*6th May,2011*

# From "Unplanned Power Outages" towards a "Strategic Energy Shift"

## A Report on Japan's Energy Shift since March 11th

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The earthquake and consequent massive tsunami which occurred on March 11th, 2011 caused a serious gap between power supply and demand. As a result, Tokyo Electric Power Co. (TEPCO) started an unprecedented rationing of power. This suspension of power, however, was not fully planned, throwing people into extreme confusion.

The Institute for Sustainable Energy Policies (ISEP) examined the current capacity for power supply in the Kanto region (Tokyo and surrounding area) as well as its past demand. Based on this analysis, we propose the following public policies in both the short and mid/long terms.

□Summary□

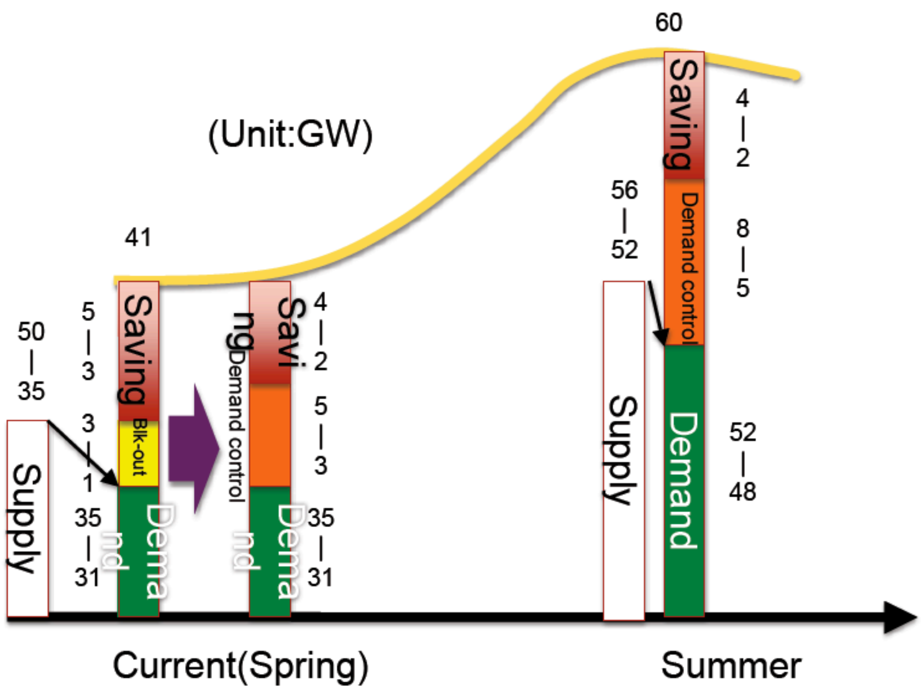
- In the Short Term (from spring to summer)

It was found that even at peak demand in the Kanto region (assuming the maximum demand per day is 55GW), appropriate measures taken toward the demand side can save the region from the need for rolling blackouts. The strategic application of "supply-demand contracts" exclusively conducted with a majority of utility customers can be especially useful in preventing outages.

Specifically, while the shutdown of not only Fukushima Dai-ihi and Dai-ni Nuclear Power Stations but also all of the units of Kashiwazaki Kariwa Nuclear Power Station would cause a maximum supply shortage of 2.7GW, the following measures are expected to decrease total demand by more than 11GW:

- For households with demands less than 50kW, cutting all the ampere-capacities by 20% will decrease demand by 2.5GW
- For users with demands of 50kW-500kW each, introducing a special price for peak-demand period will decrease demand by approximately 2GW
- For users with demands of 500kW-2000kW each, the introduction of price for peak-demand period and together with a gradual application of supply-demand contracts will decrease demand by approximately 1.5GW
- For users with demands of more than 2000kW each, the application (led by the government in principle) of supply-demand contracts will decrease demand by approximately 5GW

□Images of power supply and demand in short term□




- <u>Mid and Long Terms</u>

We propose to a shift to energy policies to focus on regional distributive renewable energy generation. Such a shift will not only help revive regional economies devastated by the earthquake in the short term, but will also be an aggressive and strategic energy shift to provide stable energy supply, energy independence, and strengthen anti-global warming measures in the long term. Under this policy, a target of 30% of electricity provided by renewable energy by 2020 and 100% by 2050 is sought.

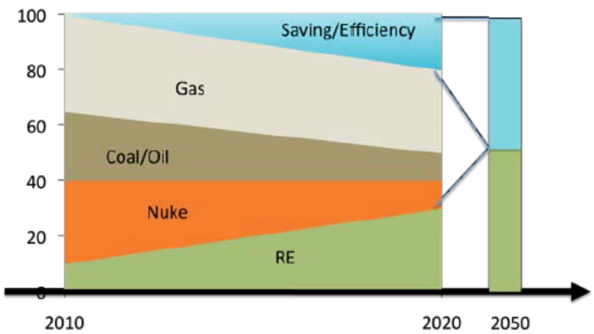
Specifically, the following measures will enable renewable energy to provide 30% of Japan's power supply by around 2020:

- Halt the current "enduring power saving" and start "saving power without sacrificing benefits" in order to decrease demand by 20%
- Expand the renewable energy ratio from the current amount of 10% to 30%
- Taking into account the attrition and damages caused by the recent earthquake, decrease nuclear power's supply to the total energy supply, making it account for approximately 10% of total power supply or be totally abolished by 2020
- Make coal and oil account for approximately 10%-15% of total energy supply by 2020 after being reduced on a priority basis, while making natural gas account for approximately 25%-30%, giving it a leading role in absorbing supply changes.

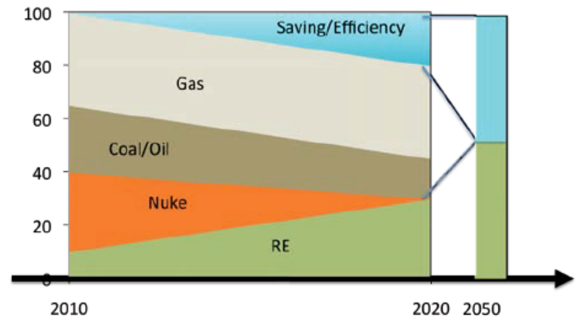
Furthermore, 100% of power supply should be provided by renewable energy by 2050 (50% of the current demand should be decreased by power saving, and the remaining 50% should be generated by renewable energy).

□Images of energy shift in mid and long terms□

40 years lifetime decommissioning




Accelerated decommissioning



## 1. Introduction

Due to the earthquake and consequent massive tsunami on March 11 in 2011, the main power stations of Tokyo and Tohoku Power Companies experienced emergency shutdowns. This caused serious gap between power supply and demand in East Japan, leading Tokyo Electric Power Co. (TEPCO) to implement “planned rolling blackouts”. However, these “planned” blackouts were not fully planned and thus caused serious confusion. Electricity was not supplied to some lifeline systems (traffic signals, railways, hospitals, etc.) or even to some areas seriously damaged by the earthquake, and the blackouts elicited objections from the commercial sector as it made production impossible to forecasts.

Regarding this, the Institute for Sustainable Energy Policies (ISEP) has examined the power demand and supply, including the capacity for power supply in the Kanto region (Tokyo and surrounding area) as well as past demand. Based on this analysis, we propose public policies for both the short and mid/long terms.

## 2. Demand and Supply Forecast

We examined TEPCO’s power supply capacity, in comparison with past demand. For the differentiation purposes, figures for power generation are colored in blue, while the ones for power transmission are in green.

### 2.1 Past Demand

Table 2.1 shows the maximum daily power as well as the maximum power of a three-day average (both at the power supply end) in recent years. Before the financial crisis in Sep 2008, the maximum daily power figures were slightly above 60GW, with figures having fallen slightly below 60GW after following the financial crisis.

Table 2.1: Maximum power output in the past(GW) [Ref. Agency for Natural Resources and Energy]

| Year(Month) | Output Max. | Output Max. 3-day Ave. |
|---|---|---|
| 2007(Aug) | 61.47 | 60.37 |
| 2008(Aug) | 60.89 | 60.35 |
| 2009(July) | 54.50 | 53.87 |
| 2010(July) | 59.99 | 59.61 |
| Estimation by TEPCO (2011 Plan by TEPCO) | 55GW (57.55) | |

The maximum daily power every month from 2007 to 2010 (including the period before the financial crisis) is shown in figure 3.1. Excluding July - September, the maximum was 55GW for January – February, 2008, with the remaining period falling between 40GW to 53GW. During the period January – February, 2008, the maximum three-day average of power demand was 53.6GW.

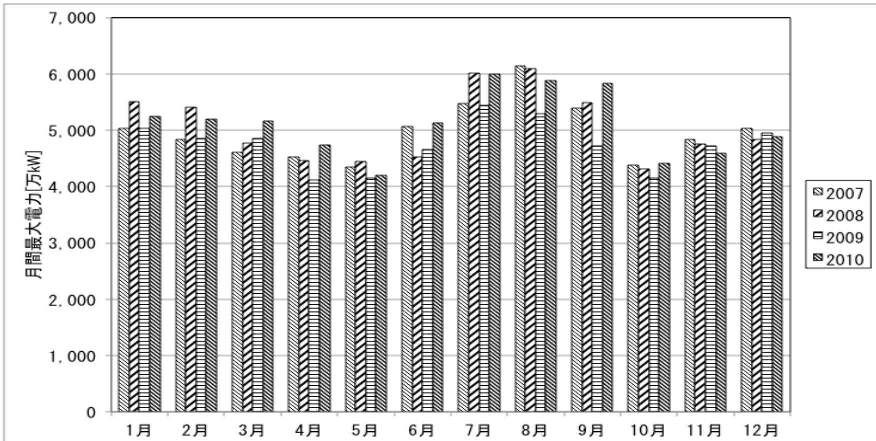



Table2.1: Maximum monthly demand of TEPCO

## 2.2 Supply Capacity

As in the announcements by TEPCO and independent power suppliers, many power stations which were temporarily shut down due to the earthquake have restarted operations by now. We revised our assumptions in response to these changes.

(1) TEPCO's Thermal Power Stations

TEPCO's thermal power stations as of the fiscal year 2010 are listed in Table 2.2. As shown in the table, the simple sum of all supply capacities (at power generation edge) was 38.47GW. Excluding the power supply of stations damaged by the earthquake as well as those under scheduled long-term suspensions in Ibaraki and Fukushima prefectures, the total capacity falls to 27.17GW.

Table 2.2: TEPCO's thermal power stations as of fiscal year 2010

| Fuel | Site | Unit | Output (MW) | 2008 Utilization Time Rate | Note |
|---|---|---|---|---|---|
| Coal | Hirono | 5 | 600 | 68.9% | Damaged |
| | Hitchi-Naka | 1 | 1000 | | Damaged |
| Oil | Yokosuka | 3～8 | 2100 | 39.3% | Planned Shutdown |
| | Kashima | 1～6 | 4400 | | Restarted (Partly damaged ) |
| | Ooi | 1～3 | 1050 | | Restarted |
| | Hirono | 1～4 | 3200 | | Damaged |
| LNG | Chiba | 1･2 | 2880 | 61.9% | |
| | Shinagawa | 1 | 1140 | | |
| | Minami-Yokohama | 1～3 | 1150 | | |
| | Goi | 1～6 | 1886 | | |
| | Anegasaki | 1～6 | 3600 | | |
| | Sodegaura | 1～4 | 3600 | | |
| | Kawasaki | 1 | 1500 | | |

| | | | | | |
|---|---|---|---|---|---|
| | Yokohama | 5〜8 | 3325 | | |
| | Futtsu | 1〜4 | 5020 | | |
| | Higasi-Oogijima | 1･2 | 2000 | | Restarted (Partly Damaged) |
| Total | | | 38470 | | Total |
| Total (excluding Fukushima and Ibaraki) | | | 33070 | | |
| Total (excluding Planned shutdowns, Fukushima and Ibaraki) | | | 27170 | | |

As in the table above, units 3 through 8 at TEPCO's Yokosuka Thermal Power Station are under scheduled long-term suspension, with the total capacities of these units coming to 2.1GW.

Three scenarios of recovery are considered (Table 2.3).

In "Case 1", it is assumed that only thermal power stations that are currently under operation supply. This is a reasonable assumption in the immediate future.

In "Case 2", it is assumed that, in addition to the power stations assumed in Case 1, TEPCO's Kashima Thermal Power Station is to be restarted. It further assumes that 1.12 GW worth of gas turbines canbe operated. This level of recovery is expected by the summer of 2011.

Finally, "Case 3" assumes that, in addition to the assumptions of Case 2, 0.2GW worth of gas turbines of the Yokosuka Thermal Power Station are also put in operation.

In addition, 2.1 GW worth of gas turbines of the Yokosuka Thermal Power Station are expected to be recovered. Also, partial recovery of the Hirono Thermal Power Station may be possible.

Table 2.3: 3 recovery scenarios concerning TEPCO's thermal power plants

| Case | Supply [GW] | Estimation | Note |
|---|---|---|---|
| 1 | 30.98 | Only the power stations that are currently under operation (Hirono 1-5, Hitachi-Naka, Kashima 1 are shut down) | Expected recovery in the immediate future |
| 2 | 32.69 | In addition to Case 1, the Kashima Thermal Power Station is restarted, adding 1.12GW worth of power from the gas turbines | Expectation for summer of 2011 |
| 3 | 32.8 | In addition to Case 2, an additional 0.2GW gas turbine is put in operation in the Yokosuka Thermal Power Station | |

(2) TEPCO's Hydroelectric Power Stations

According to electricity statistics by the Agency for Natural Resources and Energy of Japan, TEPCO's certified capacity of hydroelectric power is 8.989GW (at power generation edge), including pumped-storage hydroelectric power stations. The pumped-storage stations listed in the Electricity Review Japan 2010 by the Federation of Electric Power Companies (FEPC) have a capacity of 6.8GW, thus the capacity of the non-pumped storage stations is assumed to be 2.19GW.

Due to these stations having been reported as being restarted, all hydroelectricity power stations including pumped-storage stations are assumed to be in operation. In Case 1, power output of the pumped-storage hydro electric stations is estimated at 4GW. Cases 2 and 3 assume full power from the pumped-storage hydro electric stations by this summer.

(3) TEPCO's Nuclear Power Stations

As of 11 March 2011, units 1, 5, 6, and 7 (a total capacity at power generation edge of 4.912GW) were in operation, with two of these units scheduled to go under maintenance in the summer of 2011. This analysis assumes that all units are to be shut down, taking into consideration the revisions to be made in safety review standards as a result of the earthquake disaster.

(4) Backup Access to Electricity Provided by other Power Companies

Currently 1GW is provided by Chubu, Hokuriku, Kansai, and Kyushu power companies, and this analysis assumes this will continue. In addition, Hokkaido Power Company also supplies 0.6GW via Hokkaido-Honshu linkage, which is also assumed to continue.

(5) Access to Electricity from other Companies

As for non-pumped-storage hydroelectric power generation, 2.103GW from Electric Power Development Co., Ltd. (J-Power), The Tokyo Electric Generation Company, Incorporated (TEGCI), and several public hydroelectric stations (Tochigi, Gunma, Tokyo, Kanagawa, Yamanashi) are assumed to be available, as well as 2.85GW of pumped-storage hydroelectric generation from J-Power and Kanagawa Prefecture. In order to not be overly optimistic, power provided from stations currently stopped (non-pumped-storage stations of TEGCI and Numahara Pumped-storage Hydroelectric Power Station of J-Power) are not assumed to be restarted.

As for nuclear power generation, access to 1.244GW of power was recorded in 2008, but most of it was from the Japan Atomic Power Company's Tokai Dai-ni Power Station, which is currently suspended, and therefore it is assumed there is no access to this power.

Access to power from thermal power generation was 7.855GW in August 2008. Details are shown in Table 2.4. The portion of in-house consumption is not shown in the table. J-Power's Isogo Coal Thermal Power Station supplied only 0.6GW from New Unit 1 (0.5GW for TEPCO, 0.1GW for Tohoku Electric Power Company), but was able to supply an additional 0.6GW from New Unit 2 (0.5GW for TEPCO, 0.1GW for Tohoku Electric Power Company) which started operation in July 2009.

Case 1 assumes present status. In Cases 2 and 3, 5.83GW of power (deducting powerof the suspended stations, Joban Joint Power, Soma Kyodo Power, Hitachi Zosen Corporation from the total of 7.855GW, which was the actual total for 2008) as well as 1GW of power is added. Details about this addition is stated later.

Table 2.4: Thermal Power Plant of other companies

| Company | Site | Capacity(MW) | Max Power (MW) | Present Operation (MW) | Operation In Summer (MW) | □□ |
|---|---|---|---|---|---|---|
| J-power | Isogo | 1200 | 1000 | 1000 | 1000 | For TEPCO |
| Joban Power | Nakoso | 1625 | 812.5 | | | Damaged |
| Soma Power | Sinchi | 2000 | 1000 | | | Damaged |
| Kashima Power | Kashima | 1050 | 716 | | 716 | Damaged |
| Kimitsu Power | Kimitsu | 1000 | 520 | 520 | 520 | |
| Sumitomo Steel | Kashima | 475 | 475 | 475 | 475 | |
| JFE Steel | Chiba | 382 | 382 | 382 | 382 | |
| JX | Negishi | 342 | 342 | | 342 | Damaged |
| GENEX | Mizue | 238 | 238 | 238 | 238 | |
| Hitachi Zosen | Ibaraki | 212 | 212 | | | Damaged |
| Tokyo Gas | Yokosuka | 200 | 200 | 200 | 200 | |
| Others | | *(1958)* | *1958* | *172* | *1958* | |
| PPS | | | | | 1000 | PPS |
| Total | | *(10680)* | *7855* | *4535* | *6831* | |

1GW of power is assumed based on power interchange of in-house generation surplus by a 3rd party generator.

For example, the Oogishima Power Station, the gas thermal power station (0.81GW) owned by Tokyo Gas Co., Ltd. and Showa Shell Sekiyu K.K. as well as Kawasaki Natural Gas Power Station (0.84GW) which are owned by Tokyo Gas Co., Ltd., and JX Nippon Oil & Energy Corporation have indicated plans to operate at full capacity and supply as much electricity as possible to TEPCO. Therefore, this additional 1GW does not seem to be an over exaggeration. The government assumes additional 1.64GW by operating in-house electric generators which were unused.

Table 2.5 summarizes TEPCO's access to electricity from other companies for each scenario.

Table 2.5: Electricity from other companies

| Case | Supply[MW] | Estimation | Note |
|---|---|---|---|
| Case 1 | 5930 | Present capacity and recovery plant<br>Plus addition of 1GW from PPS etc. | In the immediate future |
| Case 2,3 | 6830 | Case 1 plus additional power from Kashima | By summer 2011 |

(6) Power interchange from Tohoku Electricity Power Company

As Tohoku Electric Power Co. was damaged even more than TEPCO, it is assumed that no interchange of power occurs between TEPCO and power generation companies in the northeast.

(7) Renewable Energy

The total amount of energy authorized for TEPCO by RPS is 2.47GW (assuming specified solar PV is 7.5GW). Since a part of biomass energy is included in thermal power by other companies (including co-combustion with coal), it is assumed that biomass energy is half of specified solar PV (household). All of large-scale PV is assumed. The half of the government's plan to add 1GW of solar PV for households for the summer is also assumed.

### 2.3 Summary of supply analysis

Table 2.6 summarizes the result of analysis.

Even in scenario 1, the worst case scenario where least number of thermal power stations operate, the total power supply should still recover enough to meet the demand for April – June. In Case 2 (which assumes some power interchange from other companies along with the restarting of some of the thermal power stations including Kashima Thermal Power Station) and Case 3 (which assumes power interchange of solar PV), also including pumped-storage hydroelectric power generation, the gap between the supply and demand is expected to be reduced to almost zero. Moreover, the demand can be reduced by energy saving mainly by offices and cutting energy use at times when demand is at peak.

Therefore, it is not necessary to operate nuclear and thermal power plants to reduce the gap between supply and demand by utilizing both pumped-storage hydroelectric power generation and planned energy savings.

Table 2.6: Summary of Power supply by TEPCO (in MW)

| | | Case1 Present | Case2 Summer | Case3 Summer best | Note |
|---|---|---|---|---|---|
| TEPCO | Hydro | 2180 | 2180 | 2180 | Excluding pumped-hydro |
| | Thermal | 30980 | 32690 | 32890 | by Table2.3 |
| | Nuclear | 4910 | 0 | 0 | Kashiwazaki-Kariwa Unit1,5,6,7 will be all shutdown for more strict safety criterion |
| | Sub Total | 38070 | 34870 | 35070 | |
| Other Companies | Hydro | 2110 | 2110 | 2110 | Excluding pumped-hydro |
| | Thermal | 5930 | 6830 | 6830 | By Table2.5 |
| | Nuclear | 0 | 0 | 0 | JAPC Tokai Daini |
| | Others | 0 | 0 | 43 | |
| | Sub Total | 8040 | 8940 | 9370 | |
| Pumped-Hydro | | 4000 | 1,0330 | 1,0330 | Total Capacity: 10330 MW |
| Power interchange | | 1600 | 1600 | 1600 | Transformer substation of Shinshinano, Sakuma, and Higashishimizu and via Hokkaido-Honshu linkage |
| Total Supply | | 51710 (47710) | 55750 (45420) | 56380 (46050) | ( ) indicates capacity excluding pumped-hydro The maximum back-up capacity is 5300MW |
| Demand estimation | | 55000 | | | Estimation by TEPCO |

### 2.4 Pending issues regarding analysis of power supply

As the maintenance status of TEPCO's thermal power stations is unclear, it is difficult to perform further detailed analysis regarding TEPCO's own power sources.

A large assumption in this report's analysis is the purchases of power from other in-house power generators (Tokyo Gas Co., Ltd., etc.). A more detailed analysis of in-house thermal power generation sources could lead to a more realistic overall analysis.

In addition, supply limitations caused by transmission systems were not analyzed in this report. The performance of a power flow calculation could help increase the persuasiveness of this report's stance.

## 3. Measures to ensure power supply - from "unplanned outages" towards a "strategic energy shift" -

### 3.1 Measures to be taken in the short term - in response to peak power demand during the summer -

【Summary】

It was found that even at peak demand (assuming that the maximum daily demand is 55GW on the generating side), appropriate measures taken on the demand side can help keep the Kanto region from experiencing power outages. Strategic application of "supply-demand contracts" which are exclusively concluded with major utility customers can especially be useful to avoid outages.

Specifically, even when not only Fukushima Dai-ichi and Dai-ni Nuclear Power Stations but also all the units of Kashiwazaki-Kariwa Nuclear Power Station are shutdown, the following measures are expected to have effect in decreasing demand by more than 11GW which exceeds the target reduction of demand, 10GW:

- For demands of households less than 50kW, cutting all ampere-capacities by 20% can decrease overall demand by 2.5GW.
- For users with demands between 50kW-500kW, introduction of special prices for peak demand periods can decrease overall demand by approximately 1.5GW.
- For users with demands between 500kW-2000kW, the introduction of prices for peak demand periods and gradual shift toward application of supply-demand contracts can decrease overall demand by approximately 2GW.
- For users with demands more than 2000kW, the application (led in principle by the government) of supply-demand contracts can decrease demand by approximately 5GW.

#### (1) Unplanned "planned outages" can lead to an economic crisis

Under the current emergency strategy of "planned power outages" or "rotation blackouts", electricity is automatically shut off in corresponding regions. This can have a serious negative impact on the whole society due to electricity shutdown without any proper care for lifelines such as traffic lights, railways, hospitals, and corporate activities.

The consequence of the catastrophe at the Fukushima I nuclear power plant remains unclear. However, the problem of power shortage appears to have been lessened to some extent with voluntary efforts to reduce power use also being quite effective. In the current situation, at a minimum, the following principals should be applied.

【Basic concepts concerning power supply】

1. Give first priority to maintaining power supply to lifelines.
2. Maintain power supply to private households while calling for power saving.
3. In industrial sectors, where supply/demand of electricity can be individually controlled, extend "supply-demand contracts" strategically and exercise supply/demand management through market mechanisms and initiatives.

**(2) Estimated power demand from the spring to summer of 2011**

A breakdown of estimated power demand from the spring to summer of 2011 is shown in Figure 3.1.

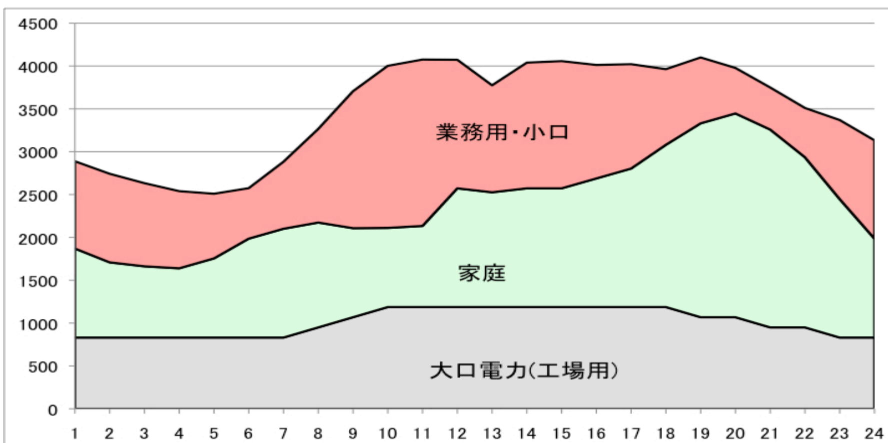
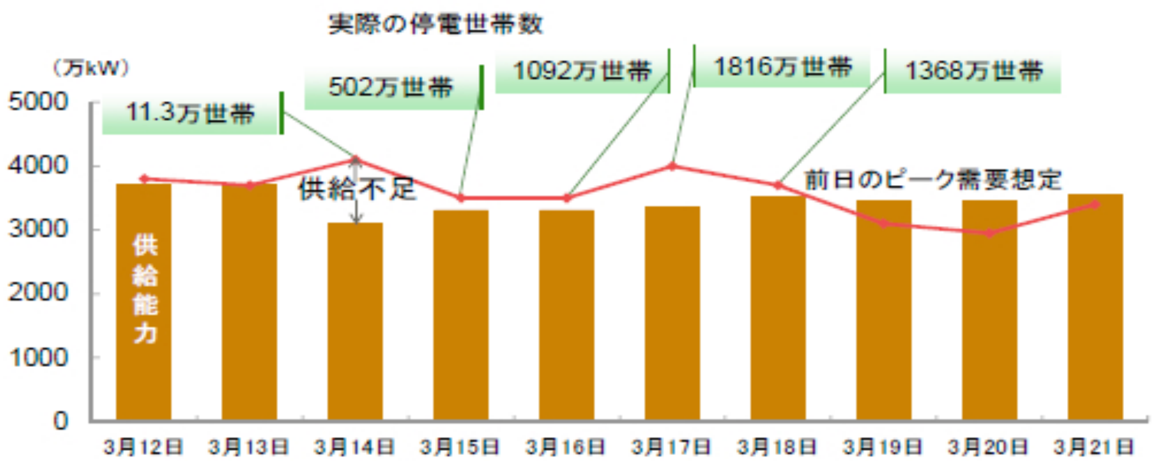



Fig. 3.1: Estimated demand in service area of TEPCO in spring 2011 (in 10MW).
*Estimated by Institute for Sustainable Energy Policies.

TEPCO hastily introduced planned power outages because only 34~35GW of supply capacity was expected for the time being, while the company estimated a maximum power demand of 41GW (around 18:00 -19:00) for the week which started on March 14th. Due to short notice concerning the blackouts, the whole region experienced great confusion. However, an appeal for power saving together with efforts at power conservation by citizens and businesses had an unexpected effect in greatly reducing overall power demand, allowing TEPCO to reduce the outages to very limited regions and time period.

It is estimated that these efforts had effect of saving about 5GW of electricity. As a result, TEPCO was able to lower its estimated maximum demand rate (around 18:00 -19:00) for the following week which started on March 22nd to 37GW (Source: the website of TEPCO, 22 March 2011).

Planned outages since the earthquake continued to be implemented or not to be implemented on a day-to-day basis, depending on the power and demand status resulting from the effect of power saving efforts by citizens and businesses.




(Source) Hiroshi Takahashi, "Think about planned outage: Reconstruction of power supply system" FUJITSU RESEARCH INSTITUTE, Opinion (29. March 2011)
http://jp.fujitsu.com/group/fri/column/opinion/201103/2011-3-7.html

On the other hand, the Figure 3.2 shows the estimated power demand for TEPCO for summer 2011.

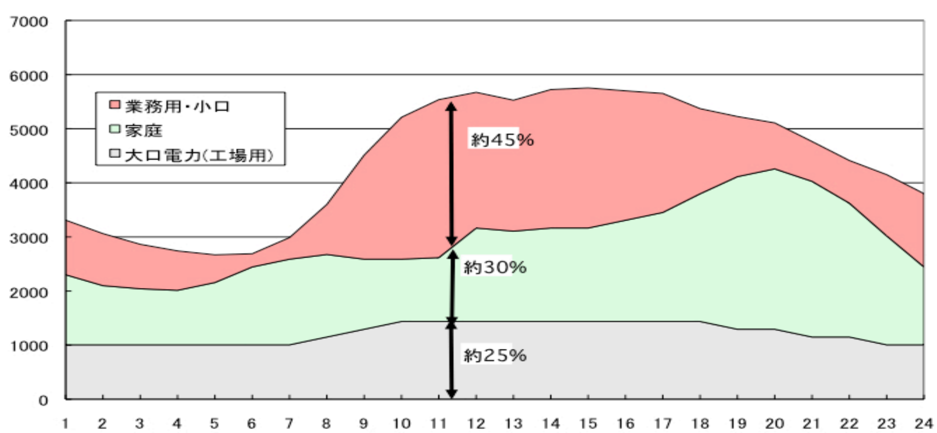



Fig. 3.2: : Estimated power demand for TEPCO in summer 2011 (in 10MW).
*Estimated by Institute for Sustainable Energy Policies.

As mentioned above, TEPCO expects a maximum power demand of 55GW (on the generating side). As shown in the Table 2.6, the expected supply capacity exceeds this demand. However, it is needed to save energy and electricity in order to secure reserves and to correspond to cases when higher demand during daytime last longer (if it occurs, demand exceeds total capacity even with pumped storage power generation). Thus, to be on the safe side, expected demand should be 20% lower than the total capacity (excluding pumped storage power generation).

**(3) Proposal for strategic control of electricity demand control without having to utilized "unplanned power outages"**

**(3.1) Overview**

Although a power shortage over this spring and summer is inevitable according to the supply-demand situation shown above, this shortage can be overcome without difficulty through the current efforts of voluntary energy/power saving. However, it is proposed that the following strategies on the demand side be taken in order to ensure power supply.

In order to implement the measures, the Electricity Business Act Article 27 should be applied and cabinet orders specifying concrete measures should be enacted immediately. Specifically, the following two measures should be taken.

- Impose a surcharge duty in order to reduce peak demand.
- Apply supply-demand contracts to customers that consume over 500KW of electricity.

**(3.2) Type 1: Apply uniform reduction of contracted amperage to small customers as households and small-and-medium-sized companies (amperage of under 50KW).**

A variety of strategies for power saving is also to be introduced in households and small/medium companies. However, the expected effects such power saving is not enough due to a lack of specialists in energy control. Therefore, ISEP proposes that "contracted amperage" be reduced uniformly by 20% during the summer. For example, at a household with a contracted amperage of 60 ampere, the amperage should be reduced to 50 ampere, and similarly, from 50 ampere to 40 ampere. This can be easily conducted by changing the ampere breaker.

Assuming that the reduction of the contracted amperage has an effect of 50% power reduction, it is estimated that approximate maximum power consumption of 25GW at households and smaller customers can be reduced by 2.5GW.

**(3.3) Type 2: Applying peak pricing to customers consuming 50 - 500KW of electricity.**

It is estimated that there are about 75,000 small-and-medium-sized companies consuming 50 - 500KW of electricity, amounting to 7.5GWof power demand. Reduction of power consumption is expected by applying peak pricing to the customers of this category. In order to achieve a total reduction of about 2GW, electricity rates should be set so that the peak demand is reduced by about 25% by imposing a surcharge duty at times of peak power demand. The government can receive the profit from the surcharge and apply it to power saving measures etc.

**(3.4) Type 3: Applying supply-demand contracts to customers consuming over 500KW of electricity.**

The supply-demand contracts are concluded between electric power companies and major utility customers, enabling the electric power companies to demand reduction of power consumption from the customers in case of emergencies. There are three types of supply-demand contracts depending on when announcements are made to customers regarding consumption reduction.

1. "Immediate Limit Contracts", where power supply is limited immediately after the announcement (23 customers as Showa Denko, Asahi Glass, Kobe Steel, Tokyo Steel, Tokyo Kohtetsu, Asahi Industries, Toho Zinc etc. are under the contract with TEPCO.)
2. Contracts where power supply is limited one hour after the announcement (over 500 customers are under the contract).
3. Contracts where power supply is limited three hours after the announcement (over 700 customers are under the contract).

(Source: Website of TEPCO, http://www.costdown.co.jp/blog/2007/08/post_583.html)

TEPCO applied the contracts in 2007 for the first time in 17 years when the Kashiwazaki-Kariwa nuclear power plant was shut down due to an earthquake. At that time, about 1.4GW of power demand was able to be reduced through this planned control and 1.3GW through the control on as-need basis, amounting to 3.1GW in total power reduction.

(Source: Website of TEPCO, http://www.tepco.co.jp/kk-np/nuclear/pdf/150714.pdf)

Considering the recovered power supply and efforts of power saving after the earthquake in March, it is assumed that applying the existing supply-demand contracts would be almost sufficient. However, in order to further ensure control over power demand, the implementation of an incentive reward program should be discussed between the government businesses. The program would for example to reward companies that take initiative in reducing power consumption and offer them a subsidy depending on the reduction volume.

First, with the exception of lifeline utilities, supply-demand contracts should be concluded with all of the estimated 3,000 customers consuming over 2MW of electricity, amounting to about 20GW of power consumption as a total. Peak pricing should be applied to the customers that do not accept to conclude the contracts. This way, an average of 25% in electricity reduction can be assumed, which amounts to about 5GW of total electricity reduction.

Second, peak pricing should first be applied to the estimated 6,200 customers consuming 500KW - 2MW of electricity, amounting to about 6.5GW of power consumption as a total. Then, with the exception of lifeline utilities, supply-demand contracts should be gradually applied to all the customers. Peak pricing should be applied to the customers that do not accept to conclude the contracts. This way, approximately 25% in electricity reduction can be expected, which amounts to about 1.5GW of total electricity reduction.

### (4) Reasonable and effective power saving plan

At present, a power saving effect up to several million kW is achieved due to extensive power saving efforts, which is a great result. However, much of this is a type of "enduring power saving" which makes people feel pressure and inconveniences. Hereinafter, we should switch from such the "enduring power saving" to reasonable power saving that does not deteriorate convenience as much.

#### a. Factory and office building

Energy conservation and power saving are possible in both factories and office buildings by improving energy efficiency.

For factories, more energy and power can be saved by thoroughly reusing waste heat and steam, introducing high-efficiency devices, introducing inverters, and so forth.

For office buildings, more energy and power can be saved by adopting thermal insulation architecture, introducing high-efficiency devices, introducing inverters, eliminating equipments with exaggerated specifications, eliminating too bright lights, and so forth. While thermal insulation, high-efficiency heat sources and high-efficiency devices have been advanced, the energy saving effect is sometimes negated by exaggerated specifications and the like, which results in energy increasing. For example, it is found that a recently constructed office building located at central Tokyo is three times larger in energy expenditure and CO2 emissions per unit floor area as compared with an existing building, according to Green Building Program by Tokyo Metropolitan Government. It is essential to make a change in the energy conservation by introducing policies.

It is necessary to promote capital investments in a well-planned manner so that all business institutions including factories introduce the "best available technologies" regarding thermal insulation performance and large energy consumption equipments/devices to be "leading runner" in terms of the energy conservation and measures against global warming by the year 2020. To achieve this, it is important not only to expand mandatory emission reduction policy to all over Japan by applying the Green Building Program and disclosure system (including energy expenditure and CO2 emissions per unit floor) with respect to each business institution, as in the case of Tokyo Metropolitan Government, but also to provide energy saving diagnosis to help recognize where to take measures for effective energy saving.

#### b. Household and small-and-medium-sized enterprise building

A lot of measures are also possible for household and small-and-medium-sized enterprises. However, to raise awareness about energy saving is not enough because there is no professional energy manager.

For households, provision of concrete and specific information is desirable, such as instructions "not to concurrently operate a several large-size power consumption devices from 10 am to 6 pm" and "to stop operations of nonessential and non-urgent devices such as a heated toilet seat".

Indication of large energy consumption devices that should be replaced also is effective. Here, it is important to specifically indicate them in order to avoid information overload; for example, electric water heaters (all), electric heaters (all), air conditioners (old models), refrigerators (old models) etc. It is also effective to require home appliance stores not only to provide information of energy-saving home appliances but also to educate how major appliances can cause greater energy waste and inconvenience in the disaster area as compared with compact appliances.

Moreover, local governments should provide consultation services for the household energy saving.

In some communities, it is also effective to ask residents to turn off household air conditioners and instead gather in neighboring public facilities in the daytime. Moreover, it is necessary to provide public baths while household baths using electric water heaters are renovated. Note that this policy should be conducted in an unconstrained manner and air conditioning facilities of public facilities, if they are made in 1980's, are far from efficient. It is therefore desirable that the government proposes a guideline and each community determines whether or not to adopt it.

**c. Elimination of inefficient electric heater and electric water heater**

It is important to urge people not to use electric heaters and electric water heaters, which are sometimes expressed in such a sarcastic way as "using an electric chainsaw to cut butter", in the short-term as well as medium-term. This year, the power supply-and-demand balance is tight, and thus the government should ban construction and restoration of all-electric houses, manufacture and sales of electric water heaters and electric heaters.

Table 3.1: Examples of measures for reducing electricity consumption for sectors

| Sector | Measures | Reduction % | Reduction (MW) |
|---|---|---|---|
| | Total | 20% | 11 |

| | | | | |
|---|---|---|---|---|
| Large-scale | Manufactures | managing energy demand (elimination of equipments with over-specifications, reconsideration of clean-rooms, simple construction of high energy-efficiency, inverters etc.) | 25% | 3.5 |
| | Offices | Total | 40% | 5.5 |
| | | reasonable air-conditioning | 25% | 1 |
| | | reconsidering data centers, clean-rooms | 50% | 0.1 |
| | | reasonable lighting | 50% | 2 |
| | | renewing and taking is high energy efficient/smaller equipments | 15% | 0.6 |
| | | eliminating equipments with over-specifications, reinforcing energy demand management, suspending unused equipments | 15% | 1.9 |
| Small-scale | Offices | planned shut off of air-conditioning and lighting | 10% | 1.3 |
| | Households | avoid using energy consuming devices simultaneously etc. | 5% | 0.9 |

As we have described above, the power supply-and-demand balance can be fully achieved over a period from this spring to power demand peak time in the summer (expected maximum power demand = 55GW at generating end) by taking appropriate measures for the demand side; especially by **strategically leveraging supply-and-demand adjustment contracts with large electricity customers, without carrying out unplanned "planned power outages"**.

## 3.2 Mid-and-Long Term Plan - A Vision Particularly for 2020~2050

**[Summary]** A shift to energy policies which focus on distributed renewable energy not only contributes to earthquake reconstruction economies in the short term but also can achieve **bold and strategic energy shift** which contributes to stable power supply, energy independence and measures against global warming in the mid- and long-term. **Specifically, we propose an aim to increase the renewable energy percentage by 20 % to 30 % of the total energy by the year 2020 and 100 % by the year 2050.**

Since there is no problem with the short-term electric power supply and demand, we can spend a great deal of time to think mid- and long-term electric power supply and demand. Hereinafter, let us consider nuclear power, (anti) fossil fuel and two key components: energy conservation/power saving and renewable energy.

### (1) Freezing nuclear power and stimulating national debate

Nuclear power plants in Japan are getting old and will enter a phase of rapid decline, given that a conventionally-estimated lifetime is 40 years. Moreover, installed capacity of nuclear power plants is expected to decrease dramatically due to abandonment (at least we suspect) of new and additional nuclear power plant construction plan and the shutdown of the nuclear power plants affected by the earthquake (see Fig. 3.3).

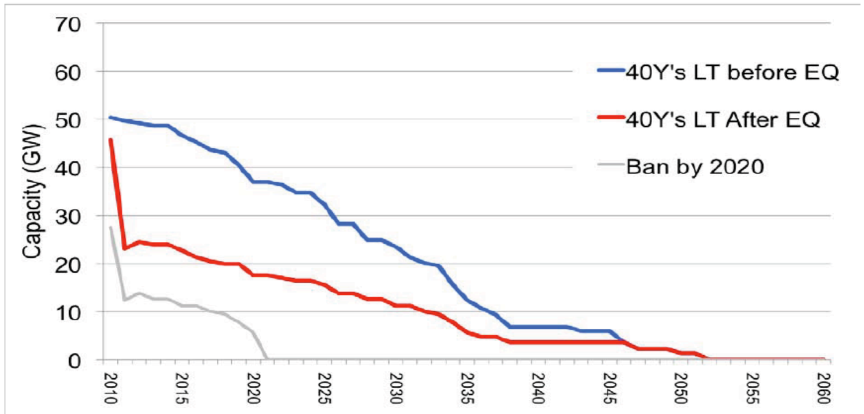



Fig. 3.3: Trend of nuclear power plants in Japan (before and after the earthquake disaster)
* Estimation by Institute for Sustainable Energy Policies (ISEP)
Note: After the disaster, Fukushima, Onagawa, Higashitori, Hamaoka is stopped. And Kashiwazaki-Kariba and Shimane should be stopped step by step.

Regarding policies for development of nuclear energy that have caused tremendous damage to people's lives, it is essential for political parties to completely change their minds' regarding energy policies / nuclear power policies and conduct a thorough national debate. In the meantime, the following measures are important.

① Freezing the development of nuclear fuel recycling

② Freezing new and additional nuclear power plant construction (including those currently under construction)

③ Immediate shut down of operation of a nuclear power plant (e.g. Hamaoka nuclear power plant) that has the same type of reactor and the same level of earthquake risk as the Fukushima nuclear power plant.

* This is important because a safety analysis according to the new earthquake resistance standards is invalid at this time.

### (2) Anti-fossil fuel

Regarding the short-term power supply for the next several years, fossil fuels inevitably become the main component. Besides the global warming problem, above all, there is a fear of energy supply risk due to skyrocketing prices of oil and coal. Japan spends up to 23 trillion yen, namely about 5 % of GDP for importing fossil fuels (see Fig. 3.4).


Fig. 3.4: change in Japan's fossil fuel imports

Coal prices have been soaring even before the earthquake disaster due to factors such as a rapid increase in China's demand. Moreover, a trend toward avoidance of nuclear power plants is occurring worldwide due to the earthquake disaster this time, which could spell an increase in coal demand. Therefore, there is fear that the coal prices further soar hereinafter. Oil prices also are soaring due to political changes in the Middle East. Due to this situation, it is necessary to set policy goals to decrease dependence on oil and coal while ensuring the electric power supply and demand.

**(3) Accelerated spread of renewable energy**

A leading player of future electric power is definitely renewable energy and energy conservation/power saving. In other countries, renewable energy is already growing rapidly, being called the "fourth revolution" following the agricultural revolution, the industrial revolution and the IT revolution. Japan has been completely left behind by the movement. The recent nuclear power plant accident can be a chance to reverse such the situation.

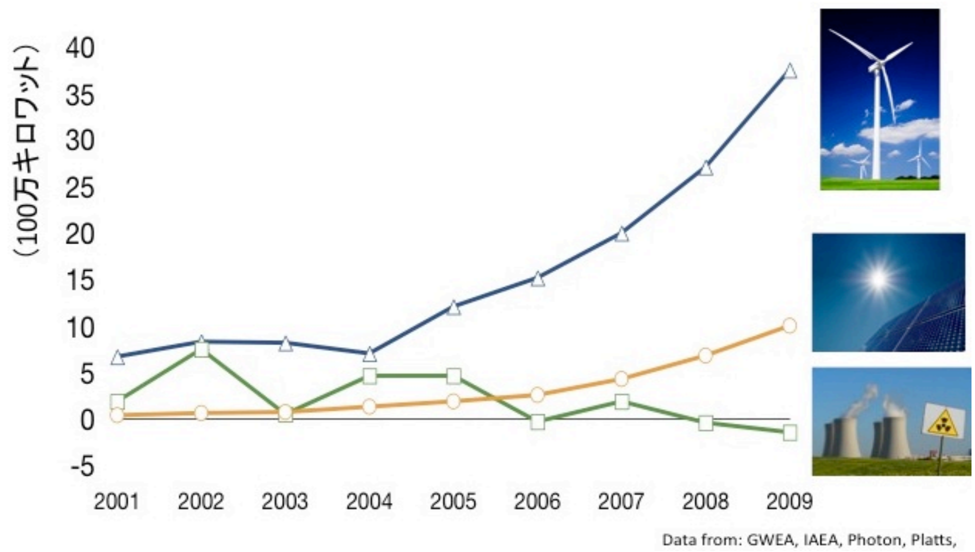



Fig. 3.5: accelerated spread of renewable energy in the world

(annually installed capacity in GW)

The spread of renewable energy is achievable in an extremely short time. Therefore, encouraging the spread of renewable energy can remarkably effective as economic stimulus measures in the earthquake reconstruction and as measures against energy risk and global warming. Moreover, renewable energy, which is the same small-scale and distributed-type of technology as personal computers, cell phones and liquid crystal display televisions, is characterized in that "the wider it spreads, performance is further improved and costs are further reduced". That is, the pace of the spread can be accelerated much more and implementation costs can be reduced greatly over the next decade as compared with the past decade.

Regarding a target level, Germany' case would be a good example. Germany has increased a percentage of the renewable energy in the total electric energy by 10 % (from 6 % to 16 %) over the past decade and, moreover, has a policy goal to further increase it by about 20 % (from 16 % to 35 %) in the next decade. Also, a scenario to cover the entire electric power by the renewable energy by the year 2050 is proposed by a government agency (refer to "Renewables Japan Status Report 2011", http://www.re-policy.jp/jrepp/JSR2011/).

We propose to set a policy goal to increase the renewable energy percentage (including large-scale hydroelectric power) in Japan, which is currently about 10 %, by 20 % to be 30 % in the next decade. This renewable energy percentage of 30 % is equivalent to 37 % when based on the total electric energy at the year 2020 and substantially exceeds the Germany's goal. We further propose to consider a scenario to increase the renewable energy percentage to 100 % by the year 2050 as in Europe and Germany (see Table 3.1). Table 3.1 shows the proposed goals where potential for introduction of renewable energy in Japan is considered based on "2050 Renewable Energy Vision" (see http://www.re-policy.jp/2050vision/index.html) published in 2008 by Japan Renewable Energy Policy Platform (JREPP).

Table 3.2: study of goals of renewable energy expansion

(percentage in the total electric energy)

| | | 2000 | 2010 | 2020 | 2050 |
|---|---|---|---|---|---|
| Germany | | 6% | 16% | 35% | 100% |
| Japan | | 10% | 10% | 30%(37%)※ | 50%(100%) |
| | Hydro | | 8% | 10%(13%) 25GW | 14%(28%) 33 GW |
| | Wind | | 0.4% | 7%(8%) 40GW | 8%(17%) 50 GW |
| | Solar | | 0.3% | 8%(10%) 81GW | 14%(28%) 143 GW |
| | Geo | | 0.3% | 2%(3%) 3.4GW | 8%(16%) 12.2 GW |
| | Biomass | | 1.1% | 3%(4%) 4GW | 6%(11%) 8 GW |

() is ratio based on 2020

In order to achieve the above-described goal, various measures are required such as improvement of electric power transmission lines, obligation of priority access and complete strengthening of the Japan's FIT (Feed-In Tariff) scheme that was approved by the Cabinet at March 11, the day of the earthquake disaster. Details regarding these factors will be saved for a future report.

### (4) Mid- and long-term prospects for electric power supply (summary)

To summarize the above-described discussions, we propose to set an ambitious energy shift with goals as shown in the following Table 3.2 and Figure 3.6. This proposal assumes a minimum investment of 50 trillion yen in renewable energy technologies, renewable energy infrastructure improvement, and energy conservation/power saving technologies etc., which is expected to be a great reconstruction project for this disastrous earthquake. In addition, through this shift an alternative to the shrinking nuclear power is ensured. Furthermore, it offers effective measures against global warming and can reduce energy risk stemming from oil and coal whose prices are expected to soar and wildly fluctuate.

Table 3.2: mid- and long-term goals of power supply configuration (summary)

| | 2010 | 2020 40years lifetime | 2020 Zero nuclear | 2050 | Note |
|---|---|---|---|---|---|
| Efficiency | — | 20% | 20% | 50% | |
| Renewables | 10% | 30% | 30% | 50% | 37%(2020), 100%(2050) |
| Nuclear | 25% | 10% | 0% | 0% | 13%(2020), 0%(2050) |
| LNG | 25% | 25% | 35% | 0% | 32%(2020), 0%(2050) |
| Coal and Oil | 40% | 15% | 15% | 0% | 18%(2020), 0%(2050) |

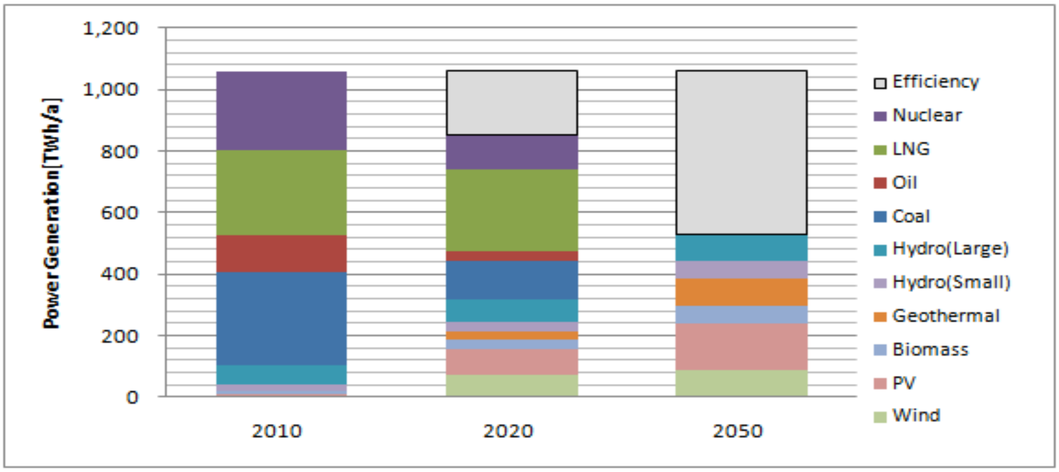



Fig. 3.6: mid- and long-term goals of power supply configuration

## 4 Concluding Remarks

March 11, 2011 is the historic "third reset" day for Japan, following the Meiji Restoration and the defeat in the Pacific War. We cannot and must not go back to the past system. Not only a large number of victims of the earthquake disaster but also tremendous fear created by the "man-made disaster" of the Fukushima nuclear power plant accident and disaster of radioactive contamination that we have to face for many more years to come will not have been in vain.

Energy policies and nuclear power policies after the 3.11 disaster should be developed, after complete change in minds of the political parties, so that people of Japan can feel hopeful about the future. This report is the first shot at such a change and asks action from all of you.