Thinking of Energy Shortage

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25th April 2011

Impact to last Decade or more if Existing Nuclear Plants Shut Down GDP Could Drop 2% on Power Shortages

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Two months have now passed since the Great East Japan Earthquake struck. Other than the tangible and intangible wounds inflicted by the disaster, constraints on electric power supplies owing to the major accident at the Tokyo Electric Power Company (TEPCO) Fukushima Daiichi nuclear station will continue to weigh heavily on the Japanese economy. According to estimates based on our economic model, if there is a 10% electric power shortage in the Kanto region this summer and economic activity in each industry declines in proportion to its dependency on electric power, economic activity in Japan could fall by over 4% during the summer and by 2% for the year as a whole.

The electric power shortage will continue for at least three years. If supplies from newly installed thermal power plants increase, the Kashiwazaki-Kariwa nuclear power plant remains in operation, and generation by Tohoku Electric Power and Japan Atomic Power Company (JAPC) is resumed without trouble, the power shortage would tentatively be resolved by the summer of 2014. However, if a number of plants suspend generation owing to the overhaul of safety standards or other reasons, power constraints could drag on for over a decade.

According to our model, the adverse economic impact this summer could be eased by 3% or more provided that a system for the sharing of electric power from anywhere else in the country is established. Even if it is impossible to make it in time for this summer, a system for supplying power evenly nationwide should be established in order to protect against possible damage from future earthquake disasters.

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The cleanup following the nuclear power plant accident is likely to cost at least \(\frac{1}{2}\)6 trillion. In addition to TEPCO's reserves and net assets, this should be financed by diverting a portion of the existing nuclear power budget. If the nuclear power policy as a whole is reviewed, it would be possible sum up enough money for a "nuclear power burial fund" without increasing electricity rates. A total of \(\frac{1}{2}\)12 trillion could thus be raised to finance the cleanup. In March, we made an urgent proposal for the creation of a \(\frac{1}{2}\)5 trillion "recovery tax" to be imposed on all fossil fuels. Revenues from this tax should be used to finance the cost of investment and compensation for recovery, and should be kept separate from the cost of the cleanup (including compensation) related to the accident.

It will also be important by some means to attract private-sector capital back into the disaster-affected areas. The three prefectures of Iwate, Miyagi and Fukushima should therefore be designated as tax-free zones of levies such as corporate income tax and fixed asset tax over the next five to ten years, with efforts also being made to promote generation of electricity through wind power and the like. Given the long-term environment-related constraints required to prevent global warming and related problems, wider use of renewable energy should form a pillar in the package of recovery measures.

<Points>

- (1) Electric power constraints will continue for at least three years: A uniform infrastructure to share electric power nationwide should be established.
- (2) Cleanup and compensation costs for the nuclear power plant accident: Finance with a ¥12 trillion "nuclear power burial fund."
- (3) Extensive efforts in wind power should form a recovery pillar: Designate tax-free zones in the three Tohoku prefectures to attract private-sector capital.

Following our urgent policy proposals of March 17 regarding the Great East Japan Earthquake, we plan to release a series of analysis and proposals for overcoming the impact of the earthquake, titled "Redesigning the Japanese Economy: Beyond the Earthquake Disaster" (For our last urgent policy proposal please see: http://www.jcer.or.jp/eng/research/policy.html).

1. Power shortages likely to continue beyond summer 2012: Future electric power supply will depend on the outcome of existing nuclear power plants

The Japanese government predicts that peak electric power demand this summer will reach

55 million kilowatts (or 60 million in the event of a very hot summer). In contrast, TEPCO says it will have the capacity to supply 52 million kilowatts by the end of July and 50.7 million kilowatts by the end of August (compared to 42 million during April) while imposing restrictions to offset the shortage of 5–10 million kilowatts. In addition to mobilizing gas turbines, which can be installed in a short period of time, TEPCO will restart long-idle thermal plants while securing other sources of power such as private electrical generation capacity owned by steel companies. However, between the end of July through the end of August, the Kashiwazaki Kariwa nuclear power plant's Units 1 and 7, now currently on line, will be shut down for regular inspection, and at the end of August, the plant's power supply capacity will fall from 52 million kilowatts to 50 kilowatts. The government and TEPCO plan to cope with the shortfall (of 3 to 10 million kilowatts) by imposing limits on large users of electric power such as factories, asking households and other small users to limit consumption voluntarily, and by obtaining supplies of electric power from business firms which have privately owned generation capacity.

The conditions of this summer are very likely to persist through next year and beyond. In addition to the Fukushima Daiichi plant (six reactors at 4.7 million kilowatts) and the Fukushima Daini plant (four reactors at 4.4 million kilowatts), it is still unknown just when operation will recommence at TEPCO's Hirono thermal power station (3.8 million kilowatts), which lies within the 20-30 km indoor evacuation zone surrounding the Fukushima Daiichi plant. Additionally, joint thermal power plants located in Ibaragi and Fukushima prefectures supplying electricity within TEPCO's service area have also been shut down owing to the impact of the disaster (Table 1).

Table 1. Main Plants Supplying	g TEPCO Service A	rea Now Offline Due to Disaster

	Plant	Capacity (M kw)
TEPCO	Fukushima Daiichi1 Nuclear*	4.696
	Fukushima Daini Nuclear*	4.4
	Hirono Thermal	3.8
	Hitachinaka Thermal	1.0
TEPCO Total		13.896
Others	JAPC/Tokai Daini*	1.1
	Soma Kyodo Power	2.0
	Joban Joint Power	1.625
Others Total		4.725
Grand Total		18.621

Source: Handbook of Electric Power Industry, 2010 edition. Asterisks indicate nuclear plants.

It is regarded as certain that TEPCO will decommission the Fukushima Daiichi nuclear power station. The situation in Fukushima Prefecture is not such that authorities will easily allow the Fukushima Daini facility to be brought back online, so it is inevitable that operation will remain suspended for a long time. It is also very likely the national quake-proofing guidelines themselves will be thoroughly overhauled. The seismic safety examination guide for power generating nuclear installations as revised in the wake of the Great Hanshin Earthquake were finalized only in 2006, more than eleven years after the quake. Five years were required from the beginning of Nuclear Safety Commission deliberations to review the guidelines. If we assume that a similar period will be required this time around, it will by no means be an easy path toward restarting even JAPC's Tokai Daini nuclear station (1.1 million kilowatts) in Tokaimura, Ibaragi Prefecture. That plant supplies electric power to TEPCO. Units 2, 3 and 4 of the Kashiwazaki Hariwa plant were shut down owing to the Chuetsu Offshore Earthquake of July, 2007, and Units 1 and 7 are due for regular safety inspections this summer. One can well imagine that, once nuclear plants such as these taken offline for regular safety inspections, obtaining permission from the competent prefectural authorities to bring the plants back online will be no easy matter.

TEPCO plans to bring a combined total of 1.5 million additional kilowatts of newly installed thermal power online in February and December of 2013. (Unit 6 of the Hirono Thermal Power Station is scheduled to restart in December of that year, but it is not included here because the great earthquake and related nuclear plant accidents are expected to cause work delays.) However, there are no concrete plans to bring online any large-scale thermal power generation facilities after that. The possibilities for receiving shared power from other electric power companies will be limited owing to frequency differences in the supplied power. (Roughly speaking, providers from and westward of Chubu Electric Power use 60 Hz while those to the east use 50 Hz.) Receiving electric power from Chubu Electric would therefore require frequency conversion, but conversion capacity exists for only 1 million kilowatts. TEPCO has a 6 million kilowatt transmission capacity between Tohoku Electric, which uses the same frequency. But Tohoku Electric's Onagawa Nuclear Power Plant (with a capacity of 2.174 million kilowatts) was shut down after suffering a direct shock in the recent earthquake, and the Higashidori Nuclear Power Plant (1.1 million kilowatts) is offline as well. So long as these nuclear power plants do not resume operation in earnest, TEPCO will have few options. (Note that the foregoing analysis leaves out of consideration any power that might be supplied from the private generation facilities owned by business firms.)

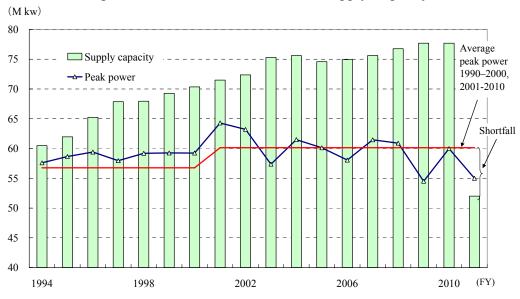


Figure 1. TEPCO Peak Demand and Supply Capacity

Sources: Electric Power Statistics, Ministry of Economy and Industry (METI); *TEPCO Fact Book*, April, 2010; Draft Framework for Summer Electric Power Demand and Supply Countermeasures, METI, April 8, 2011.

Given the above considerations, even if we assume that nuclear power plants other than the Fukushima Daiichi and Daini plants will be capable of operating as they did normally prior to the recent disaster, production and service activities in the Kanto region would still not return to a steady normal state until the summer of 2013 at least (Figure 2).

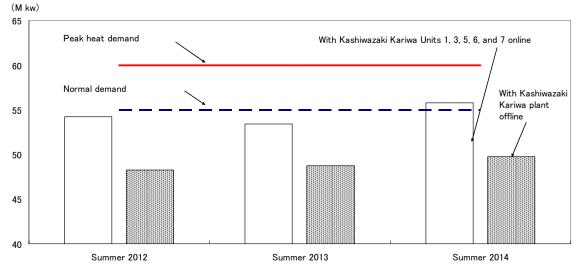


Figure 2. Outlook for TEPCO Supply Capacity

Note: Calculations assume Fukushima Daiichi and Daini plants remain offline, with new power after summer of 2011 being only Hitachi Naka Unit 2 (1 million kw) and Kawasaki Thermal Power Station Unit 2 (500,000 kw).

If the Kashiwazaki Kariwa were to operate as it did prior to the earthquake, it would be possible, with newly installed thermal power and other sources, to satisfy normal summer demand. (Note that the light columns in Figure 2 assume Units 1, 3, 5, 6 and 7 of the Kashiwazaki Kariwa plant to be in operation, which would provide 1.1 million kilowatts above present capacity. The new thermal capacity would be 1.5 million kilowatts, plus additional sources such as gas turbine facilities to provide an additional 500,000 kilowatts.) If Tohoku Electric's Onagawa nuclear power plant and JAPC's Tokai Daini nuclear plant are repaired by the summer of 2014, a considerable amount of power (over 5 million kilowatts) received from other utilities could be added to the total, which would make it possible for TEPCO to handle demand even in the event of a hot summer. As indicated above, however, if too much time is required for the government to review policies regarding readiness against further quakes and tsunami, the Kashiwazaki plant could be forced in its turn to suspend operation. In that case, TEPCO would lose about 30% of its power production sources, and electric power constrains would drag on for over a decade.

2. Possible 8% fall in Kanto economic activity this summer: Effects of power constraints evident

The next question is what impact the earthquake-related power shortage will have on the economy. To answer this question, we estimate the impact by the JCER regional computable general equilibrium (CGE) model, which divides Japan as a whole into eight regions. The government has estimated the damage to production and related facilities from the earthquake from \mathbb{4}16 to \mathbb{4}25 trillion. Based on this estimate, we have assumed that some 27% of the production facilities and infrastructure was destroyed in the three Tohoku prefectures of Iwate, Miyagi and Fukushima, where the damage was especially severe.\mathbb{2}* We have assumed that the fisheries industries of Fukushima, Miyagi and similarly affected areas are at a standstill, with the gross output of the Tohoku agriculture, forestry and fisheries industries falling by 30% or more. We have also assumed that TEPCO will be able to provide nearly 55 million kilowatts of electric power this summer. We have estimated power demand at 60 million kilowatts in the event of a hot summer, in which case the Kanto region would face a 10% power shortage this summer. Assuming that the power supply limits impact all industries equally, we have not anticipated any major changes in supply chains, such as moving of business offices or reshuffling of suppliers.

Our findings indicate that damage to the production facilities and infrastructure from the earthquake principally in the Tohoku area, combined with electric power shortages in the Kanto

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² *Government estimates put the damage in the three prefectures at ¥14–¥23 trillion, so for present purposes we have used an estimate of ¥19 trillion.

region owing to the Fukushima Daiichi nuclear power plant accident, may result in a substantial decline in gross domestic product (GDP) (Figures 3-1 and 3-2).

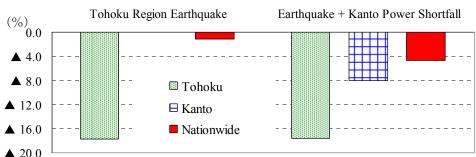
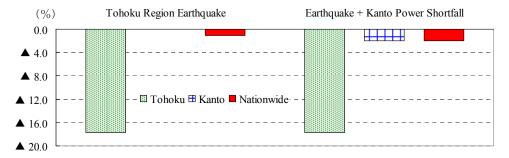


Figure 3.1. Economic Toll of Great East Japan Earthquake (Real Summer GDP Growth)

Figure 3-2. Economic toll of Great East Japan Earthquake (Normal Year; Power Shortfall only in summer)



The above model does not take account of any government fiscal measures such as public works spending aimed at recovering from the earthquake. In the case of the Tohoku earthquake alone, the decline in GDP this summer (from mid-June through mid-September) would be limited to -1.1%. However, there is some risk that that the impact of power shortages in the Kanto region, which experienced a stoppage in power supplies from Fukushima Daiichi and Fukushima Daini, may expand to -8%, while that for the nation as a whole may worsen to -4.6%. The Kanto region accounts for just fewer than 40% of Japan's economy and can greatly impact the economy as a whole. The figure of -4.6% would be on a par with the slump which followed shortly after the "Lehman Shock" of September, 2008. (GDP fell -2.9% Q/Q in the October-December quarter of 2008 and 5.4% Q/Q in the January-March quarter of 2009.) If we assume no power shortage other than in the summer, however, the impact on GDP in an ordinary year would be -2%. If the government does not work out a reconstruction package, the Japanese economy will shrink.³

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³ In our short-term economic forecast released on April 12, we revised down our pre-quake 1.5% economic growth forecast for the 2011 fiscal year (April 2011 - March 2012) to -0.1%. Applying that revised forecast to estimates under the CGE model results in a growth rate of about -0.5%. This discrepancy results from differences in projected recovery-related demand.

The impact on GDP here may come out somewhat large. This is because, under the present model, electric power shortage is assumed to be directly linked to declines in production and gross revenue. In reality, there is some leeway to ameliorate the shortage, as by operating factories in the evening and on holidays rather than at peak periods. It also appears that, in the services industry, electric power and productions (or gross revenue) are not as tightly linked as they are in the manufacturing industry.

3. Use of Surplus Power Could Greatly Alleviate Negative Impact

The situation at the Fukushima Daiichi plant remains dire, and the maker of the reactor states that it will take a decade or more to decommission. It very well takes thirty years.⁴ Even if existing nuclear power plants can remain online after being strengthened against future earthquakes and tsunami, construction of any new nuclear power plants will be extremely difficult until a tentative milestone is reached in the cleanup of the present accident. One anticipates a situation similar to that which transpired in the United States, where no new nuclear power plants have been built since the accident at Three Mile Island in 1979. But a look at the situation nationwide shows that there is in fact a surplus of electric power generation facilities. For example, even during the hot summer of 2010, Kansai Electric was using only 40%- of capacity at its thermal generation plants.

Table 2. Thermal Plant Capacity Utilization of Three Power Companies

	Chubu	Hokuriku	Kansai	
Aug 2010 thermal plant capacity utilization (%)	51.2	58.2	40.9	
Summer 2007 TEPCO-level capacity utilization (%)	70.0	70.0	70.0	
Leeway to increase capacity utilization (%)	18.8	11.8	29.1	Total
Potential supply capacity (million kw)	4.507	0.518	4.914	9.939

Source: Electric Power Statistics, METI.

When all units of the Kashiwazaki Kariwa nuclear power plant were shut down due to the Chuetsu Offshore Earthquake in the summer of 2007, TEPCO boosted its thermal plant operating capacity to over 70%. But as shown in Table 2, Chubu Electric, Hokuriku Electric and Kansai Electric together would be able to supply a combined total of about 10 million kilowatts of power if they were to similarly boost their own capacity to 70%. If only this power could be transmitted to the TEPCO service area, no power shortage would arise even in the event of a hot summer.

Because of the different frequencies between these three power companies on the one hand and TEPCO on the other, it will be impossible to for TEPCO to receive shared power from them without frequency conversion (the maximum conversion capacity being 1 million kilowatts). If it

⁴ Nihon Keizai Shimbun, April 13, 2011, as well as other media reports.

were possible to share electric power nationwide by making the frequency uniform, the negative impact on the economy would be substantially ameliorated. Using the CGE model, we have gauged what the economic impact would be if it were possible, while the Fukushima Daiichi and Daini plants remain offline owing to the disaster, for TEPCO to receive supplies of power from anywhere else in the country.

Figure 4. Economic Impact of Kanto Area Power Restrictions or with Shared Power (the Case of this summer)

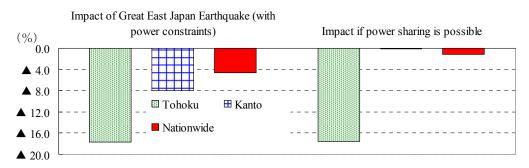


Figure 4 shows that the impact on GDP would be substantially reduced, from -4.6% to -1.2%. In short, if TEPCO were able to received shared electric power from utilities such as Chubu Electric through such means as the standardization of frequencies, the electric power shortage in the Kanto region would be greatly relieved, and the negative impact on the economy would be reduced. Since costs would be required for the transmission, however, the price of electric power could rise by about 2%. The -2% would fall to -1.1% within a year, softening the negative impact by about \mathbb{\feft}5 trillion. In other words, it would be worthwhile to invest in eliminating the electric power constraints if the cost were \mathbb{\feft}5 trillion or less per year.

4. Alternatives to Fukushima Daiichi and Daini Plants will cost ¥10 Trillion over the next Ten Years

There are no detailed estimates as to just how much would be required to standardize frequencies between eastern and western Japan. We understand from sources in the electric power industry that household appliances or production facilities equipped with inverters would not encounter problems even if the frequency were to change (for example, if 60 Hz power were supplied within the TEPCO service area). There would supposedly be little impact for households and large companies. The problem, if standardization is attempted, would be with small and medium sized enterprises (SMEs).

In the transition from analog broadcasting to terrestrial digital broadcasting, specialized tuners were distributed to low-income users, and if a similar approach were adopted in the standardization of electric power frequencies, it would, according to the industry, be physically possible. The problem is the cost. Not enough information is available to formulate an estimate of the cost of frequency standardization, including the extent of SME facilities which would be temporarily impacted. As a result, it is impossible to estimate such costs at the present time.

Instead, we have estimated the costs which would be required to compensate for the suspended Fukushima Daiichi and Daini plants by increasing the number of frequency conversion stations or the number of thermal generation facilities. After all, these two options will be weighed when estimating the expense necessary to standardize frequencies.

We have also assumed that the frequency conversion facilities would cost ¥800 million per 10,000 kilowatts and that the transmission line unit cost would be ¥700 million per kilometer. For the thermal power substitution scenario, we have assumed that TEPCO would raise its existing thermal power operating rate from 50% to 70%, with the shortfall (of about 600,000 kilowatts) being made up through installation of new facilities. We have estimated fuel costs based on an assumed oil price of about \$100 per barrel (although we have not taken into consideration any increase in fossil fuel prices as may follow from a rise in operating rates at thermal power plants).

Table 3. Cost of Substituting Thermal and other Power for TEPCO Nuclear Plants (\(\xi\)Trn)

	To replace Fukushima Daiichi, Daini nuclear			To replace Kashiwazaki Kariwa nuclear		
Means	Construction cost (building converters also includes transmission infrastructure	Fuel costs (for ten years)	Total	Construction cost (building converters also includes transmission infrastructure	Fuel costs (for ten years)	Total
Frequency						
Converters	2.0	7.7	9.7	4.0	14	18.0
New thermal	1.1	7.7	8.8	3.9	14	17.9
Source: Estimates based on direct inquiries with power industry sources.						

These data show that, whether an attempt is made to boost thermal generation facilities within the TEPCO service area or whether the effort is to enable utilities to share power, replacing the capacity of the Fukushima Daiichi and Daini nuclear plants will require expenses totaling about \$10 trillion over ten years (about \$1 trillion per year). Table 3 does not include costs related to CO₂ emissions (about 30 million tons annually in the case only of substituting thermal power for the Fukushima Daiichi and Daini nuclear power plants), but if that cost is included, it would amount to an additional \$30 billion to \$110 billion per year. If \$1 trillion or more is invested per year, would it be impossible to assume frequency standardization could be realized nationwide? (When TEPCO

was forced to shut down even the Kashiwazaki Kariwa nuclear power plant, construction expenses rose more than two-fold, giving rise to a new burden of just under \(\frac{1}{2}\) trillion per year).

5. Nuclear Accident Cleanup Cost Affordable without Electricity Rate Hike

The Japanese government has estimated the economic damage from the Great East Japan Earthquake at about \(\frac{4}{20}\) trillion, including damage to infrastructure, housing, factories and other facilities. Added to this, as indicated above, will be costs related to coping with electric power constraints in the Kanto region as well as costs for the cleanup of the Fukushima Daiichi and Dain nuclear power plants. Although we speak of coping with power restrictions, it will by no means be easy to estimate the cost of cleaning up the Fukushima Daiichi plant so long as highly radioactive material continues to leak.

TEPCO has stated that its nuclear power plants will be stabilized within six to nine months, but there is so far no end in sight since no means exists to dispose of the highly radioactive water at the plants. There is a twenty kilometers no-go zone surrounding the Fukushima Daiichi nuclear plant. It is highly likely that, in the end, the government may have to buy up this land. In addition to these purchase costs, we have made, based on the number of evacuees, a rough estimate of the income compensation and reactor decommissioning expenses.

Table 4. Fukushima Daiichi Nuclear Plant, Estimated Cleanup Cost (\(\xi\)Trn)

	Purchase of land within 20 km of plant	Income compensation	Cost to decommission nuclear reactor	Total
Fukushima Daiichi Cleanup	4.3	0.63	0.74 ~ 15	5.7 ~ 20

Note: Estimated expenses for land purchase and income compensation are based on official land values and average salaries in Fukushima Prefecture. Those for decommissioning the reactor are based on the cleanup costs following the accidents at Three Mile Island and Chernobyl. We have also assumed a ten year period for income compensation.

In view of the costs arising in the wake of the accident at Three Mile Island, just under \(\)46 trillion over ten years, or about \(\)4600 billion per year, will be required for the cleanup. In making this estimate, we have only taken account of income compensation to be paid to evacuees from within the 20 kilometer designated evacuation zone (now a danger zone into which entry is prohibited). We have not taken into consideration the damage to surrounding agriculture or the agriculture, forestry and fisheries industries of Miyagi and Tochigi prefectures. Moreover, the decommissioning process will not be completed in ten years if it follows a course similar to that of Chernobyl, which was enclosed in a sarcophagus without removal of the fuel rods, rather than that of Three Mile Island, where it was possible to remove the fuel rods. We have assumed that the amount required will be \(\)420 trillion, which is equivalent to the amount of damage from that accident. Our

estimate of the cost of a cleanup lasting ten years should probably be seen as the minimum cost of the cleanup.

6. Cleanup should be financed through Complete Overhaul of Nuclear Policy

In the urgent policy proposals we made on March 17, we proposed a reconstruction tax of ¥5 trillion to be imposed on fossil fuels, but this should not be allocated for the accident cleanup. The cost of the cleanup in all events should be financed first through reserves which TEPCO has set aside for reprocessing of spent nuclear fuel and TEPCO's retained earnings and related funds, which together amount to some ¥3.7 trillion.

Funds could also be raised from a review of the nuclear power budget of ¥430 billion annually. Excepting grants made to the region where the nuclear plant is located, freezing research on development of a fast breeder reactor and the nuclear fuel cycle would make available some ¥200 billion annually. Freezing operation (scheduled to continue for forty years) of the reprocessing facility at Rokkasho in Aomori Prefecture would make it possible to use a portion of the ¥12 trillion (of which about ¥2 trillion is already funded) to be reserved by the electric power industry as reserves for reprocessing. This would be possible merely by overhauling the existing nuclear policy structure. One might call it the "¥12 trillion nuclear power burial fund." There will be no need to increase taxes or electricity rates in order to finance the accident cleanup. If the accident can be resolved quickly, there will be no need to worry for the present so long as ¥12 trillion is available over the next ten years to finance the cleanup (Table 5).

Table 5. Possible Sources to Fund Fukushima Daiichi Cleanup (\(\xi\)Trn)

	1 /	
Review of nuclear power budget		2.0
Freezing of fuel reprocessing		6.0
TEPCO reserves and retained earnings		3.7
Total (over ten years)		11.7

Sources: Federation of Electric Power Companies of Japan, Radioactive Waste Management Funding and Research Center *Business Report*, and other sources. Note: We assume the accident cleanup take place over a ten-year period and that half of the reserve for reprocessing will be allocated to the disaster cleanup.

7. Wind Power Potential of 16M KW, Rivaling Tohoku Electric Power Suppy: Exploit for Reconstruction

Thus far, we have considered measures related to the constraint of electric power in the Kanto region and measures relating to the cleanup of the crippled nuclear plant, but there is also an urgent need to expedite recovery and reconstruction in the Tohoku region, above all Iwate, Miyagi

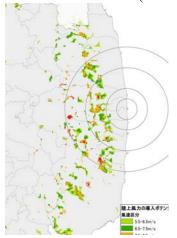
and Fukushima prefectures. Would it not be a good idea to encourage residents to make a concentrated move away from coastal areas affected by the tsunami to safer high ground and to turn the areas vulnerable to tsunami into bases for new forms of energy, such as wind power? In the same way, could not the evacuation zone surrounding the Fukushima Daiichi plant be turned into a massive base for wind power generation? Wind power generation does not require a constant human presence in order to operate, and from the standpoint of disaster prevention, would be unlikely to suffer significant impairment in the event of a tsunami.

There is vast untapped potential for wind power generation in the Tohoku region. According to studies by the Ministry of the Environment, there is a potential for 72 million kilowatts of terrestrial wind power generation in the region. Tohoku Electric has a total electric generating capacity of 16 million kilowatts, and adding the capacity of the Fukushima Daiichi and Daini plants yields a combined capacity of 65 million kilowatts. Even if one considers the operating rate of wind power generation (about 25%), the potential generating capacity is on a par with that of Tohoku Electric. The revenues produced by this wind power generation would then be returned to those former residents who owned land in the evacuation zone. The effort, then, would be to build urban living space with an eye to disaster prevention, and at the same time, turn the work of building eco-industries and eco-cities into a means of supporting recovery, ultimately returning the gains to those forced to become evacuees in the wake of the nuclear plant accident. Such an effort would also be meaningful in terms of easing the need to rely on fiscal resources to support recovery, just as it would play a role in easing the need for power constraints. It could also serve as an important pillar in combating global warming at a time when it is impossible to rely on nuclear energy.

The urban areas of the Sanriku coast suffered from the tsunami and must begin their recovery from square one. But in restoring towns to their former state, problems will remain from the perspective of disaster-prevention. Would this therefore not be a good opportunity to harness the eco-city concept as an aid in recovery? We have made an estimate based on the Environment Ministry's "Study of Potential for Introduction of Renewable Energy."

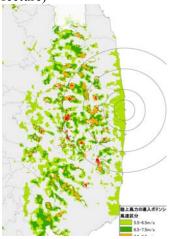
Figure 5. Potential for the Introduction of Wind Power Generation

With land use restrictions (left) and without (right) (In the case of Hamadori area of Fukushima Prefecture)



No restrictions on land use \rightarrow

Colored areas indicate good wind conditions. Where there are no land use restrictions, as in the right-hand map, the potential for wind power generation would expand.



Source: "Study of Potential for Introduction of Renewable Energy (FY 2010)," Ministry of the Environment, April, 2011, with additional data.

Table 6. Revenues Obtainable from Wind Power Generation				
Installation location	Generation Capacity (M kw)	Total revenue (20 years)	1 Year's contribution	
Costal areas of Iwate, Miyagi, Fukushima Prefectures	8.75	2,457.0	122.9	
Hamadōri region of Fukushima Prefecture (indicated separately)	2.0	561.6	28.1	

Sources: "Study of Potential for Introduction of Renewable Energy (FY 2010) and industry sources. Note: We assume a generation capacity of 10,000 kw/km², a construction unit cost of \(\frac{\pmathbf{4}}{3}00,000/kw\), with installations being made on about half of the potential installation area 350km along the Pacific coastal and 5 km inland. We have also assumed that the electricity generated over a period of twenty years would be purchased at a rate of \(\frac{\pmathbf{2}}{2}0/kwh\).

In the Pacific coastal areas which suffered damage from the tsunami, it would be possible to freely construct wind turbines, and this could be done for about 350 kilometers where the wind conditions are good. Estimates indicate that in the three prefectures it would be possible to build enough to provide 9 million kilowatts. If operating rates are estimated conservatively at 20% and electric power utilities buy the power at \(\frac{4}{20}\)/kwh over twenty years, the residents owning the wind power generation facilities would earn a total gross profit of about \(\frac{4}{2.5}\) trillion (about \(\frac{4}{120}\) billion per year) after deduction of construction costs. In the case only of facilities constructed in the Hamadori region of Fukushima Prefecture, estimates indicate a potential total gross profit \(\frac{4}{560}\) billion \(\frac{4}{28}\) billion per year). The central and/or local governments could also purchase tsunami-threatened land along the coast from the landowners, build wind power generation facilities and then return to the landowners about half of the resulting revenues as a portion of their income compensation (the other half being used for maintenance expenses when repairs are needed and to

finance the purchase of the land.) If this were done, it would make it possible to distribute ¥60 billion annually to these three Tohoku prefectures, including about ¥14 billion to the Hamadori area of Fukushima Prefecture (Table 6).

For example, owners of the land where wind power generation facilities are located could be given "wind power generation bonds" in accordance with the value of their land, and if a system were set up to pay a fixed amount of the revenues from the facility as a kind of interest payment, it render it unnecessary to come up with a mammoth amount of money up front to pay for the land while paying them compensation at the same time. It would also make it possible to reduce the burden on government finances.

Table 7. Tohoku Corporation and Fixed Asset Taxes (FY2009)

(¥Bn)

Prefecture	Corporation Prefectural Residence Tax	Corporation Enterprise Tax	Fixed Asset Tax (special exception portion)	Corporation Municipal Residence Tax	Fixed Asset Tax	Total
Iwate	4.0	14.9	0	9.8	72.3	101.1
Miagi	11.6	48.0	0	28.4	139.8	227.8
Fukushima	6.9	38.6	0.5	16.2	133.1	195.3
Total	22.5	101.6	0.5	54.4	345.2	524.1

Sources: Research Institute for Local Administration and Finance materials; *Shichōson-betsu Kessan Jōkyōchō* (Report on the Condition of Municipalities' Balance Sheets), Ministry of Internal Affairs and Communications.

According to our estimates, if all of the revenues from the ¥5 trillion reconstruction tax we have proposed are earmarked for recovery and reconstruction, any negative impact from such tax relief would be eliminated. That said there would be a corresponding negative impact for all other regions (and our estimates do not account for any multiplier effect from investment in Tohoku). Needless to say, the understanding of citizens nationwide would be necessary (Figure 6).

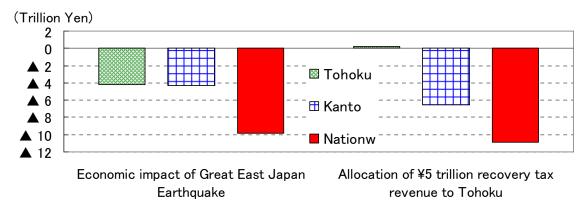


Figure 6. Economic Impact of Reconstruction Tax on Tohoku Region

Note: As with the impact of the earthquake, we analyzed the effect of the recovery tax using the CGE model. A reconstruction tax imposed on fossil fuels would be imposed nationwide, including the Tohoku region, with the entirety of the revenues being allocated to Tohoku.

8. Reconstruction Efforts will support future Growth

It is certain that the damage from the recent earthquake disaster will exceed that of the Great Hanshin Earthquake, but by no means does that mean it can not be overcome. We question whether an overly pessimistic view of Japan's nationwide growth prospects over the medium and long term is really warranted.

One study of the impact of natural disasters on economic growth was made by Eduardo Cavallo et al.⁵ Cavallo and his colleagues argue that, theoretically, natural disasters varied in their impact, from those which had only a short-term impact (the traditional neoclassical growth model), to those which rather had a positive impact over the long term (models based on Schumpeter's creative destruction process), to those which had a negative impact (models incorporating economies of scale). They argue that the question of how and to what extent natural disasters affect economic growth is ultimately an empirical one. Based on this view, they studied the impact which major natural disasters occurring prior to 2000 had on the per-capita growth rate over the medium and long term and found that even massive natural disasters did not have a significant impact on economic growth so long as they were not followed by destructive political revolutions in which the economic system was changed.

We suggest it would be possible to boost the capability for economic growth through a shift to an energy-saving industrial structure while encouraging a shift away from fossil fuels. This is, in fact, the thinking which underlies our recent proposal for a reconstruction tax, which would amount

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⁵ Cavallo, Eduardo, Sebastian Galiani, Ilan Noy and Juan Pantano (2010), "Catastrophic Natural Disasters and Economic Growth," IDB Working Paper Series, No. 183, Inter-American Development Bank, June, 2010.

to a carbon tax imposed in accordance with the volume of CO₂ emitted by any given fossil fuel. It is said that, in Germany, merchandise using less packaging has become the most competitive since the implementation of container recycling legislation. The Porter hypothesis proposes that a business firm's competitiveness is enhanced by environmental regulations. This hypothesis may not yet have empirical proof, but so long as efforts to address global environmental problems can not be abandoned, Japan's options are limited now that nuclear power can not be relied upon.

Although the following estimates are based on the medium-term economic forecast we made prior to the recent earthquake, failure to take measures to cut CO₂ (that is, to save energy) would mean a 2.5-fold rise in fossil fuel prices over present levels, with ¥8 trillion in income draining away to oil-producing countries by 2035 (Figure 7).

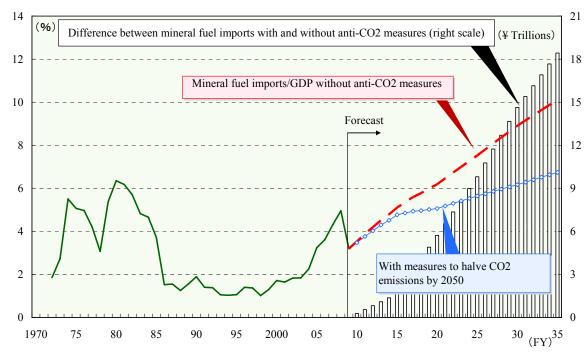


Figure 7. Income Lost Abroad from Rise in Fossil Fuel Prices

Sources: JCER Medium-Term Forecast, with crude oil price projections based on International Energy Agency (IEA) data. Note: Mineral fuel import volume and currency rates after 2020 treated as fixed.

It is quite possible that Japan may follow the path of not implementing measures to cut CO₂ emissions as indicated in Figure 7. However, it is critical that Japan use eco-industries and eco-cities to spur industrial development. Stubborn, mainly industry naysayers argue that a carbon tax on fossil fuels would have an adverse impact on Japan's competitiveness. But rather than avoiding the implementation of such measures, would it not be wiser to refocus the debate on the

issue of how to soften any adverse impact, as by considering the removal of export duties and adoption of border tax adjustments on imports.

The damage from the recent earthquake disaster was indeed catastrophic. However, in the absence of drawn out restrictions on electric power supplies owing to extended problems at the crippled nuclear reactors, and in the absence of any major deterioration in government finances as might arise from massive issuance of government debt to cover reconstruction costs, there is basically no cause for pessimism regarding the long-term growth potential for the nation as a whole. Rather, this disaster can and should be seen as an opportunity to create a new Japan for the twenty-first century.

We sympathize strongly with the evacuees who have been affected by this terrible disaster and are now compelled to reside in evacuation shelters and temporary housing. We prevail upon the government and opposition parties to exercise every effort to make it possible for them to rebuild their lives as early as possible.

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