Sustainable best-mixed Outlook of Japanese Primary Energy Supply and Demand after the 3.11 Eastern Japan Earthquake
to establish Environment-Friendly Low-Carbon Society

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ABSTRACT

When we predict a long-term forecast of Japanese primary energy supply and demand, we can not ignore the
global warming effects by green house gases as well as the environmental protection issues. In addition, Japan,
who must import most of the required primary energy resources, would be seriously affected by the great
fluctuations of the crude oil prices although its effects on Japanese economy were softened by the depreciation of
the dollar.

It is noted that on 11th March in 2011, the Great Eastern Japan Earthquake happened and led to a subsequent
serious accident of nuclear power plants in Fukushima. An element of Japanese energy consumption units is
forced to be changed because of this accident. Especially the future share of nuclear energy would be reduced to a
great degree from the present share of 11.4% and measures for substituting energy sources should be investigated.

1. Introduction

President Obama launched a new energy policy, so-called “a Green New Deal” as a breakthrough for the financial
crisis due to the Lehman shock on September 15, 2008 1). “A Green New Deal” moved into the limelight from a report
titled “A Green New Deal: Joined-up policies to solve the triple crunch of the credit crisis, climate change and high oil
prices” by the Green New Deal Group 2). The triple crunch remains crisis even now. Policies on the promotion of
renewable energy to expect a job creation and economic development and nuclear energy were thought as a solution.

![Renewable Energy Investment Transition](image)

Fig.1 Renewable Energy Investment Transition (Daiwa Institute of Research Ltd draw up by UNEP data)
United Nations Environment Program (UNEP) released the report titled “Global Trends in Renewable Energy Investment 2011” on July 7\(^3\). According to the report the amount of the investments in renewable energies increased by 32% compared with the previous year to 211 billion US dollars (about 17 trillion yen at the rate of 80 yen per a dollar) in 2010 as shown in Figure-1. The main factors behind the increase are wind farm development in China and small-scale solar photovoltaic installation on rooftops in Europe. But Renewable energy share in total generation of electric power is only 8%. The investment for renewable energy resources in the developing nations occupied only one forth of that of the developed nations group in 2004. However in 2010, the investment of the developing nations, which was about US$72 billion, overtook that of the developed countries, which was about US$70 billion. In fact, Chinese investment in 2010 recorded to be US$48.9 billion, which was increased by 28% at the maximum in the world. Southern & Central American countries invested US$13.1 billion, which was increased by 39%. Middle East & African nations invested US$5 billion being increased by 104%. India invested US$3.8 billion at the increasing rate of 25%. The other Asia developing nations invested US$4 billion in renewable energy which swelled by 31% comparing with the previous year.

But 2010 was the sufferings year for the renewable energies in the world because the policy was changed so that purchasing prices were pulled down in Spain, Czech, Germany and Italy according to the natural gas price slumping and stagnating trend of international cooperation for global warming measures. Nevertheless both the developed and the under developing countries ever accelerated their investment for the renewable energies. UNEP reported as follows\(^4\), “It is hard for rising and developing nations to plan enrich subsidy for projects like the developed countries. There are wide areas where electrical power cables are not equipped yet although the electrical power demand is rapidly increased in the developing countries. In fact there are many areas having renewable energy potential such as the wind power and the solar power generations. Therefore these energy resources have price competitive advantage as off-grid power resources. An executive director, Achim Steiner of the UNEP said, “The continuing growth in this core segment of the Green Economy is not happening by chance. The combination of government target-setting, policy support and stimulus funds is underpinning the renewable industry’s rise and bringing the much needed transformation of our global energy system within reach”.

On 11\(^{th}\) Mar. 2011 the Great East Japan Earthquake with M9.0 and the earthquake-related Great Sanrikuoki Tsunami inflicted catastrophic damage at the east Japan area. Some people say the earthquake is closely related to the New Zealand Earthquake which happened lately. Now in Japan many earth scientists give a warning of a strong earthquake like old Kanto-Tokai Earthquake happened in Taisho era. But the great East Japan disaster gave us disastrous damages not only with the earthquake and tsunami but also severe meltdown accidents of BWR nuclear reactors at the Fukushima dai-ichi nuclear power station. As we know that President Obama came out with positive nuclear policy to break away from the fossil fuel dependency as a new milestone of Green New Deal Policy. In fact, the serious accident of oil spill from deepwater horizon at Gulf of Mexico had accelerated the world opinion to convert the energy system towards nuclear power generation. However such direction was being overturned from its very foundations.

On the same day of the Great Earthquake in Japan, “Renewable Energy Particular Measure Bill” including renewable energy “Feed-In Tariff issue” was ready to deliberate in the Diet. The bill was not actually deliberated at that occasion, but later it was reorganized and finally approved on the 26\(^{th}\) August as one of resignation conditions of the former Prime Minister, Naoto Kan. However there still remain some exceptional regulations and the electricity purchase feed-in prices for the renewable energy has not been clarified yet. In fact, this act is scheduled to be in effect as in July, 2012.

2. Purpose

Problem of green house gases which causes global warming is at critical time and Kyoto Protocol’s commitment on 2012 is close-by. In addition oil demand increased by population increase and economic growth at developing nations was jumping the oil price and it was kept high level about $90/bbl after Lehman shock. The other resources prices became high level. Therefore the oil price became to counterbalance development cost of renewable energy and searching for natural gas resource and so on, but the exploration cost was too high in comparison with the former oil price before then. In addition to it electric power loss by suspending to operate nuclear power plant by the earthquake and energy policy is pressed to be reconsidered not only in Japan but also in the world.

In this study we analyze on the world primary energy supply and demand trend and we pay attention to the primary energy supply and demand structure and CO\(_2\) emission in green house gas of top10 world primary energy consumer. In addition, we discuss on the best-mixed Japanese primary energy supply and demand share in the post Fukushima era.
3. Data and Methodology

The data used for this study is based on Web site data of “BP Statistical Review of World Energy 2011” (term: 1965~2010) and EDMC (The Energy Data and Modeling Center) Handbook of Energy & Economic Statistics in Japan 2011” (up to the year of 2009). Population and GDP data are taken from IMF (International Monetary Fund) database. We draw figure by time series, correlation and trend analysis.


The component shares of the primary energy consumption on top 10 countries in the world are shown in Table 1, Fig. 2, and Fig. 3. Ranking is as follows, 1st China, 2nd USA, 3rd Russia, 4th India, 5th Japan, 6th Germany, 7th Canada, 8th Korea, 9th Brazil, and 10th France. China was placed at the 1st position since 2009 when she overtook USA. India ranked at the 4th position by passing Japan. It is noted that both China and India were remarkable in coal consumption.

Table 1   World Top 10 Countries on Primary Energy Consumption in 2010

<table>
<thead>
<tr>
<th>Ranking</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Consumption (MTOE)</td>
<td>World Total</td>
<td>China</td>
<td>USA</td>
<td>Russia</td>
<td>India</td>
<td>Japan</td>
<td>Germany</td>
<td>Canada</td>
<td>S.Korea</td>
<td>Brazil</td>
</tr>
<tr>
<td>% of the World</td>
<td>100%</td>
<td>20.3%</td>
<td>19.0%</td>
<td>5.8%</td>
<td>4.4%</td>
<td>4.2%</td>
<td>2.7%</td>
<td>2.6%</td>
<td>2.1%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Source and Share %</td>
<td>Oil</td>
<td>33.6%</td>
<td>17.6%</td>
<td>37.2%</td>
<td>21.4%</td>
<td>29.7%</td>
<td>40.2%</td>
<td>36.0%</td>
<td>32.3%</td>
<td>41.4%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>23.8%</td>
<td>4.0%</td>
<td>27.2%</td>
<td>53.9%</td>
<td>10.6%</td>
<td>17.0%</td>
<td>22.9%</td>
<td>26.7%</td>
<td>15.1%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Coal</td>
<td>29.6%</td>
<td>70.5%</td>
<td>23.0%</td>
<td>13.6%</td>
<td>52.9%</td>
<td>24.7%</td>
<td>24.0%</td>
<td>7.4%</td>
<td>29.8%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Nuclear Energy</td>
<td>5.2%</td>
<td>0.7%</td>
<td>8.4%</td>
<td>5.6%</td>
<td>1.0%</td>
<td>13.2%</td>
<td>10.0%</td>
<td>6.4%</td>
<td>13.1%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Hydro electricity etc</td>
<td>7.8%</td>
<td>7.2%</td>
<td>4.3%</td>
<td>5.5%</td>
<td>5.8%</td>
<td>4.8%</td>
<td>7.2%</td>
<td>27.3%</td>
<td>0.5%</td>
<td>38.4%</td>
</tr>
</tbody>
</table>

Data source: statistical_review_full_report_workbook_2011

In Fig.2 we recognize most of developed nations decreased 2009’s primary energy consumption due to Lehman shock in 2008. China, India, and Brazil continue to increase energy consumption after Lehman shock and it pulled economic growth in the world. At present final energy consumption diversified. However in Fig.3 we recognize that renewable energy share is small and most nations of the world depend on fossil fuels.
Fig. 3  Primary Energy Consumption by Fuel of Top Ten Countries 2010

Fig. 4 and Fig. 5 are historical trend figures of the primary energy consumption. First Fig. 4 shows Top10 countries and Fig. 5 shows No. 3 through No. 13. We recognize that USA pulled the world economy while it continued consuming much energy. It is noted that China grew up her economy so that the world energy consumption was jumping up. It should be also noted that Iran and Saudi Arabia which are huge oil producing and exporting countries ranked No. 11 and No. 13 respectively. These facts suggest that the following increasing portion of world energy consumption.
In Fig. 6 we compare energy consumption of OECD nations with Non-OECD nations and we recognize that OECD nations’ energy consumption is affected by Oil crisis and Lehman shock but Non-OECD nations’ energy consumption is increasing smoothly. There are up and down movement in the Non-OECD energy consumption but the trend is much similar to Russian trend. Four countries in BRICs affect the Non-OECD trend.

As shown in Fig. 7, CO₂ emission in China had overtaken the emission in USA in 2006 and in recent years India had emitted more CO₂ than either Russia or Japan.
5. Energy Supply and Demand Trend Analysis for the World

We conducted the 2-demensional analysis on Top10 nations. Fig.8 shows a correlation of the GDP per capita on the horizontal axis and the primary energy consumption per capita on the vertical axis, including China, India, and Brazil as the under developing nations. We have no idea about when they would reach many developed nations level of 4 TOE per capita or USA level of 8 TOE per capita but we recognized GDP per capita of nations exceeding $15,000 had been not fluctuated practically like energy consumption per capita of USA or Japan etc. Therefore their energy consumption per capita has the possibility to increase there.

Fig.8   Correlation between real GDP per capita and Primary Energy Consumption per capita
Fig. 9 Two Dimensional Shared Analysis for Oil vs. Natural Gas in Japan (BP data from 1880 thru. 2010)

Fig. 10 Two Dimensional Shared Analysis for Fossil Fuel vs. Nuclear in Japan (BP data from 1880 thru. 2010)
As the oil crisis happened twice on 1973 and 1979, world energy consumption diversified its resources. We recognize it by Fig.9 and Fig.10. Main energy consumption share of China and India was converting from coal to oil and natural gas resources. They were categorized as “Type of extricating from dependence on Coal”. USA increased coal share a little according to the crude oil price escalation, however the total world trend leave for energy consumption of environmental consideration. Before the Great East Japan Earthquake happened the nuclear regression was main METI’s energy policy in Japan. After Fukushima dai-ichi nuclear power plant accident caused radiation leakage, the nuclear regression policy decelerated the current rapidly. From now on the existing Japanese nuclear power plants which reach the end of their life will be thought to be examined about decommissioning or replacing.

6. Discussion

6-1 Japanese Latest Status and Presumable Nuclear Policy

In Japan energy conservation technology advanced since the twice of oil crisis in 1970’s and average ratio of energy conservation is said to reach the level of about 30%. It became an urgent task how to cope with electric power loss caused by the Fukushima nuclear plant accident during high electric demand season in coming summer. METI urged Japanese nationals to save electricity by 15% as well as energy consumption.

As of August 26th, only 13 nuclear power plants were in operation among total 54 existing plants as shown in Fig.11. Their operating output capacity was only 10,754MW out of the total capacity of 48,960MW, that is, the utilization rate is only 22.0%. But we took measures to save electricity in companies and households, such as interchange electricity among electric power companies, full utilization of privately-owned power generators. Fortunately we rode out electric power shortage in this summer without power failure programs.

In this uproar of electricity saving, Japanese nationals recognized that we wasted electricity at home and in the factory. Now in Japan we started with R&D intensive program regarding “technology innovation of energy conservation,” “propagation of renewable energy,” “improvement of smart power grid system”. We believe that we are now in a good position to promote this campaign at a good chance as our golden opportunity. Reflecting this point of view we draw Japanese primary energy share trend from 1880 to 2009 in a triangular diagram as shown in Fig.12 and Fig.13.
After Japan experienced oil crisis twice, Japanese energy policy was well-balanced import of its energy resources to disperse the supply risk. Now, Japanese total supply quantity is 514.8 MTOE in 2009. The primary energy shares are oil 45.8%, coal 20.7%, natural gas 17.5%, nuclear 11.4%, hydro 3.3%, geothermal 0.16% and the other renewable 1.13%. At present Japan depends on imported coal almost fully consumption of which is about 165Mt per year since Japanese domestic coal production became negligibly small since 2002. Consumption of nuclear power which supplies only electricity is about 58.9 MTOE. Nuclear power is allocated in the domestic energy source in Japan, but nuclear fuel is really imported. Thus Japanese primary energy import dependency ratio is 94.4%. In another words, Japanese primary energy self sufficiency ratio is only 5.6%. This situation is very dangerous considering our energy security.

EU nations which advocate prevention of global warming has been promoting renewable energy propaganda. Everybody feels that Feed-in Tariff for renewable energy at EU nations was successful, but the policy is pressed to
reexamine renewable energy by price competitiveness and problem of market balance. That is grim reality at present. EU hit a snag about renewable energy policy, but Japan doesn’t even hit a snag 6). We think Japanese companies show their stuff for the snag. “Renewable Energy Particular Measure Bill”, in which Kan Naoto Cabinet recommended to compel Feed-in Tariff, was finally approved on 26th Aug. 2011. But it will be enforced in effective on 1st July, 2012 in.

6-2. Recommendations towards the year 2020

The accident at Fukushima dai-ichi nuclear power plant has forced the drastic and comprehensive revision of “the Basic Act on Energy Policy” and “Strategic Energy Plan of Japan” by going back to the fundamental concept of energy. At the same time review of nuclear policy, the national dissemination of renewable energies, innovative technological development of battery and energy resource development of hydro, geothermal, from methane hydrate deposits became a matter of urgency.

However, review of nuclear power is not immediately feasible. Nuclear has the more difficult problem with much time, cost and danger even if we withdraw from it or promote. After recognizing it making the mechanism to facilitate the phase down and substitute of the nuclear power plant becomes important. It is said that the industrial hollowing-out occurs if the power supply stagnates. However, should the industrial hollowing-out have occurred already as they had been saying that it would happen by the transfer of production offshore as a result of the abnormal appreciation of the yen? It will be the time soon for the globalization of Japanese human resources not only its language.

The key to each country’s long-term energy policy is to set the long term goal clearly and develop its legal systems accordingly. My idea for our long term goal is to raise the self-sufficiency ratio of our energy consumption. Therefore our country, Japan should have various choices of energy resources by 2030 considering the global environmental protection. Our power saving in this summer proved that we can show very big power if we together can stride to the same direction. Again it is very important for us to raise the self-sufficiency ratio by using methane hydrate producing methane with small CO2 exhaustion, biomass of the waste origin, solar cell battery and so on. Even if uranium could be reprocessed it must be a limited resource 7). Further more if a large earthquake of the same scale occurs in Japan we will not live in Japan anymore to say nothing of Japanese economy. After deep consideration of the situation I think that we urgently need to find something to replace nuclear power.

After all, an important thing is to develop scientists and engineers with religious and cultural insights who always lead the world in looking out for the development of innovative technologies considering the future and are active with global leadership 7). It might be the truth that energy resources of the earth depend on the blessings of solar energy. The blessings of older one come from hundreds of millions years ago and it is beyond time and space. At present the last resort of the CO2 control in Japan is nuclear, hydro, geothermal, solar, and wind. However each has issues of the waste, the environment or efficiency. Especially nuclear power was made to stand at the crossroads due to the accident of this March. Therefore, I want to appeal the need to seek the direction of energy independence enjoying the limited blessings.

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