: The Institute of Energy Economics, Japan, *EDMC Energy Data Bank.*

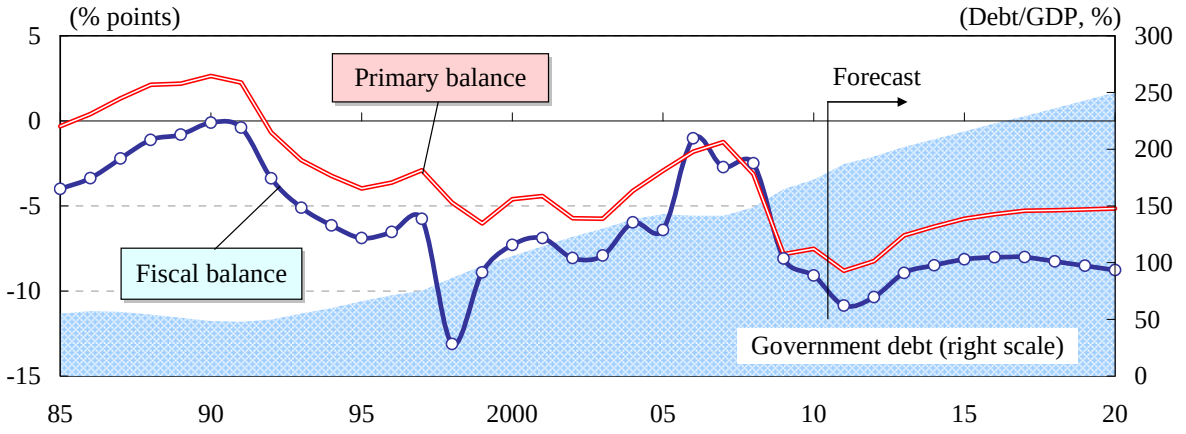
3.4. Government Finances, Savings-Investment Balance: Steadily Worsening State Finances

Given the total of ¥14.4 trillion in government spending for restoration and reconstruction in the face of falling tax revenues, the deficit margin in the government's basic fiscal balance will be greater than anticipated in our February forecast, thus growing even further as a percentage of GDP (from 229.3% to 250.2% by FY2020), which is already expected to rise.[9] Payments will grow even further if the government bears some portion of the cost of dealing with the nuclear power plant accidents and costs related to the "dual loan" problem.

Figure 16. Primary Balance of National and Local Governments, Fiscal Balance and

[9] Under the basic scenario outlined in our February forecast (which anticipates a rise in the consumption tax to 10% over two steps in FY2015 and FY2019, the outstanding balance of government debt to GDP is projected to reach 220.5% by FY2020.

Outstanding Debt/GDP: Pessimistic Scenario

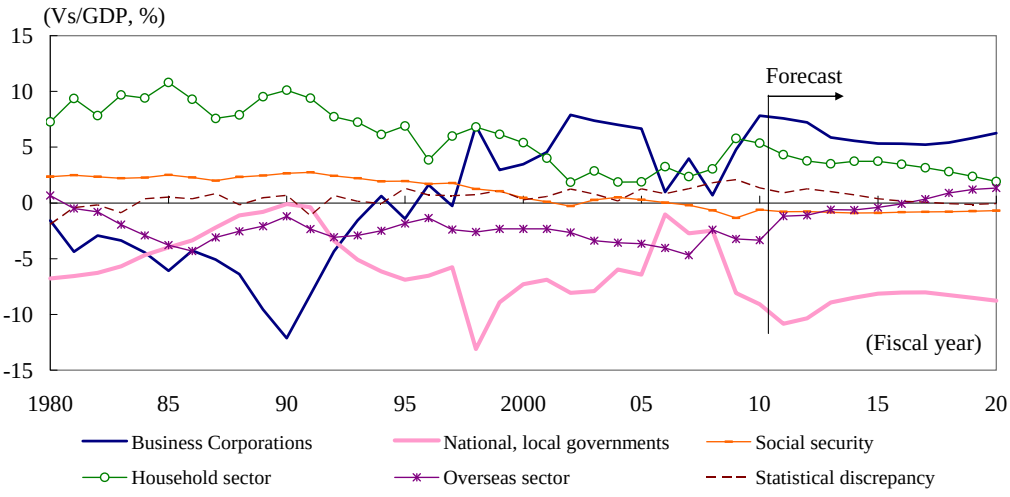


Source: Ministry of Finance, Cabinet Office, *National Accounts.*
Note: The primary balance data does not reflect the impact of such factors as transfers from the fiscal investment and loan special account. Data for outstanding government debt represents the total for ordinary Japanese government securities (JGBs), local government securities and the outstanding balance of the Local Allocation and Local Transfer

With regard to the savings-investment balance (flow), we see the deficit for the overseas sector shrinking and the deficit of the general government (national and local) rising more than anticipated in our February forecast. As a result, in terms of stocks (as of FY2020), we see the debt of the general government (national and local) rising more than anticipated in comparison to our February forecast, with net liabilities of the overseas sector (external net assets) declining, implying even further risk of government insolvency. Furthermore, once markets fully perceive this higher risk, interest rates could rise, further constraining the leeway of business and government to act.

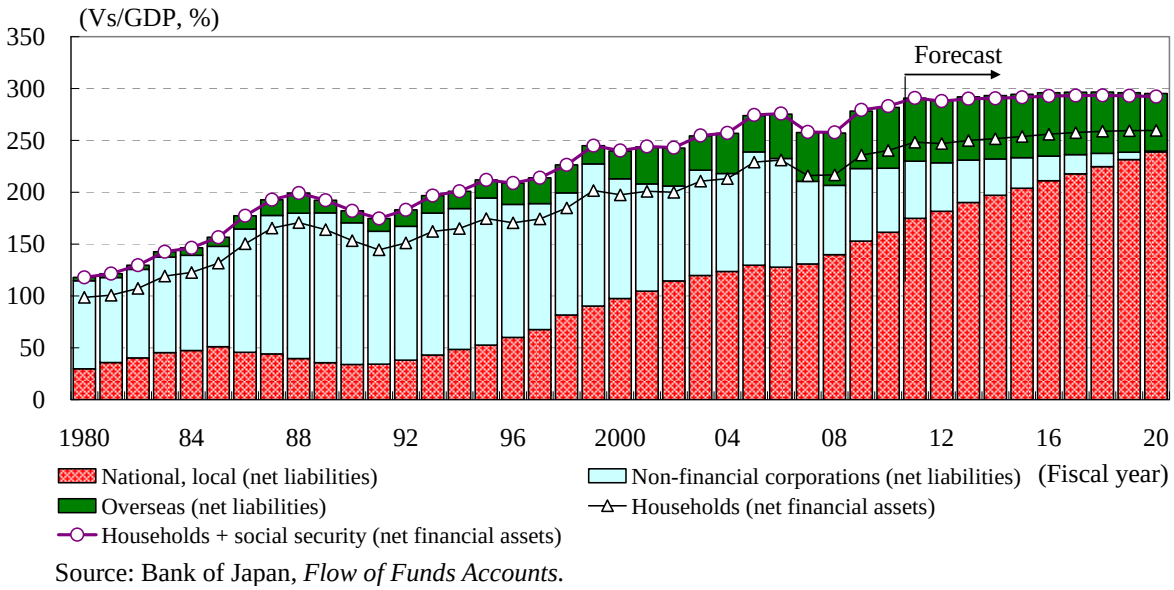
Averting such increasing risk would require that restoration and reconstruction costs be financed through the issuance of reconstruction bonds. Then, as the economy recovers, measures should be taken to increase revenues through such means as a reconstruction tax. We argued in our March 17 policy recommendation "Urgent Need for ¥5 Trillion Disaster Recovery Package" that, given the need to reduce energy consumption, one promising method would be to impose a recovery tax on the prices of all types of fossil fuels.

Figure 17. Savings-Investment Balance (Flow): Pessimistic Scenario



Source: Cabinet Office, *National Accounts.*

Figure 18. Investment-Savings Balance (Stock): Pessimistic Scenario



Source: Bank of Japan, *Flow of Funds Accounts.*

4. Conclusions: Returning to a Growth Path

Kazumasa Iwata, Research Director

As we predicted early on in our policy proposal of March 16, it has become abundantly clear that the problem of supply-side constraints caused by electric power shortages will affect the Japanese economy not just in the short term but the medium and long term as well. If this problem is left unaddressed, the power shortage will become even more severe in FY2012. In the present forecast, we have anticipated the worst-case circumstances in which Japan must prepare itself in this crisis. We have also clarified, by means of simulation analysis, what sort of course the Japanese economy is likely to follow if all of the nation's nuclear power plants remain to cease through FY2020. The main points of this analysis are as follows.

First, the supply-side constraints arising from electric power shortages will have a major impact on the level of potential GDP. Even in the event that supplies increase as newly installed thermal power generation comes into operation, GDP would be pulled down by an annual average of 1.2% (or over ¥7 trillion each year). From FY2011 through FY2013, the potential growth rate would be around zero.

Second, owing to rising prices of fossil fuels and other imports, rising fossil fuel imports and eroding exports due to supply-side constraints, Japan's trade and services balance will fall into the red in FY2011, after which the deficit will continue to widen. The surplus in Japan's income balance would continue, but the nation would face a current account deficit from FY2017. This would hasten Japan's move from a "mature creditor nation" to a "credit disposition nation."

If the current account deficit and primary balance deficit mentioned above persist, Japan would face the same "twin deficit" problem as the United States. Without large inflows of capital from abroad, it would be impossible to maintain a balanced economy. In the restoration process of the global supply chain, Japan's capital outflows would eventually exceed its capital inflows, threatening to push up interest rates dramatically.

Third, the primary balance to nominal GDP ratio for the national and local governments will deteriorate, with the deficit reaching 8.8% in FY2011, even after which it will remain at an expected 5.8% in FY2015. This is still far short of the government's goal of halving the primary balance deficit to 3.7%. In FY2020, the primary balance deficit is expected to be 5.2%, which will still be well short of the government's target. In fact, it would be nearly impossible for the government to reach its target even if the consumption tax were raised to 10%. The government debt to GDP ratio will swell by 20% or more to reach 250%. In addition, contingent liabilities could also accumulate that may ultimately have to be burdened by the government. These include the problem of damages compensation associated with the Fukushima nuclear power station (which we estimate at between ¥5.7 to ¥20 trillion but which risks exceeding this amount), the dual mortgage loan problem arising from the disaster, electric power bonds and the increase in additional supplements to the equity capital of financial institutions as may be necessary in connection with the borrowings of TEPCO.

Fourth, because Japan's dependency on fossil fuels to provide for electric power supplies will increase, the nation's CO_2 emissions will rise sharply, rising 12% versus 1990 levels in FY2011 and 14% versus 1990 levels in FY2020. This will make it impossible for the nation to reach its targets under the Kyoto Protocol and will render the creation of a post-Kyoto framework hopeless.

Fifth, although not taken up in the present analysis, another problem faced not just by Japan but by China is the shortage of electric power from coal-fired thermal power generation owing to the rise in the price of coal. There is a strong possibility that, owing to the rise in demand, fossil fuel prices could rise even further due to factors related to real demand. The United States is also facing an economic soft patch owing to rising gasoline prices, further erosion of home prices and sluggish production due to the disruption of the supply chain in Japan. The sharp rise in crude oil prices is likely to drag out this period of weakness. Deterioration of Japan's terms of trade will crimp domestic demand, strengthening pressures for an unhealthy rise in the price level. There is some danger that the process of recovery from the recent earthquake disaster could be slower than markets are expecting.

Policies to Ease Supply-side constraints Arising from the Electric Power Shortage

(1) It is conceivable that private electric power generation could provide the electric power otherwise supplied by nuclear power plants. If more thermal power plants are built and full use is made of privately owned electric power generation, the decline in potential GDP would be limited to about one third of the decline it would otherwise experience. For this reason, the supply-side constraints affecting the market for privately owned power generation need to be removed. Over the long term, strenuous efforts should be devoted to the development of alternative energy technology.

(2) It will be necessary, based on meticulous investigation of the causes for the accidents at the Fukushima nuclear power station, to create, under the jurisdiction of a new regulatory authority, a new set of safety standards which are internationally consistent. It would then be desirable to restart those nuclear power stations which have cleared these new safety standards. In practice, however, governors of the prefectures where the nuclear plants are located will need to grant their approval before a plant can be brought back into operation. One option which could make it easier for the local population to grant approval would be

to put nuclear power stations directly under the administration of the national government in order to show that ultimate responsibility will be borne by the state.

(3) With regard to CO_2 emissions, implementation of a ¥5 trillion environmental tax (in the form of a fossil fuel tax) from FY2012 as a three-year reconstruction tax would make it possible to cut emissions by about 4%. Although such a reconstruction tax would become a factor in lowering the pace of growth, it could be refunded in the form of reductions in the corporate and income tax from FY2015 onward, thus for the most part offsetting any negative impact on the growth rate. Imposition of such an environmental tax will not only discourage consumption of fossil fuels and promote frugal use of energy but will make it possible for Japan to extricate itself from its structural dependence on imported oil, which is a basic destabilizing factor for the Japanese economy. It will therefore help the nation's transition to alternative forms of energy.

After the economic bubble began to deflate in 1990, the Japanese economy endured a series of shocks, each of which took potential GDP a notch lower. Any economy characterized by a contracting equilibrium does not have a bright future. The electric power shortages and supply-side constraints arising from the drop in nuclear-generated power are worsening the basic conditions of the economy. Japan must arrest this process and get back on a new path for growth. In addition to furthering growth-oriented market reforms and the creation of a growth-friendly tax and social security system, Japan needs to work strenuously to extricate itself from dependence on oil and to develop alternative energy technologies.

Supplement

Principal Assumptions Regarding the Great East Japan Earthquake

1. Degree of Supply-side constraints and Electric Power Shortages

1.1. Electric power shortages and economic growth: constraints basically in summer only

With regard to the electric power shortages and supply-side constraints from nuclear power plants shutting down, the government, TEPCO, Tohoku Electric and Chubu Electric have issued a number of statements on which we have made certain assumptions, which underlie our estimates. With regard to electric power shortages, we have defined an electric power "constraint ratio" describing the gap between the average system peak load since FY2001 (for each electric power company) and electric power generation capacity. For Hokkaido Electric Power, peak demand is reached in the winter. For Tohoku Electric, it is reached in the summer as well as the winter. But for other power companies, it is reached in the summer. The system peak load refers to the amount of power consumed in one day. However, if factories, offices and households are notified of power supply constraints in advance, they will act to conserve power carefully during that time. For this reason, we have assumed that supply constraints owing to electric power shortages will arise throughout the summer as a whole (or the summer and winter for Tohoku Electric and the winter for Hokkaido electric).

With regard to the impact on aggregate production in various regions owing to the power shortages, we have derived an elasticity value for the relationship between aggregate production and electric power sales volumes (as defined below). We have then multiplied this elasticity value by the electric power shortage ratio in order to estimate the impact on aggregate production in each service area. Because it is basically only in the summer months of July through September that electric power shortages will occur, we have used a factor of 0.25 (0.50 in the case of Tohoku Electric) as representing the impact on economic growth throughout the summer as a whole (the summer and winter for Tohoku Electric and the winter for Hokkaido Electric).

Service area aggregate production growth rate = Elasticity value *x* Electric power sales volume growth rate

Rate of decline in aggregate production within service area = Elasticity value *x* Electric power constraint ratio *x* 0.25 or 0.50

Next, to see the effects that the power shortage has on Japan as a whole, we have measured the aggregate production of each power company's service area weighted as a percentage of Japan's GDP.

Impact on economy as a whole = [Weighting for TEPCO service area *x* Rate of decline of aggregate production in TEPCO service area] + [Weighting for Tohoku Electric service area *x* Rate of decline in Tohoku] +.

Table 1. System Peak Load Assumptions Underlying Estimates									
	Hok-kaido	To-hoku	Tokyo	Chu-bu	Hoku-riku	Kansai	Chu-goku	Shi-koku	Kyu-shu
Peak power (million kW)	5.47	14.65	60.14	26.84	5.47	30.77	11.67	5.76	16.95
Elasticity weight	0.34	0.62	0.64	0.86	0.62	0.70	0.49	0.35	0.61
Weight in Japan GDP (%)	3.5	10.1	37.5	15.4	2.5	15.5	5.7	2.6	8.6
Source: Ministry of Internal Affairs and Communications, *Prefectural Accounts*. *Electric Power Statistics*. Note: For computational reasons, service area weightings may not total 100%.									

1.2. Generation capacity to drop to 2/3 with all nuclear plants shut down: Pessimistic Scenario

Under the Pessimistic Scenario, we assume all nuclear power plants will be shut down from FY2012 through to the end of the forecast period, resulting in the loss of 30% (about 49 million kilowatts) of power sources. We assume that, by summer 2011, some forty-two nuclear power plants will be shut down, and by summer 2012, nearly all plants would very likely be shut down. Until the cleanup at the Fukushima Daiichi nuclear power plant reaches some stable threshold, it will be very difficult for the government to release such tentative safety guidelines as would allow for the resumption of operations at those nuclear plants which have been shut down for regular safety inspections. So as long as stress tests are not carried out based on objective standards, as in Europe, governors of prefectures in which nuclear power plants are located will have no basis to judge whether or not plants should be brought back into operation. For instance, a gubernatorial election is scheduled in the fall of 2012 in Niigata Prefecture, where the Kashiwazaki Kariwa nuclear power plant (8.21 million kilowatts) is located, and the currently fired-up units 1, 5, 6 and 7 are due for regular safety inspections next summer. Once they are shut down, the governor's approval will be necessary to bring them back into operation, but the outlook for their obtaining such license by the summer of 2012 is bleak.

This is also the case for other nuclear power plants, and if they cannot be reactivated in 2012, the situation could very well develop into one in which operation would be impossible until the completion of a thorough review of the safety inspection guidelines in light of the Great East Japan Earthquake. Completion of this thoroughgoing review will require earthquake and tsunami studies as well as highly detailed scientific simulations and other analysis. It would be no surprise at all if a period of some ten years were required before the guidelines could be completed. This would mean the loss of an additional 10 million kilowatts of nuclear power generation capacity from the summer of 2011. As a consequence, through FY2020, supply constraints due to power shortages would arise in the service areas of all companies save only that of Chubu Electric. In addition to the service area of TEPCO, comparatively severe supply shortages could be expected to arise particularly within the service area of Kansai Electric, which relies on nuclear plants for a high share of its output (Table 2).

Table 2. Service Area Supply Constraint Ratio, All Nuclear Plants Down (Negative Impact on GDP)

Utility FY	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hokkaido Electric	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tohoku Electric*	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
TEPCO**	0.4	0.6	0.6	0.4	0.4	0.4	0.3	0.3	0.3	.01
Chubu Electric	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hokuriku Electric	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kansai Electric**	0.2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2
Chugoku Electric*	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Shikoku Electric	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kyushu Electric*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nationwide**	0.8	1.6	1.5	1.4	1.4	1.2	1.0	1.0	1.0	0.5

Note: Double asterisks (**) indicate regions where constraints due to electric power shortages would be particularly severe. Single asterisks (*) indicate areas where constraints will emerge. Other regions will experience constraints, but with negligible impact (with only Chubu Electric experiencing no constraints).

Assumptions underlying these estimates are as follows.

We have that assumed the system peak load for TEPCO during the summer (July through September) will be 60.14 million kilowatts.[10] According to its announcements, TEPCO expects its electric power supply capacity to be 56.2 million kilowatts by the end of August, 2011, so we have formulated our power shortage and supply constraint estimates based on this value.

We have assumed that thermal power plants which were shut down owing to the earthquake disaster will be back in operation within the summer of 2011. In addition, we have also assumed that not only Unit 2 of the Hitachi Naka plant (1 million kilowatts, currently under construction), Unit 6 of the Hirono plant (0.6 million kilowatts) and Series 2 turbine 1 of the Kawasaki plant (0.5 million kilowatts) will come into operation according to schedule by FY2020 but that the No. 2 Series turbine 2 (0.71 million kilowatts) and turbine 3 (0.71 kilowatts) of the Kawasaki plant and Series No. 1 of the Goi plant (2.13 million kilowatts) will also do so as well.

We assume that the operating rate will be raised to 70% in line with the rate implemented in the summer of 2007, when all reactors of the Kashiwazaki Kariwa plant were shut down owing to the Chuetsu Offshore Earthquake.

As with TEPCO, we have also assumed that Tohoku Electric's supply capacity during summer 2011 will be 12.3 million kilowatts, as based on its publicly announced figures. As for our assumptions regarding thermal power, as with TEPCO, we have assumed that all plants planned and currently under construction will come into operation by FY2020. We have made the same assumptions regarding other electric power companies.

1.3. All plants other than Fukushima Daiichi, Fukushima Daini and Hamaoka in operation: Optimistic Scenario

The assumptions regarding peak load and newly installed thermal power plants under our Optimistic Scenario are the same as those made under our Pessimistic Scenario.

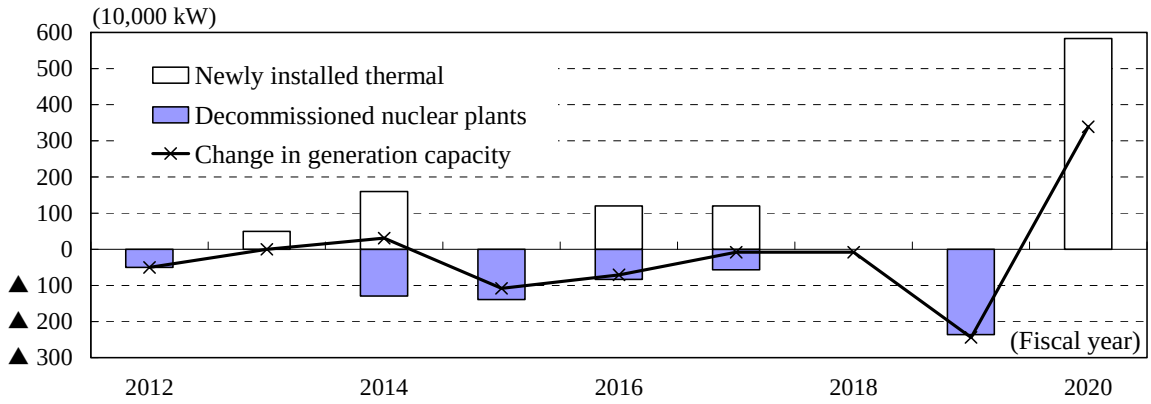
[10] TEPCO announced that its expected system peak load this summer would be 55 million kilowatts, but this estimate takes into consideration the impact of efforts to conserve electricity and the reduction in production due to the earthquake disaster, meaning that TEPCO's expected peak load is some 5 million kilowatts lower than that expected under our estimate.

In FY2011, some forty-two nuclear reactors will be shut down by this summer, but we assume that the government will release provisional guidelines on an expedited basis, making it possible to judge the safety of nuclear power plants. Safety checks will then be conducted based on those guidelines. After FY2012, the Fukushima Daiichi and Fukushima Daini nuclear power plants (totaling 9.1 million kilowatts) and Chubu Electric's Hamaoka nuclear station (with a total output of 3.62 million kilowatts), which was deemed to have inadequate tsunami safeguards in the event of an earthquake in the Tokai region, will either be decommissioned or shut down by FY2020.

With regard to other nuclear power stations, we have assumed the possibility that presently online reactors 1, 5, 6 and 7 of the Kashiwazaki Kariwa plant will continue in operation in FY2012 and that reactors 1 through 7 will all be in operation from and after FY2013. With regard to Tohoku Electric Power, we have assumed that the Higashidori nuclear station (1.1 million kilowatts) will be back in operation from FY2012 and that the Onagawa nuclear plant (2.17 million kilowatts), impacted by the recent earthquake, will be restored as early as FY2013.

As for other electric power companies, we have assumed that those nuclear plants coming up for regular safety inspection this summer will be successively back in operation from and after FY2012. In addition to assuming that nuclear plants in service for over forty years will be decommissioned, we have assumed that the ten reactors of the Fukushima Daiichi and Daini plants will be decommissioned, as will three reactors at the Hamaoka plant. In addition, we assume that ten reactors at Kansai Electric plants will be decommissioned, including Unit 2 of its Mihama plant and Unit 1 of the Takahama station. We have thus assumed the output of nuclear power plants will fall (Figure 19).

Figure 19. Nuclear Plants Decommissioned by FY2020 and the Outlook for New Thermal



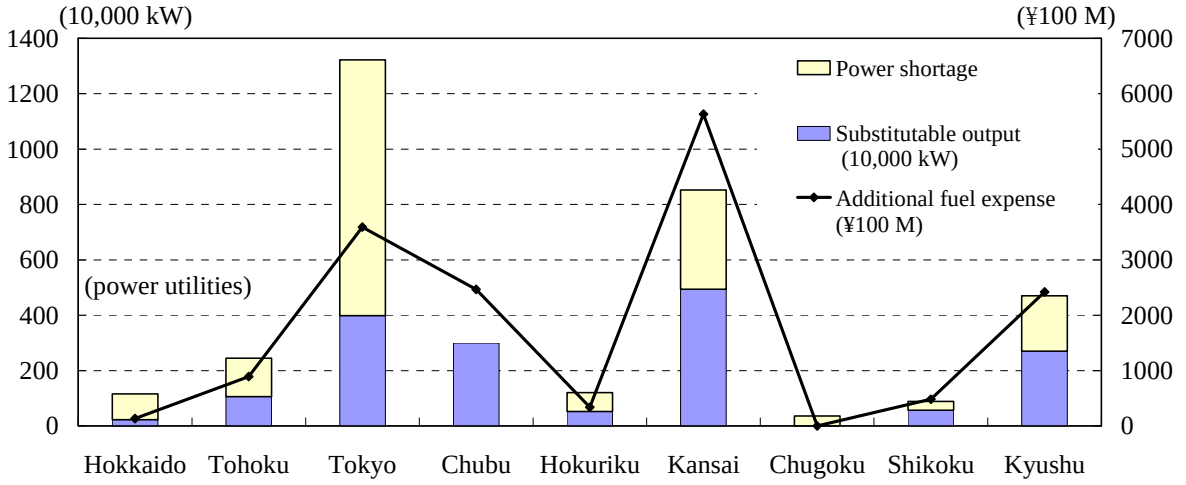
Source: Electric Power Handbook, *Nuclear Power Pocket Book,* 2010.

1.4. Fuel Cost for Switch to Thermal: Over ¥1.5 trillion in FY2012

If nuclear plants are shut down in FY2011 and FY2012, their role will be taken up by increasing the operating rate of thermal power plants. We have therefore made rough estimates regarding how much of the power shortage can be made up and what the cost will be. A comparison with peak electric power demand shows that, even if the thermal plant operating rate is raised to 70% from the 50% operating rate prevailing when nuclear plants remained in operation, it would still be impossible to fully satisfy demand, meaning that shortages would arise. Moreover, the fuel cost (i.e., the cost of importing fossil fuels) required to boost the thermal operating rate would be ¥1.5 trillion or more annually. Thus,

even if this additional expense of ¥1.5 trillion is paid, the electric power shortage would remain an issue.

Figure 20. Substitution of Thermal Difficult if all Nuclear Plants cease in FY2012.



Note: Based on comparisons with the period in FY2010, when the operating rates were highest, we have estimated the cost incurred when operating rates at thermal power plants were raised to 70%. We have estimated the necessary electric power output as: (i) the output of nuclear power plants shut down in the summer of FY2011 minus (ii) the output of nuclear power plants shut down during the peak period of 2010. (We assume that, at the time of the FY2010 peak-time operating rate, the operating rate of thermal power plants is raised in order to make up for the lost output of nuclear plants which will be shut down. We also assume that, in order to make up for any nuclear plant output exceeding this, utilities would have to raise their operating rate further than at peak time.)

We have not taken into consideration any gas turbines that may be newly installed on an emergency basis or the portion represented by power generation facilities privately owned by business firms.

Our assumed currency rate is about ¥100 to the U.S. dollar, and we have set the crude oil price at $100 per barrel.

2. Estimates of Stock Damage and Population 15 and Above

2.1. Stock damage: Under our Optimistic scenario, we estimate that the social infrastructure damage would decrease by one half and the production facilities damage one third compared to Pessimistic Scenario.

In estimating the damage from the earthquake disaster to the overall stock nationwide, we have considered the estimate of the Development Bank of Japan (DBJ).[11] With regard to Iwate, Miyagi, Fukushima and Ibaraki prefectures, we have directly adopted the values given by DBJ. With regard to other regions, comprehensive data on stock damage was available only in housing. As a result, after estimating the damage to "housing" by prefecture, we indirectly estimated the damage to "life and social infrastructure" and "manufacturing and others" from the relationship between DBJ's estimated values for housing damage and other damage.[12] With regard to the amount of damage to "housing," we used the numbers for residences destroyed by prefecture and, based on data for housing damage, assigned a weighting of 1 to those fully destroyed, 0.5 to those half destroyed, and

[11] Regions include Hokkaido, Aomori Prefecture, Iwate Prefecture, Miyagi Prefecture, Akita Prefecture, Yamagata Prefecture, Fukushima Prefecture, Ibaraki Prefecture, Tochigi Prefecture, Gunma Prefecture, Saitama Prefecture, Chiba Prefecture, Tokyo, Kanagawa Prefecture, Niigata Prefecture, Nagano Prefecture and Shizuoka Prefecture.

DBJ News of April 28, 2011, "Regarding the Amount of Damage to Capital Stock from the Great East Japan Earthquake."

[12] For the share of "housing" in stock damage, we used DBJ's estimated value of 14.6% representing the average of the four prefectures. For the share of "life and social infrastructure" in stock damage, we used the value of 45% representing the lowest value for the four prefectures. And for the ratio of "manufacturing and others" we used the remaining 40.4%

0.2 to those partially damaged. Next, we computed the average price of homes by prefecture from the *National Survey of Family Income and Expenditure*, and by multiplying the number of damaged residences by this number, estimated the damage to residences by prefecture.

The amount of damage to the stock for Japan as a whole is broken down as follows.

Breakdown of Damage to Stock (¥Bn)

Life and social infrastructure:	9,124
Housing:	2,632
Manufacturing, other:	6,255
Nationwide stock damage:	18,011

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