Deliberative Poll on Energy and Environmental Policy Options

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Implementation of Study:
The Executive Committee of the Deliberative Poll on Energy and Environmental Policy Options

About this material

1. This material was edited by the Executive Committee of the Deliberative Poll on Energy and Environmental Policy Options and checked by the Specialists Committee in order to provide you information about energy issues for your deliberation at *the Deliberative Poll on Energy and Environmental Policy Options*.

2. This material summarizes what the issues are and some of the arguments in each theme.

3. However, this material does not cover all aspects of the issues. Please feel free to discuss other related information in your discussions at *the Deliberative Poll on Energy and Environmental Policy Options*.

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1. Why will we conduct “the Deliberative Poll on Energy and Environmental Policy Options”?

The Japanese government and the public need to make a very difficult decision on energy issue now. Needless to say, because of the Great East Japan Earthquake on March 11 2011 and the Fukushima Daiichi nuclear disaster, the government has had to discard many energy and environmental plans. Therefore, the government has to create new mid- and long-term plans again. This is the reason why there is a national debate now. Discussion at the deliberation forum in order to find a path until 2030 is one of them as well.

Finding the path to 2030 requires the public to make difficult decisions. There is a situation that makes difficult to paint a bright future. For example, there is no such energy on the earth such as safe, low cost, available for stable supply, and does not emit CO2. Can people endure a rise in electricity costs? Or, can we continue energy conservation and save power forever? Many people might want to avoid both sudden and planned blackouts. Of course, it might be possible that we take this opportunity to change our life style dramatically and make Japanese economy competitive in the future by transforming industries.

However, under the current options, we need to give up some of them above that force us to sacrifice something. Also, the subject of the public’s decision is about society in the year 2030 and it will become a constraint condition for future generations.

The purpose of this deliberation forum is neither to discuss very technical problems nor examine energy prediction in detail. Rather, the public will choose options so we can make a decision now after taking account of rough predictions. Although the cost of oil has declined after the discovery of large volume of shale gas, the price in the global oil market may increase again. Japan cannot control them. It is possible that similar change may happen in the future. The objective is to make decisions for these issues 20 years from now.

At the same time, it means we will consider how Japanese people will be involved in a society chosen by themselves and what people will have to do.

Everyone believes that energy and environmental issues are difficult. Certainly, issues about nuclear power have been depended on a small number of specialists. However, nuclear power generation is a theme that Japanese people want to discuss now. You might be wondering which of a variety of information sources is correct. In Germany and Spain, “Feed-in tariff” has been already introduced. Some media say that it has greatly contributed to the penetration of renewable energy. Other media say consumers started reducing fixed purchase prices and solar power companies did not grow as their initial goals in Germany and Spain. It is natural that you want to know what is actually going on.

This deliberative poll is one opportunity for the public to discuss important national policies. You can take advantage of it by understanding energy policies and make sure its safety.

Furthermore, it is an opportunity for the government to understand people's preferences and to prepare them for it. For example, if the government wants to know how much cost increase people can accept, or if they would prefer to switch energy sources even if it would be inconvenient, we would need a survey method superior to a normal opinion survey.

It does not mean that the public cannot discuss about it. The Deliberative Poll on Energy and Environmental Policy Options is the place where the public discusses what Japan should do with a basic knowledge of issues in advance in the light of the public.

2 What you should know before your discussion

2.1 Introduction – three "options" and the public debate

After the Great East Japan Quake on March 11 2011 and the Fukushima Daiichi disaster, the government established *the Energy and Environmental Committee* under the Cabinet Secretariat in June 2011 in order to revise Japanese mid- and long-term energy and environmental strategy. Since then, the Committee has collaborated with related organizations such as the Atomic Energy Commission, the Advisory Committee on Energy and Natural Resources, and the Central Environment Council and aggressively discussed the issues with economic organizations, members from NGOs, and specialists in the related fields.

On June 29 2012, the Energy and Environmental Committee summarized their discussions over a year and proposed three options (scenarios) for the energy and environmental policy for the year 2030 with four points of view in terms of reducing the dependency on nuclear power for the Japanese public. The Committee has promoted a national debate for these three options and collected opinions from a variety of areas to summarize them as a new strategy by the end of August. The outlines of these three options (scenarios) are:

<Three Options (Scenarios) of Energy and Environmental Policy in 2030>

Option	Dependency of Nuclear Power	Renewable Energy (Solar, Wind, etc.)	Thermal Power (Coal, Oil, Natural Gas)	Amount of Greenhouse Effect Gas (Compared to the level in 1990)	Total Electricity Output	Final Energy Consumption	Spent Nuclear Fuel
①zero Scenario	0%	35%	65%	▲23%	About 1 Tkwh	0.3 B kl	All direct disposal
②15 Scenario	About 15%	30%	55%	▲23%	About 1 Tkwh	0.31 B kl	Reprocessing & direct disposal
③20-25 Scenario	20%-25%	30-25%	50%	▲25%	About 1 Tkwh	0.31 B kl	Reprocessing & direct disposal
As of 2010	26%	10%	63%	—	About 1.1 Tkwh	0.39 B kl	All reprocessing

According to the explanation by the government, the government will maximize the usage of renewable energy and energy conservation, reduce the dependency on nuclear power generation and fossil fuels, improve energy security, and reduce greenhouse effect gas. However, in the process of discussion by deliberation councils, there was a wide gap in the opinions among specialists at the meeting such as how long we should take, by how much we should reduce our dependency on nuclear power, and how much we should spend to change economic and social

structures in Japan through energy issues.

The choice of energy is related to each person's life. It is an important issue for future generations. We need to know the history of energy policy, understand what kind of future we would have through these three governmental options, discuss issues aggressively, and pursue and express your own opinion.

2.2. Japanese Energy and Environmental Policy

When considering these three options, it is important to know some of the historical background for the necessity of this national debate and our current situation. Let's take a look at the previous paths and choices we made during high economic growth after WWII, the global warming issues, and the revision of energy and environmental policy after 3.11.

2.2.1. From Oil Shock to Global Environmental Issues

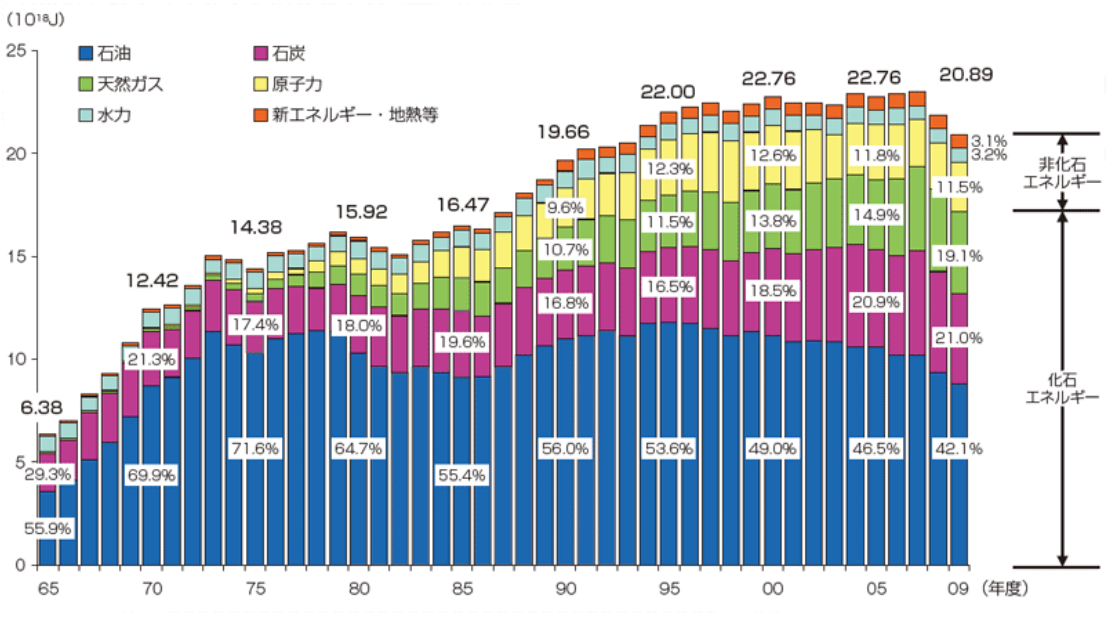
After WWII, Japanese recovery had been supported by domestic energy such as coals and hydraulic power. However, since the high economic growth from the late 1950s, oil, which was cheap and highly efficient, dealt with the rapidly increasing energy demand. A drastic shift from coal to oil occurred and oil became 75.5% of supplied energy in 1973.

However, the Oil Shock in the 1970s provided Japanese energy policy a significant change. Because 90% of energy sources were from overseas, Japan needed to promote energy conservation as well as adopt an "energy mix," a usage of combined multiple energy sources such as coals, natural gas (LNG), and nuclear power, as a basic concept of energy policy for stable energy supply. From 1973 to 1986, Japan could achieve stable economic growth even through the energy supply did not change.

Since the 1990s, we have had to consider a new factor, countermeasures against global warming. In order to reduce CO2 emission, which is a cause of global warming, we need to promote energy conservation more and reduce our dependency on fossil fuels. To do so, the government has promoted nuclear power and introduced a "new energy" such as wind, solar, geothermal, and biomass power as a core energy policy.

Based on this basic idea, *the Basic Energy Plan of 2010*, which was created before 3.11, promoted nuclear power as a base of national energy supply. For example, the government aimed the increase of dependency on nuclear power generation in electricity by 50 percent and emphasized a stable supply, environmental acceptability, and economic rationality. However, since 3.11, Japanese society has had to revise this *Basic Energy Plan* from the beginning.

Figure: Change of primary energy supply in Japan



Source: (http://www.enecho.meti.go.jp/topics/hakusho/2011energyhtml/2-1-1.html)

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After two experiences of Oil Shock, our dependency on oil has been decreased (green line) and we use many energy sources. At the same time, the usage of nuclear power has been increased. On the other hand, solar and wind powers were not increased. The amount of supplied primary energy is almost same within recent ten years.

2.2.2. Profound Revision of Energy and Environmental Policy after *3.11*

The Great East Japan Earthquake with magnitude 9.0 on March 11 2012 triggered a powerful tsunami and caused a historical disaster. Utilities such as electricity and gas were damaged significantly and it showed a weakness in our energy system.

The Fukushima Daiichi Nuclear Power Station lost all energy sources by the quake and tsunami and it caused nuclear meltdowns and leaked nuclear radiation. The damage to and stop of thermal power plants and nuclear plants, which before had generated large amount of electricity caused a very serious electric shortage and had an effect on social and economic activities in Japan. Because the Japanese public lost trust in the safety of nuclear power, the government needs to revise existing energy policy and countermeasures against global warming from the beginning.

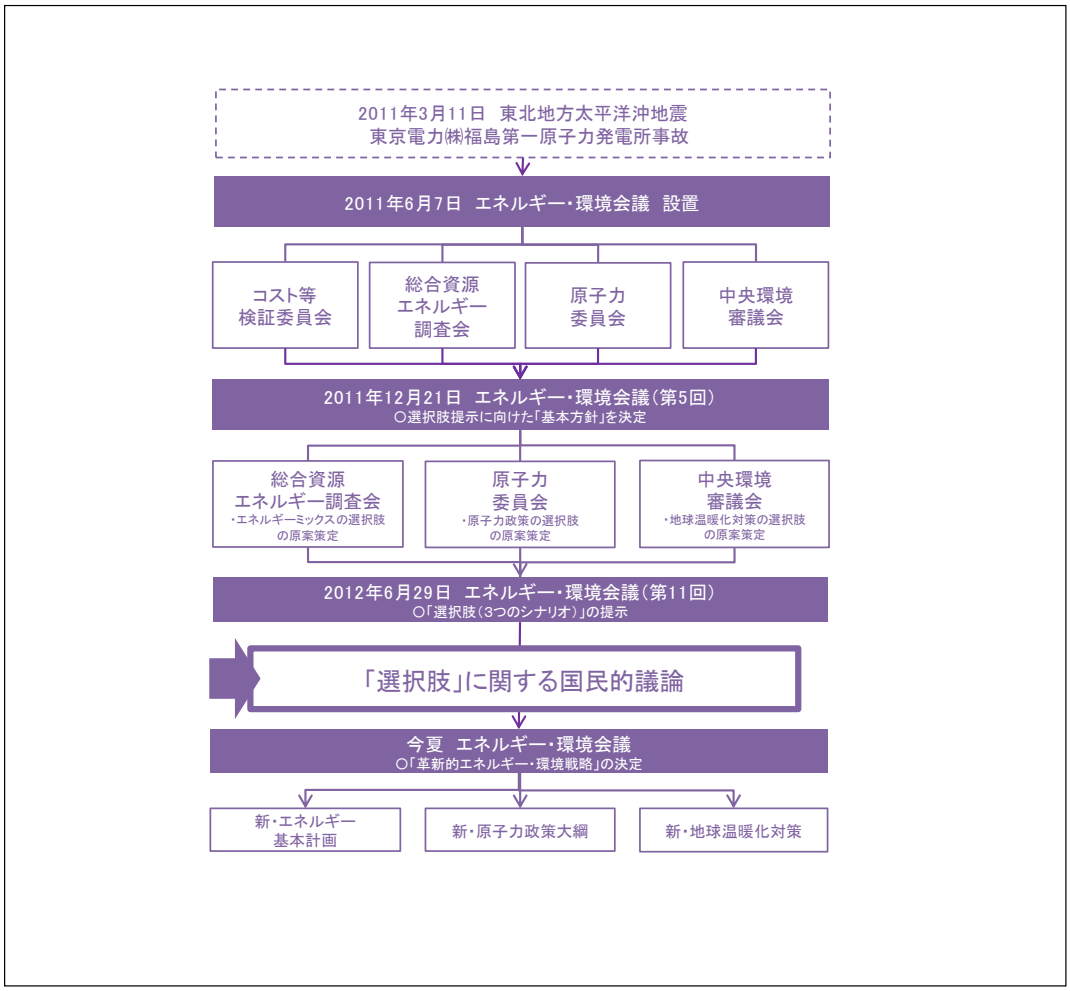
The government established the Energy and Environmental Committee (organizer: the National Policy Unit) comprised of the prime minister and Cabinet members, and has discussed the revision of entire energy policy under the policy of reducing our dependency on nuclear power in the mid- and long term. The government and specialists had discussed and made decisions on policy until now. However, this time, the government proposed options for energy policy to the public to promote national debate and then the government would make a decision responsively. Therefore, the public needs to think about the issue and provide their voices to the government.

After the outcome from *the Cost Verification Committee*, which calculates economic factors of electricity for the base of the discussion on energy issues, three organizations had discussed nuclear power policy, energy mix, and domestic policy for climate change.

Specialists and experts in many areas have aggressively discussed the issues everyday at the Atomic Energy Commission, the Advisory Committee on Energy and Natural Resources at the METI, and the Central Environment Council at the Ministry of the Environment.

The Energy and Environment Council summarized the discussions by these three organizations and created three options. The government planned to announce these three options this spring and planned to make a decision by this summer. However, the government announced them on June 29 and the public will discuss them during a very short period.

○ Discussion Process by the Government, Councils, and Committees after 3.11



Source: the Energy and Environment Council. December 21 2011. “Basic Policy (draft) for the Proposal of Options for the Energy and Environmental Strategies.” Reference #1

2.2.2. How should We Think about Our Energy and Environmental Issues after 3.11?

Since the Great East Japan Earthquake, the public can no longer trust in the safety of nuclear power and is looking for alternative energy. At the same time, Japan has been faced with the difficult situation of solving issues such as reducing CO2 emissions and reducing our

dependency on fossil fuels.

Roughly speaking, choosing energy is a national decision to define what the “rich” country is. It is also a choice that affects future generations in terms of ensuring natural resources, investigating infrastructures, and solving the issue of waste products. This decision may require people to prepare for a tough decision. At the same time, the Japanese decision may affect other countries’ energy choice because Japan has high quality technology and human resources. Japan has a responsibility in the international society as one of the developed countries as well as a country that imports many natural resources.

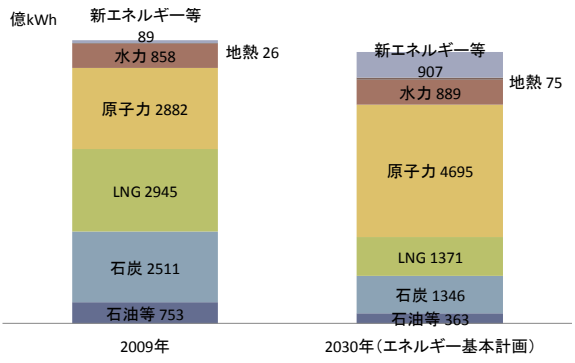
If so, what kind of energy should we choose for our future in 2030 while trying to make our dependency on nuclear power as small as possible?

This choice is involving not only issues of technology and money but also our ideas on what kind of lifestyle we want to have and where we would feel “rich” could come from. That is, we can define energy choice by many factors. What kind of society can we build for our children and grandchildren? Let’s think about these issues on a grand scale.

Colum: *the Energy Basic Plan* before 3.11

The government had a plan where the ratio of “zero” emission energy,” the ratio of energy source without CO2 emission, would be 70% in 2030 by nuclear power and renewable energy. In terms of leadership in global warming solutions in the international society and cost and energy security, the ratio of nuclear power would be increased by 50% by 2030 and more than 14 reactors would be planned with 90% of operating rate.

Figure: structure of energy



3. Theme 1: Deliberations on Energy and its Judgmental Standard

3.1 Three points of view we should pay attention to as prerequisites for discussion (Change in Energy Structure)

When we think about scenarios for our future, there are some prerequisites. Many people agree that we should reduce our dependency on nuclear power and fossil fuels simultaneously, meaning we would promote introducing renewable energy and energy conservation. The Energy and Environment Council argues that (1) shifting to clean energy and ensuring economic growth; (2) energy system reform (systems where users voluntarily choose an energy source); and (3) multidimensional international contributions to the energy and environmental areas are prerequisites for choosing energy options. We summarize their "energy and environmental options" below.

(1) Shifting to Clean Energy and Ensuring Economic Growth

In order to reduce our dependency on nuclear power and fossil fuels, we need to change our energy structure and shift to using renewable energy, clean energy, and energy conservation. To that end, we need to promote consumptions of renewable energy and investment in order to change industrial and life structures and increase investment in research and development of green-innovation and energy networks for the next generation.

(2) Energy System Reform (Systems where users voluntarily choose an energy source)

If we reduce our dependency on nuclear power, renewable energy that users generate themselves, energy conservation, and distributed energy will play an important role. Each person will need to have the right attitude for choosing his/her own energy and shift to the new energy system as a user and also as an energy supplier.

(3) Multidimensional International Contribution to the Energy and Environmental Areas

Through green energy development and a structural shift toward the innovation of high efficiency, we share issues with developing countries and establish an international contribution to the energy and environmental areas. It will become the model of a solution to the global warming.

Because Japan has experienced the Fukushima Daiichi disaster, we have an responsibility for a peaceful usage of nuclear power through ensuring human power and technology. To do so, we will share our experience and what we have learned from the disaster with other countries.

3.2 Four Aspects as a Premise of Judgment

When we think about energy and environmental issues, there are many decision criteria and values. We choose four typical examples below but there are many other criteria. For example, risk belongs to all aspects but we do not cover it here.

3.2.1 Safety (Ensuring Safety of Nuclear Power and Reducing Risks in the Future)

After the Great East Japan Earthquake on March 11 2011 and "unexpected" disaster of the Fukushima Daiichi plants, a basic premise as "nuclear plant is safe" has been shaken. It has been required that we should be faced with the reality that nuclear disaster cause a serious damages and Japan is earthquake prone then ensure sustainable safe and relief. Some say we can keep nuclear power by enhancing safe standard and intensive countermeasure for safety in order to minimize its risks.

●Main opinions and arguments regarding safety●

Safety
• We should break away from the "myth of the safe nuclear power plant" and make an effort to improve safety and reliability based on investigation reports from the Accident investigation Commission. • We should minimize the risks by improving safety countermeasures in technology and regulations. • We should ensure technology and human resources for safe countermeasures • On the other hand… • The government should understand the public's feelings toward safety and reliefs against nuclear power generation. • Ensuring the safety of nuclear power plant may increase the cost of generation. As a result, the electricity price may increase and it would become a burden on the public and industries. • Because of the emphasis on safety, electricity costs would be more expensive than now and it would become a burden on businesses and households.

3.2.2. Cost (Reducing cost, prevention of Overseas Transfer)

If generation cost would increase because of change in energy mix, our monthly electricity cost would increase as well. If a burden on companies that have to compete in the international economy would heavier and they decided to move to overseas, we would lose domestic industries and employment.

Some energy is limited in supply now. When we introduce high-cost energy, we also need to spend money toward energy conservation in order to avoid a cost increase. There is also a social cost therefore we need to establish a system where energy companies (and users) pay for it. It is also important to establish an optimal energy structure in our society where users make their own choices about energy. On the other hand, we need a cost for grids for renewable energy and its stable supply but we may treat it as an investment for future generations and use taxes for the investment.

[Referential index] electricity cost, grids cost, investment on energy conservation, residential electricity costs, industrial electricity cost, real GDP, etc.

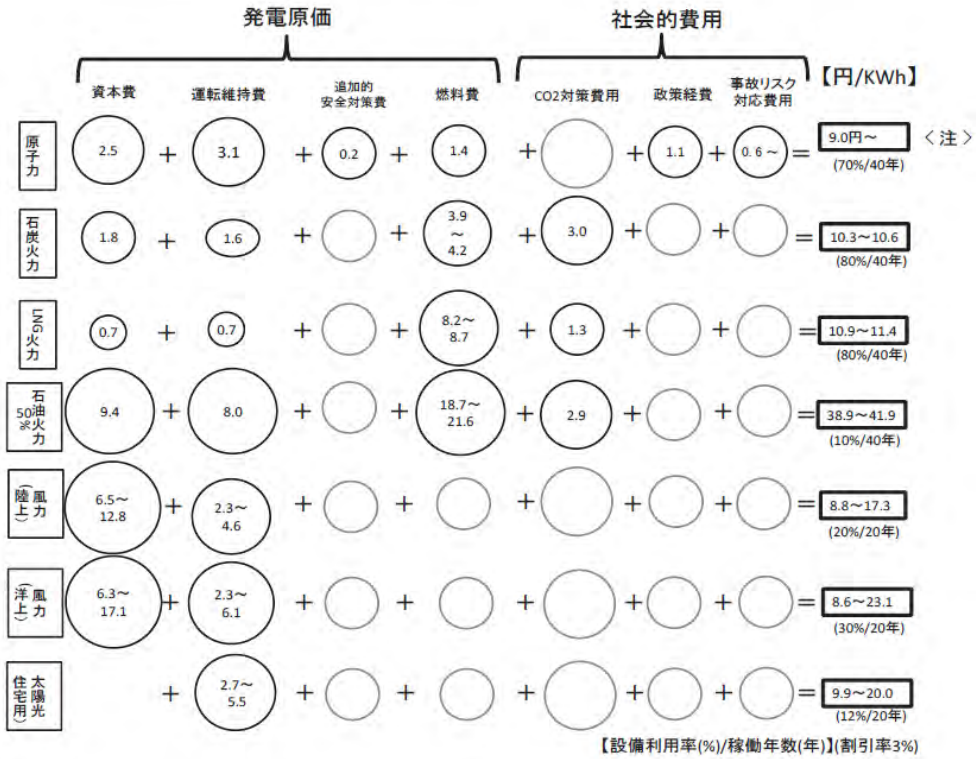
●Main opinions and arguments regarding cost●

Importance of Cost
• Low energy cost sustains the competitiveness of Japanese manufacturers in international competition.
• It avoids the hollowing out of industry and creates employment
• Low electricity cost helps household expenses
• It keeps industries and stimulates consumption which would cause an increase in GDP
On the other hand…
• If we only pay attention to low cost, we cannot take care of safety, stability, or the environment.
• If we rely heavily on cheap energy sources, it would become more difficult to react against the freeze on energy source import or accidents flexibly.
• Environmentally harmful energy sources would remain
• It would provide a negative impact on later generations as an overconsumption of natural resources
• It is possible that we could not invest in renewable energy and its technical innovation would not develop because the current cost is high although it has a potential in the future.

Power generation costs are used when we evaluate an energy's economic efficiency. After the Great East Japan Earthquake, the hidden costs in nuclear power were pointed out and the cost calculation method was criticized. Therefore, *the Cost Verification Committee*[1], which was established by the Energy and Environment Council, evaluated costs without any exceptions. (See figure below) [2].

[1]It was established on October 3 2011. The chair is the vice minister of the National Policy Unit. There are 10 members.

[2] The Cost Verification Committee, December 19 2011. *The Cost Verification Committee Report*.



コラム：主な電源の発電コスト（2030 年モデルプラン）

<Details>
Capital costs: construction costs, fixed asset tax, facilities' decommissioning costs
Operation costs: Labor costs, repair costs, miscellaneous, general administration costs
Fuel costs: Reprocessing costs for spent nuclear fuels are included in nuclear power plants
Expenditures on government policies: Costs in introduction support are included into construction costs
Expenditures on countermeasure for risks of accidents: Because the costs for accidents are uncertain, it was calculated as a minimum
* Costs for stability of grids are not included.

3.2.3 Stable Supply (Enforcement of Energy Security)

It is essential for a necessary amount of energy to be stably supplied at acceptable prices. However, the international energy situation and prospect of ensuring alternative energy are

uncertain. We are able to ensure energy security by increasing energy self-sufficiency rate and diversification of energy sources.

The government currently has stored oil for emergency situations. We need to store additional fossil fuels for the possibility that the ratio of renewable energy increases and a supply shortage would occur.

【Useful evaluation index】 energy self-sufficiency rate, degree of dependence on fossil fuel, degree of dependence on oil, etc.

Opinions and arguments for stable supply

Importance of Stable Supply
• We can prevent blackouts and stop importing energy resources to sustain important infrastructure for people's life. • We need international strategies because Japan relies on overseas for many energy resources. • We can prevent suspend social infrastructures that affect human life such as hospitals On the other hand… • Safety would decrease because of the necessaries of sustaining highly dangerous power plants. • We would downgrade damages from electric generation accidents. • We need to introduce high cost energy now and it causes increase of electricity cost and becomes a burden on industries and people's living. • We need to keep fossil fuels such as coals and oil that emit large amount of greenhouse effect gas. As a result, we cannot contribute to the prevention of global warming

3.2.4 Prevention of Global warming (CO2 Reduction)

Based on the premise that all major countries would participate in and agree with fair and practical goals, the Japanese government announced to cut our CO2 emissions to 25% below the 1990 level by 2020. In a long run, it is becoming a common goal among the advanced countries to cut CO2 emissions 80% below 1990 level by 2050. However, it is very difficult goals not only reducing our dependency on nuclear power but also reducing CO2 emissions and we need to revise our plans fundamentally. Some say we will make effort for ensuring safety and stable energy supply first and will work on the countermeasure for global warming later. Other say we should work against global warming even if it would require costs regulations because the global warming affects ecosystem and weather in a long run.

[Referential index] greenhouse gas amount (1990 level), CO2 per GDP, CO2 per capita, CO2 per kWh, value of elasticity of energy against GDP

Opinions and arguments for prevention of global warming

Importance of Prevention of Global Warming
There are some opinions regarding the prevention of global warming such as … • Global warming prevention leads to the protection of the global environment • We can reduce the risks of global warming so that future generations won't have trouble with it. • Raising the bar for the reduction of greenhouse effect gas enforces international partnership. • It becomes a significant contribution to the international society and Japanese diplomatic influence becomes stronger. On the other hand… • Achieving high goals for cutting down on greenhouse effect gas requires keeping low safe levels of energy sources such as nuclear power. • Cutting fossil fuel consumption affect energy supply sustainability in the short term. • Ensuring alternative energy is uncertain • We need to use high-cost energy sources and implement additional electricity cutbacks and energy conservation. As a result, it would cause an increase in electric prices and would become a burden on industries and the people's living.

3. 2. 5 Additional issues

We did not argue about the risks independently. However, risk is related to all arguments here. When we think about safety, we also think how much the risk is. When we think about energy supply stability, on the other hand, we also think about being ready for urgent risks such as the suspension of import energy from overseas. Hedging risks against price fluctuation is often argued. If we give priority to global warming prevention, there is a risk against industrial development. Crisis control is a systematic preparation for risks. We will not argue about the risks in detail, but we cannot argue about ensuring energy without risks.

Some people say we have to pay more attention to Japan's future to discuss energy issues. Thinking about energy issues in the year 2030 requires us to consider in energy structure. In other words, we should take advantage of the crises and difficulties we have experienced as a chance to draw pictures and concepts for the future.

We have argued four criteria above. That means we have more than a *trilemma*, that is, we have *quadrilemma* now. In order to solve these problems simultaneously, we will expect to new technologies, the government will need to change policies drastically, and the public will be expected to change their ideas. We should think of the future as an extension of now.

These four criteria above are just some examples. Priority varies person to person. It means this is a controversial issue. It is commonly said that it is difficult to meet on common ground to discuss this issue. However, it is important to understand which criterion we take

priority of first. If we discuss on common ground, it is relatively easy to discuss and compromise with each other. Before that, let’s understand which criteria people use for each opinion at the macro level. Or let’s listen the opinions of others who differ from yours. It is possible that there is common base between opinions.

3.3. Features and Issues of Each type of Energy

When we think about the future energy situation, it requires us to consider four aspects: safety, stability, cost, and countermeasures for global warming. In this section, we will consider the pros and cons of each type of energy in terms of these four aspects.

3.3.1. Nuclear Power

We can use nuclear power energy for electricity generation. Before 3.11, nuclear power was a main electric source and accounted for 26% of it. As of June 2012, there are 50 reactors in Japan but none of them are operating now except the *Oi* nuclear plant, which resumed on July 1st 2012. We are faced with creating safety standard for resuming reactors and issues of spent nuclear fuel. That is, we need to find answers for how to deal with nuclear power in Japan.

Pros	• Able to generate large amounts of energy from few fuels • No CO2 emission • Able to reuse spent nuclear fuels
Cons	• Generate nuclear waste • Possibility of running out of uranium • Serious disaster after accidents • Requires long-term processing and disposal of nuclear waste

- Safety

Nuclear power poses a high risk for security effecting the environment like what happened with the Fukushima Daiichi disaster. The Japanese public lost trust in the safety of nuclear power. This disaster made us reconsider the seriousness of risks and the importance of ensuring the safety of nuclear power construction in earthquake country.

On the other hand, some people say we can learn from this disaster and take advantage of it for the improvement of safety standards and additional regulations.

- Stable Supply

A large amount of uranium, fuel for nuclear power generation, is produced and reserved in Kazakhstan, Canada, and Australia and we can import it at a low cost. Its storage effect is high.

Nuclear power has been used as a base electric source because it can generate power stably 24 hours a day. It can generate large amounts of energy with small amount of fuel.

- Economic Efficiency (cost)

In the past, it was believed that the cost of nuclear power is cheaper than other energy sources because it avoids the effect of fuel cost increase. However, after the recalculation with costs of capital, operations, nuclear fuel cycle, additional safe countermeasure (7.3 yen / kWh), research and development, policies such as location (1.1 yen / kWh), decontamination and

decommissioning (0.6 yen/kWh), we found out the cost is on the same same level as thermal plants.

o Global Warming

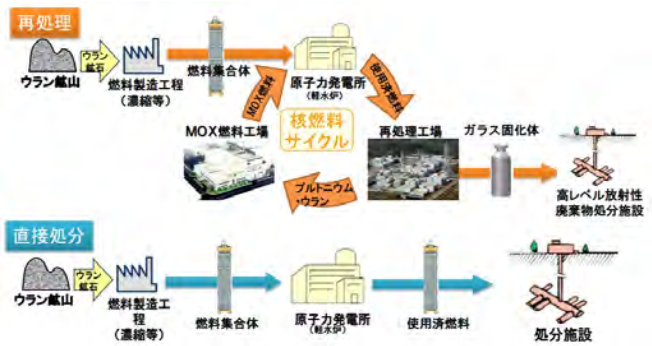
Because it generates energy using heat energy from uranium splitting, it does not emit CO2, SOX, or NOX during power generation.

●Opinions and Discussions in the Governmental Committee ●

The opinion that is best to get rid of nuclear power	• The nuclear power accidents bring serious influence on citizens' living, our economy, and our industries. Is it really worth it to just ensure energy security? People who lost their homes and their security have been threatened. • If and only if we can improve the safety of plants after a disaster, it means the system has problems because it ignored the pre-existing problems. Therefore, there is no guarantee whether or not we can expect drastic reform. • Nuclear technology has been supported by direct and indirect subsidies from the government. It is not necessary to spend tax money on the nuclear industries. In terms of the international market, the size of industries related to renewable energy and energy conservation are larger than that of nuclear power. • It is ethically unacceptable to increase the amount of spent nuclear waste without solving the problem of final disposal sites. • Keeping nuclear power for sustaining technologies and its improvement is not logical. We cannot keep nuclear plants only for maintaining technology.
The opinion that is best to keep a certain amount of nuclear power	• Regarding the importance of "the base load" we should utilize nuclear power with the premise of the revision of safety standards and regulation system. • Since the disaster, the safety in plants has been improved. We need a system to evaluate safety levels accurately. • Because there are no political and economic effects on resources, we can continue to expand the usage of nuclear power once we have its technology。 • Because we cannot store technology, it is necessary to keep industries running on a certain level. • We need to provide engineers with a work environment where they can obtain hope and pride in order to sustain and improve nuclear power technologies. • As a non-nuclear-weapon country and the only country where we have gotten permission to use nuclear fuel cycle from the international society, accumulation and maintenance of technologies by peaceful utilization is important.

o Other: Spent Nuclear Fuel

How to dispose of spent nuclear fuels and radioactive waste is an issue. The nuclear fuel cycle is a recycle method utilizing uranium,



which is the fuel of nuclear power generation. The government had a policy to promote the nuclear fuel cycle (we would reprocess all spent nuclear fuel) in order to ensure a stable energy supply. Recently, the nuclear fuel cycle is recognized as a useful method to reduce the space of disposal sites and potential poisonous property.

However, after 3.11 the government has included the nuclear fuel cycle policy as one of the subjects for the revision of all nuclear power policy and included a “direct disposal” policy which states that spent nuclear fuel would be buried in the ground.

Any methods have some issues. “Reprocessing” in combination with a certain level of usage of nuclear power requires highly advanced technologies for the nuclear fuel cycle *per se* and each processing step would become a development process. A technical feasibility is not established yet for the fast-breeder reactor, which we had already invested 2 trillion yen in. It became obvious that direct disposal is more economical than using the nuclear fuel cycle.

There is a plan called “geological disposal” where high-level radioactive waste is buried hundreds of meters under ground, but there is no potential location yet. The same problem would exist even if we do not use a reprocessing method and just choose direct disposal. Therefore, we have to solve the geological repository issue. In addition, if we shift from the “all reprocessing” method to another method, we need to reach an understanding within the local government near nuclear plants get them to accept the construction of the plants with a premise of the “reprocessing” business.

In any case, the storage of spent nuclear fuel from nuclear plants is a serious issue. “Dry storage,” a safe and economical storage method where spent nuclear fuel is stored in a cask, is in practical use now. However, the problem is we cannot find their storage location. Until now, it is stored at nuclear plants’ sites and in Aomori Prefecture but some say we should store it at consuming region in the future.

Moreover, because Japan is a non-nuclear-weapon state and plutonium is used in nuclear weapons, it is important that we establish technologies of the nuclear fuel cycle to meet the needs of nuclear power plants in developing countries in terms of contributions to nuclear non-proliferation and nuclear security.

3.3.2. Renewable Energy

Generally speaking, renewable energy is infinite energy that comes from nature such as solar, wind, hydraulic, geothermal power, and biomass. Renewable energy is also used for hot water by solar power and biomass fuels, but in most cases, it is used to generate electricity.

- Safety

There are some risks to spread out energy systems such as settlement of equipment in houses (it is rare but there is a possibility of fire caused by a solar power equipment on the roof of a house).

- Stable Supply

We can obtain renewable energy domestically but the available amount is limited. Also, the outlets for solar and wind generation vary depending on the weather. Therefore, it needs some countermeasures such as a suppressing outlet and an electric accumulator. If power facilities are large, the range of outlets becomes smaller but requires infrastructures such as substation facilities, and reinforcement of power grids and cables.

We are expecting the development of a “smart grid” that reads supply and demand by IT technology and can send and use electricity efficiently.

- Economic Efficiency (cost)

The cost of energy in existing facilities such as hydropower plants is already low. However, the cost of renewable energy from newly constructed facilities such as solar and wind power would be more expensive than other energies. However, their cost is expected to decrease due to technology and development as well as the establishment of the market. At the same time, the infrastructure cost for its large volume supply would cause the price of electricity to increase.

- Against Global Warming

Renewable energy does not emit greenhouse effect gas.

- Other: Location Limitation

In terms of the effect on the environment, there are noise issues, bird strikes, and impairing scenery. It is difficult to build new hydropower facilities. In terms of geothermal power, many sites are located in national parks and developments are restricted. On the other hand, suitable locations for wind power are limited because Japan is a mountainous country.

- Other: Electrical Grids

Pros	• Unlimited and domestically produced energy • No CO2 emission
Cons	• Wind and solar power rely on weather • Limitation of location • Some issues in the grids

“The grids” is a system to connect the generation output to transmission lines. If we will introduce large amount of electricity, it requires the voltage adjustment, storage technology, and the development of smart grid. If the power stations are far away from consuming locations, the issues about the accessibility to the grids and limitation of volume in grids should

be solved. To do so, it requires additional technology and development as well as investment in the infrastructure. The issues about capital and burden must be solved.

●Opinions and Discussions in the Governmental Committee●

The opinion that we should introduce renewable energy drastically	• It is the safest energy with is no risk of sudden stop like nuclear power • The cost is high in the short term but it will decrease. Even though the public will pay some of the cost we should receive their understanding and introduce it. • There is great potential in terms of outlet and it is the most efficient way to increase a self-sufficient rate of energy. • It is a chief player in "green growth" by technological development and economic impact. It will utilize unused natural resources and create jobs in the local area. • It is closely related to revitalizing regional development.
The Opinion that it is difficult to introduce renewable energy drastically	・ It will become expensive if many facilities were built rapidly. ・ We need to reach a balance between stable (thermal, biomass, hydro) and unstable (solar and wind) supplies for cost minimization. ・ Many polar power electric companies went bankrupt in Europe. We cannot expect a large amount of jobs to be created. ・ Its energy density is small so its effect on the increasing self-sufficiency rate is limited. ・ We need to recognize the uncertainty of technological development, countermeasures for the stability of grids, and solutions for the restriction of location.

3.3.3 Fossil Fuel Energy

Fossil fuels such as a coal, oil, and natural gas are important and used not only for power generation but also for cars and airplanes all over the world. It is easy to transport and store them. However, there are some issues such as the ones we have mentioned below.

- Safety
  There is some risk for accidents in thermal power generation.
- Stable supply

The supply of fossil fuels is finite. A reserve-to-production ratio of oil, natural gas, and coal are 46 years, 63 years, and 119 years, respectively[3]. If we keep using them at the current rate in the future, the amount of production might decrease someday.

On the other hand, if energy consumption would increase by economic growth in developing countries, the competition for natural resources would become intense. If the ratio of consumption by developing countries becomes larger in the market with a strong influence, it would become difficult for Japan to purchase these energies stably and at a low cost.

The government has stored a certain amount of oil in preparation for energy restrictions that might be caused by conflict and war. Because oil is liquid at normal temperature, it is suitable to store. We can store large amount of coal if the space is available, On the other hand, it is difficult to store natural gas because it is necessary to be kept at a low temperature.

- Economic Efficiency (cost)

Coal is relatively cheap. On the other hand, the price of oil is risky because it may vary by political situations in oil countries. The price of natural gas is in parallel with the price of oil. Additionally, there are costs for liquefaction to LNG and transportation and storage facilities.

- Against Global Warming

When fossil fuels are burned, they emit CO2. Among fossil fuels, the amount of CO2 from natural gas and coal is smaller than that of from oil.

Because thermal power plants emit NOx and SOx, which might be a cause of acid rain and damaging to human health, there are countermeasure facilities to control air quality. Coal emits more pollution gases such as SOx and NOx than oil or natural gas. (countermeasures already exists).

[3] On the other hand, other people say fossil fuels will not run out within 100 years.

Features of Fossil Fuels

		Oil	Coal	Natural Gas
Economic Efficiency	Generation cost yen /kWh (2010)	36 yen/kWh (facility operation rate 10%)	9.5 yen/kWh	10.7 yen/kWh
	Price (2010) CIF＊price	45,398 yen/kL	9,773 yen/ton	50,114 yen/ton(LNG)
	Per Calorie	4.97(yen/ thousand kcal)	1.59(yen / thousand kcal)	3.84 (LNG, yen / thousand kcal)
	Transportation, Storage	Easy	Inconvenient	In the case of LNG, it is high cost
Stable Supply	Reserves-to-production ratio	46 years	119 years	63 yeas
	Distribution	Mainly in the Middle East	North America, Europe (including Russia), Asia	Middle East, former Soviet Union
Environment	CO2 (by power generation)	694 (g-CO2/kWh)	864 (g-CO2/kWh)	476 (g-CO2/kWh)
Other		・Fuel for car and airplane ・Raw material for synthetic fiber and plastic	・Suitable for iron-making	・No SOX emission

CIF is a price in trade including cost, insurance, and freight

(1) Oil

Oil is a convenient natural resource that is used as a raw material for synthetic fabrics and plastics and fuels for cars and airplanes. It is easy to transport and store it as well. Japan imports most oils for consumption. Some amount of oil is produced in Niigata, Akita, and Hokkaido but it is only 0.4% of the entire consumption. The cost of oil is the most expensive per calorie and also in terms of generation cost.

(2) Coal

Compared to oil and natural gas, coal is ubiquitous all over the world and its reserve is rich. About 20% of coal is used for steal manufacturing because it is suitable in the world.

Although the price of coal per calorie is cheaper than oil or natural gas, there are also costs for the purification of polluted gas such as SOx and NOx. Even so, the cost for its generation is cheaper than that of oil or natural gas.

The research and development in “integrated coal gasification fuel cell combined cycle (IGFC)” and “storage and fuel cells,” which capture CO2 at generation plants and store them

under ground, have been promoted in order to increase the efficiency of generation by coal and make clean energy.

(3) Natural Gas

Japan is the largest LNG import country and we import 30% of LNG in the world.

There are large amounts of natural gas in the Middle East and the former Soviet Union. We can find natural gas in Asia, Europe, North America and other regions. 80% of natural gas comes from Asia-Pacific regions. Because politics in the former Soviet Union are unstable, it is important for natural gas to come from many countries in order to have a stable supply.

Natural gas is a green-friendly natural resource compared to other fossil fuels because of its lower CO2 and soot emission. We need additional funds for its transportation because we import LNG while natural gas is transported by pipeline in Europe and the U.S.

Natural gas comes from not only gas fields but also from sand (“tight-sand gas”), deep oceans (“methane hydrate”), and from within shale formations (“shale gas”). Shale gas has been recently developed and is expected to increase its yield and decrease in price. Natural gas is also expected to become an important energy sources for the realization of low-carbon societies. The government has promoted the shift to natural gas through a stable supply by receiving interest from producer countries, shifting fuels in industries, usages of cogeneration technology, and the development of fuel battery.

Natural gas is an attractive energy at the initial stage of a low carbon society. We can proceed to obtain a stable supply of natural gas. At the same time, “a shift toward natural gas” has been promoted by the switching of fuels to natural gas in industries, promotion of “cogeneration,” which generates electricity and heat simultaneously, and the promotion of technological development of batteries.

●Opinions and Discussions in the Governmental Committee●

The opinion that we should introduce natural gas drastically	• Since the “shale gas revolution,” the price of natural gas has gone down and we have been able to import it from the U.S. and Canada. The construction of a pipeline in Russia would be expected. • We should promote a drastic diffusion of the cogeneration system, which utilize electricity and heat together.
The opinion that it is difficult to introduce natural gas drastically	• The price of natural gas is higher in Japan than in it is in the U.S. It is difficult to store it. There are geographical risks such as the Strait of Hormuz, which may cause price change and supply shortages. • As an alternative to using nuclear plants as our base electric source, we should take advantage of coal because its clean technology has been advanced and its supply risk is relatively small. Also its price is stable and cheap. • There is no pipeline in Japan.

4. Theme 2: “Deliberation on the Scenario for Options in 2030”

4.1 Summary of Issues

The Basic Energy Plan of 2010 describes that in the year 2030, we will be reliant on nuclear power generation for more than half our supply of electricity. However, since the nuclear disaster, the government is reconsidering its entire energy policy, including this plan.

In the process of revision, the government has made an agreement to reduce our dependency on nuclear power in the mid- and long-term period. However, there is no unanimous opinion on the following issues:

- How much time are we willing to spend on reducing nuclear power
- How much we will reduce nuclear power
- Alternative energy
- How much we will spend in order to change the structure of the public’s life and economic activities.

Regarding the nuclear power,

- In terms of the safety of nuclear power generation, some people say we should decommission old nuclear plants and build new plants to ensure safety. On the other hand, other people say we should not decommission all the nuclear plants immediately because we could not ensure safety even in new plants.

- In terms of a stable supply of energy and generation cost, some people say that we should sustain a certain level of nuclear power generation. On the other hand, other people say we should shift to renewable and fossil energy and we should break away from nuclear power generation completely.

Therefore, the Energy and Environment Council has proposed three scenarios, that is, “zero scenario,” “15 scenario,” and “20-25 scenario” in terms of the following arguments:

(1) “Three point of view” in section 3.1 as a prerequisite,
1) To accelerate economic growth by green energy
2) To have system consumers choose energy
3) To have multidimensional international contribution

(2) In terms of the “four aspects as premises for judgment” in section 3.2,

- Judgment standard 1: Ensuring safety in nuclear power and reducing of its risks in the future
- Judgment standard 2: To enforce energy security
- Judgment standard 3: Contribution to solutions of global warming
- Judgment standard 4: Cost reduction, prevention of transfer of industries overseas

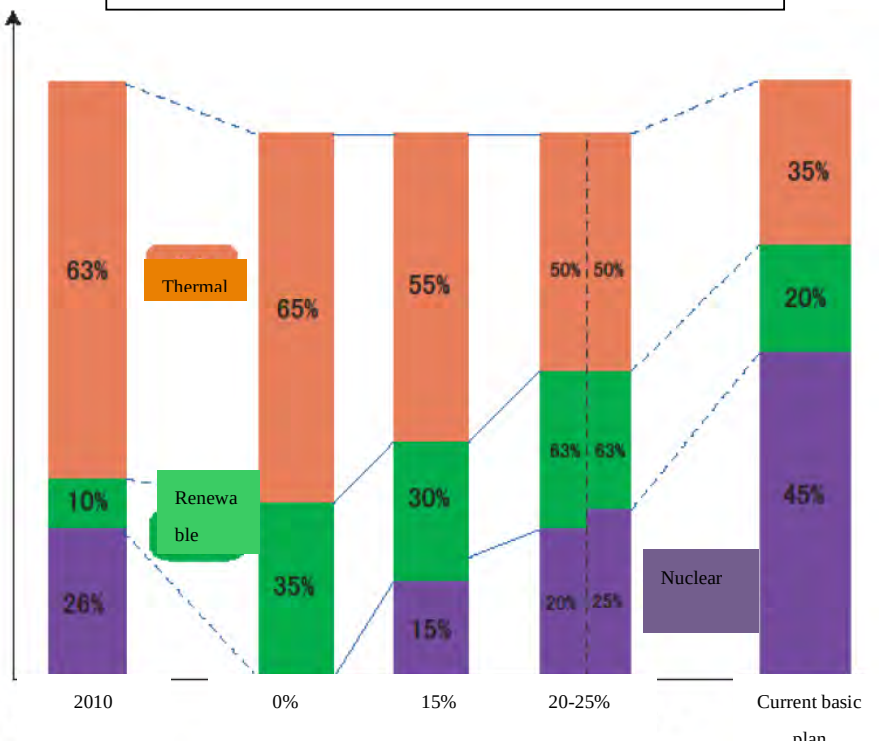
(3) The Council announced “three scenarios” that will help when we choose Japanese energy and make environmental choices. In these scenarios, there is a prerequisite for us to reduce the ratio of nuclear power in total energy by 2030. Then we have to decide on the following issues:

- How much we will reduce it
- How much we will expand renewable energy and promote energy conservation
- How soon we will shift the energy

In the following section, we will introduce these three scenarios. We also introduce pros and cons of each scenario. Please think about Japanese energy policy in both the mid- and long term.

When we consider these three scenarios, nuclear power generation is one factor but the reduction of nuclear power generation is related to other issues such as what we should do for energy conservation, renewable energy, and the purification of fossil fuel. The criteria of safety, cost, stable supply, and prevention of global warming in Theme 1 would become important criteria for judgment. It is a little complicated but let's think about each scenario.

Energy Structure in each Scenario in 2030



- “Energy structure” is the combination of many electric power sources such as nuclear power, renewable energy, and thermal power. Based on levels from the year 2010, we expect to reduce each energy source by 10% and increase energy conservation by 20%.

- Each “scenario” includes not only a ratio (% based on levels from 1990) of electricity from nuclear, renewable energy, thermal, and non-fossil fuel generation but also the amount of greenhouse effect gas (minus %), electric generation cost, investment in energy conservation, residential electricity prices, and increase in the GDP.

4.2. Explanation of the Three *Options* (scenarios)

1) "Zero Scenario"

We will try to make our dependency on nuclear power zero as soon as possible by 2030. Electricity will be generated by renewable energy and fossil fuels. We will reduce our usage of fossil fuels as much as possible and reduce CO2 until it reaches the same levels of other scenarios. To do so, we will pay the financial costs and make regulations then shift to high quality renewable energy and natural gas.

In this scenario, the ratio of nuclear power will be zero by 2030 and all energy will be generated by fossil fuels and renewable energy.
(Safety) Because we will not use nuclear power at all, we can avoid generating spent nuclear fuels and radiation waste as well as the risk radiation from accidents.
(Cost) If we maximize the supply of renewable energy, we need to spend at least 2.7 to 3.4 trillion yen for electrical grids (1.8 trillion yen more compared to other scenarios.) so we cannot avoid an increase in electricity price. It is more than 15% higher than prices in the other two scenarios.
(Stable supply) We need to increase our dependency on fossil fuels and introduce unstable solar and wind power. As a result, there will be additional problems such as oil procurement and supply-demand adjustment in the electricity system.
(Against global warming) If we reduce CO2 emissions without nuclear power plants, consumers will also need to save energy significantly. We need to prepare for strict regulations and a change of systems such as prohibition of the sales of energy-inefficient products and revision of traffic rules.

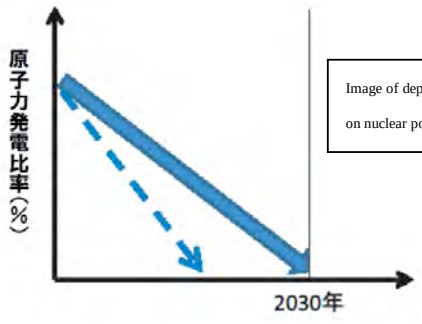


Image of dependency on nuclear power

Nuclear	Renewable	Thermo	Ratio of Non-fossil fuels	Outlet	Final energy consumption
0%	35%	65%	35%	About 1Tkwh	0.3B Kl

Amount of greenhouse effect gas （1990 level）	
In 2020	7% down (nuclear power 14%) 0% down (nuclear power 0%)
In 2030	23% down

Nuclear waste
All direct disposal

Example of Regulations

- Requirement of remedies for energy-inefficient air conditioners
- Restrictions on renting energy-inefficient houses and buildings
- Prohibition of the sales of energy-inefficient heaters
- Limitations on driving within central city
- Prohibition of usage of heavy oil boiler

Effect on a real GDP 511T (in 2010)

↓

563T yen -628T yen (in 2030)

Burden on households (electricity cost)

10,000 yen (in 2010)

↓

14,000 yen – 21,000 yen (in 2030)

0% Scenario	
Positive Opinion	Negative Opinion
(Safety) • The risk of serious nuclear plant accidents will become low significantly (Stable Supply) • Even if we do not have nuclear plants, we can replace them with many kind of renewable energy such as solar, biomass, and hydraulic power. (Cost) • The generation cost by a nuclear plant is expensive if we consider the costs of technological development, location, reactor decommissioning, processing spent nuclear fuel, and disposition of accident. Abandonment of nuclear plant can minimize energy cost. • We would not need to implement unrealistic and high costs for nuclear fuel cycle policy. • Even if we decommission all nuclear plants, the increase in burden on households and companies is within the allowance. (Against Global warming, etc.) • It is possible to reach the goal of greenhouse emission without nuclear plants by the use of renewable energy and energy conservation.	• If we think about the range in the operation rate of renewable energy sources, they may be considered an unstable energy supply. • If we would rely highly on fossil fuels, we may lose a stable energy supply. • The generation cost of renewable energy is expensive and its supply amount is low. Therefore, we are not sure whether the cost would decrease in the future. • Increase in fossil fuels would affect the Japanese economy negatively. • Decommissioning all nuclear plants would mean that electricity prices for households would be double becoming a large burden on people's living. • If we compare this and other scenarios in terms of economic activity, the decrease in the real GDP by this scenario will be larger than others. • Large energy consumption industries would shift to overseas if energy cost increases. • Because we cannot utilize the benefits of nuclear power generation, we cannot reduce greenhouse effect gas economically. • If we do not use any nuclear power, the number of people in charge of nuclear power would decrease. As a result, there would not enough people for decommissioning.

2) “15 Scenario”

We will certainly reduce our dependency on nuclear power until it reaches 15% of total energy generation by 2030. At the same time, we will implement a reduction in the dependency on fossil fuels and cut CO2 emissions. We will utilize the combination of nuclear, renewable energy, and fossil fuels and deal with many external situations such as international energy and environmental situations and change of technological innovations flexibly.

We will steadily reduce our dependency on nuclear power so that it reaches 15% of energy generation by 2030. This number is almost the same as if we would decommission 40 year-old reactors (and assume that it is difficult to build new reactors).

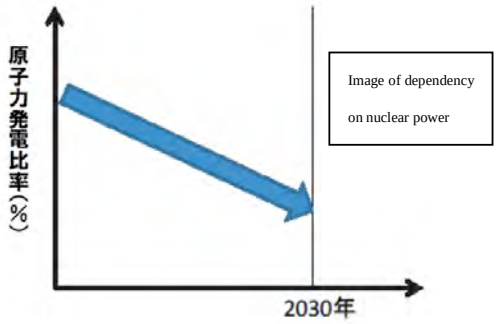


Image of dependency on nuclear power

Because we can use nuclear plants within a certain time period in this scenario, we will also reduce our dependency on fossil fuels and increase our dependency on renewable energy at more realistic levels.

(Safety) Due to the regulation of decommissioning 40 year-old reactors, we can reduce the possibility of serious nuclear accidents. However, it is important to recover trust in the safety of nuclear power among the public by reflecting situations of each facility and location and applying many types of nuclear technologies. We also need to solve issues regarding accumulating spent nuclear fuels.

Nuclear	Renewable	Thermo	Ratio of Non-fossil fuels	Outlet	Final energy consumption
15%	30%	55%	45%	about 1Tkwh	0.31B Kl

Amount of greenhouse effect gas （1990 level）	
2020	9% down
2030	23% down

Nuclear waste
All direct disposal or reprocessing by nuclear fuel cycle

(Cost) We will be able to cut import amounts of fossil fuels from 17 trillion yen to 2 trillion yen and reduce CO2.

(Against global warming) We need a drastic introduction of renewable energy and improvement of safety and technologies in nuclear plants during the period of the dependency reduction. The demand side also needs to promote energy conservation by high the use of efficient vehicles, houses, and equipment.

Some examples of policies…

- Support and promotion of cutting-edge development in facilities and equipment.
- Tax incentives for high energy efficient facilities
- Higher regulations and requirements for energy conservation criteria in new houses and buildings.
- Promotion of next generation vehicles

Effect on a real GDP
511T (in 2010)
↓
579T yen -611T yen (in 2030)
Burden on households (electricity cost)
10,000 yen (in 2010)
↓
14,000 yen – 18,000 yen (in 2030)

15% Scenario	
Positive Opinion	Negative Opinion
(Safety) • According to the criteria set by the government, we need to gradually decommission the nuclear plants that are over 40 years old. Therefore, the dependency on nuclear plants will decrease. • Safety is ensured by technologies and applicable regulations • It will become easier to achieve a stable energy supply if we combine energy conservation, the usage of renewable energy, and the purification of fossil fuels for the amount of energy made by a decrease of dependency on nuclear power generation. • We can keep the nuclear fuel cycle, which reprocesses spent nuclear fuel and use a fast-breeder reactor. (Cost) • If we keep a certain number of nuclear plants, we can reduce the negative impact on the economy such as an increase in residential electricity costs and a decrease in the real GDP. • Rapid reduction of our dependency on	• Serious risks still remain. • The safety of nuclear power generation is not ensured. • The nuclear fuel cycle is not established yet in terms of technology and economy. • If we decommission the 40 year old reactors and do not build new ones, we cannot sustain the 15% of energy from nuclear power. • In order to sustain the 15% of energy from nuclear power, we need to increase operating rate of nuclear plants. • Because the reprocessing method for spent nuclear fuel is not established yet, we should not keep nuclear power for future generations. • If we think about the range in the operation rate of renewable energy sources, they may be considered an unstable energy supply. • The amount of energy supply by renewable energy as an alternative for nuclear power is small and its cost is expensive. Therefore, we cannot expect it to be a stable energy source. • The generation cost by a nuclear plant is

15% Scenario	
Positive Opinion	Negative Opinion
nuclear power will have a negative effect on pubic life and industries. Therefore, it is better to abandon all nuclear reactors by 2050.	expensive if we consider the costs of technological development, location, reactor decommissioning, processing spent nuclear fuel, and disposition of accident. • We can achieve our goal about the reduction of greenhouse effect gas by the purification of fossil fuels and the introduction of renewable energy. • We cannot choose any of these options because there is no plan after 2030. • It is just procrastination of finding a solution. Therefore, investment for structural reform would not be promoted.

3) “20-25 Scenario”

We will gradually reduce our dependency on nuclear plants but keep them running at the level of 20-25% of total energy generation by 2030. We will promote the reduction of dependency on fossil fuels and cutting CO2 emission economically. This scenario requires the premise that the public strongly trusts nuclear power and its administration.

Before the Great East Japan Earthquake, our dependency on nuclear power was 26% of energy generation. However, we will reduce it gradually until 20-25% with a social agreement.

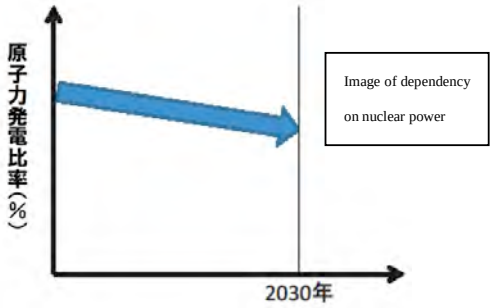


Image of dependency on nuclear power

(Safety) If we choose this scenario, we need to review safety criteria and systems. The public’s strong trust in nuclear power is a prerequisite. We also need to solve the issues regarding the accumulation of spent nuclear fuels.

(Stable Supply) In this scenario, we will have multiple energy options because we will use not only nuclear power but also renewable energy and fuel fossils that will improve stability of energy supply.

(Cost, Prevention of global warming)
Because we can reduce our dependency on fossil fuels, we can reduce CO2 emissions steadily and economically.

Nuclear	Renewable	Thermo	Ratio of Non-fossil fuels	Outlet	Final energy consumption
20%-25%	30%-25%	50%	50%	About 1Tkwh	0.31B Kl

Amount of greenhouse effect gas （1990 level）	
2020	10%-11% down
2030	25% down

Nuclear waste
All direct disposal or reprocessing by nuclear fuel cycle

Examples of policies

- Support and promotion of cutting-edge development in facilities and equipment
- Tax incentives for high energy efficient facilities
- Higher regulations and requirements for energy conservation criteria in new houses and buildings.
- Promotion of next generation vehicles

Effect on a real GDP
511T yen (in 2010)
↓
581-614T yen (in 2030)
Burden on households (electricity cost）
10,000 yen (in 2010)
↓
12,000 -18,000 yen (in 2030)

20-25 % Scenario	
Positive Opinion	Negative Opinion
(Safety) • New nuclear plants are safer than the old plants such as Fukushima Daiichi plant. So we should take advantage of the new plants. • We can ensure safety of nuclear plants by technology and regulations. • The combination of energy conservation, renewable energy use, and the purification of fossil fuels is a realistic choice. • If we take advantage of nuclear plants, we can reduce our dependency on fossil fuels and prevent greenhouse effect gas. • We can keep the nuclear fuel cycle, which reprocesses spent nuclear fuel and use a fast-breeder reactor. (Stable Supply) Because the ratio of renewable energy as an alternative to nuclear plant generation is small, it is possible to supply energy stably. (Cost) • If we reduce our dependency on nuclear plants, it would affect our economy negatively because of the increase of fossil fuel and renewable energy cost. • We can avoid overseas transfers by companies and an increase in burden on households by keeping the generation cost low at nuclear plants. （Against global warming, others） • We should keep nuclear power for sustaining the level of technology in Japan as well as the export of infrastructure to overseas.	• We should not use nuclear plants because there is still a possibility of disaster in the future. We cannot ensure safety in the plants yet. • It is still possible for disaster to occur in the future. If a disaster occurred again, the surrounding area would be contaminated by radiation and the economic, social, and psychological damage would be infinite. We would also lose international trust. • None of the accident-prevention measures based on the report from the Accident Investigation Commission are presented yet. • There are many issues in reprocessing spent nuclear fuel that we have to overcome. • The generation cost by a nuclear plant is not cheap if we consider the costs of reactor decommissioning, processing spent nuclear fuel, and disposition of accident. • The Japanese public does not trust nuclear power and its administration. • A stable supply of energy is available by the introduction of a variety of renewable energy sources and by switching fossil fuels to natural gas. • Even if we do not use nuclear power, we can reduce greenhouse effect gas by the purification of fossil fuels and the introduction of renewable energy. • The priority on the reduction of greenhouse effect gas is lower than on the nuclear plant issue. It should not be a reason for keeping nuclear plants.

5. References, Appendix

Source) Energy and Environmental Options (draft). June 29 2012. The Energy and Environment Council

Appendix 1

シナリオごとの2030年の姿（総括）

（括弧内の数値は2010年比）

	評価軸		2010年	ゼロシナリオ		15シナリオ	20～25シナリオ
				追加対策前	追加対策後		
電源構成	原発依存度		約26%	0%（▲25%）	0%（▲25%）	15%（▲10%）	20～25% （▲5%～▲1%）
	再生可能ｴﾈﾙｷﾞｰ		約10%	30%（＋20%）	35%（＋25%）	30%（＋20%）	30%～25% （＋20%～＋15%）
	火力		約63%	70%（＋5）	65%（現状程度）	55%（▲10%）	50%（▲15%）
		石炭	約24%	28%（＋4%）	21%（▲3%）	20%（▲4%）	18%（▲6%）
		LNG	約29%	36%（＋7%）	38%（＋9%）	29%（±0%）	27%（▲2%）
		石油 ※2	約10%	6%（▲4%）	6%（▲4%）	5%（▲5%）	5%（▲5%）
省エネルギー量	発電電力量		約1.1兆kWh	約1兆kWh（▲1割）	約1兆kWh（▲1割）	約1兆kWh（▲1割）	約1兆kWh（▲1割）
	最終エネルギー消費		約3．9億kl	約3．1億kl（▲19%） （▲7,200万kl）	約3．0億kl（▲22%） （▲8,500万kl）	約3．1億kl（▲19%） （▲7,200万kl）	約3．1億kl（▲19%） （▲7,200万kl）
原発依存度と原子力の安全確保	原発依存度		約26%	0%（▲25%）	0%（▲25%）	15%（▲10%）	20～25% （▲5%～▲1%）
エネルギー安全保障の強化	化石燃料依存度		約63%	70%（＋5%）	65%（現状程度）	55%（▲10%）	50%（▲15%）
	化石燃料輸入額 （一次ｴﾈﾙｷﾞｰ供給ﾍﾞｰｽ）		17兆円	17兆円 （留意事項） 規制と負担を伴う強度の対策を実施し、天然ガスシフトを他のシナリオよりも進める。安定かつ安価な天然ガスの調達が大きな課題となる。	16兆円	16兆円	15兆円
地球温暖化問題解決への貢献	再生可能ｴﾈﾙｷﾞｰ比率		約10%	30%（＋20%）	35%（＋25%）	30%（＋20%）	30%～25% （＋20%～＋15%）
	非化石電源比率		約37%	30%（▲5%）	35%（現状程度）	45%（＋10%）	50%（＋15%）
	火力発電（コジェネを含む）の石炭:ガス比率		1：1．2	1：1．3	1：1．8	1：1．5	1：1．5
	温室効果ガス排出量（1990年比）	2030	―	▲16%	▲23%	▲23%	▲25%
		2020 ※3	―	＋0%（2020年原発0%） ▲5%（2020年原発14%） （留意事項） より強力な再生可能エネルギーの普及、省エネルギー、天然ガスシフトを実現するため、省エネ性能の劣る製品の販売制限・禁止を含む厳しい規制を広範な分野に実施し、経済的負担を課すことが必要となる。（対策の詳細は表3参照。）	▲0%（2020年原発0%） ▲7%（2020年原発14%）	▲9% （2020年原発21%）	▲10～11% （2020年原発23%～26%）
コストの抑制、空洞化防止	発電コスト ※1		8．6円/kWh	―	15．1円/kWh （＋6．5円）	14．1円/kWh（＋5．5円）	14．1円/kWh（＋5．5円）
	系統対策コスト （2030年までの累積） ※1		―	3．4兆円	5．2兆円	3．4兆円	3．4～2．7兆円
	省エネ投資 （2030年までの累積） ※1		―	約80兆円 （節約額 約60兆円）	約100兆円 （節約額 約70兆円）	約80兆円 （節約額 約60兆円）	約80兆円 （節約額 約60兆円）
	家庭の電気代 （2人以上世帯の平均） ※1 ※4 ※5						
	国立環境研究所		1万円/月	―	2011～2030年で＋0．4万円/月 （2030年時点1．4万円/月）	2011～2030年で＋0．4万円/月 （2030年時点1．4万円/月）	2011～2030年で＋0．4万円/月 （2030年時点1．4万円/月）
	大阪大学・伴教授			―	2011～2030年で＋0．5万円/月 （2030年時点1．5万円/月）	2011～2030年で＋0．4万円/月 （2030年時点1．4万円/月）	2011～2030年で＋0．2万円/月 （2030年時点1．2万円/月）
	慶應義塾大学・野村准教授			―	2011～2030年で＋1．1万円/月 （2030年時点2．1万円/月）	2011～2030年で＋0．8万円/月 （2030年時点1．8万円/月）	2011～2030年で＋0．8万円/月 （2030年時点1．8万円/月）
	地球環境産業技術研究機構（RITE）			―	2011～2030年で＋1．0万円/月 （2030年時点2．0万円/月）	2011～2030年で＋0．8万円/月 （2030年時点1．8万円/月）	2011～2030年で＋0．8万円/月 （2030年時点1．8万円/月）
	実質GDP ※5			2030年自然体ケース ※2			
	国立環境研究所		2010年 511兆円	636兆円	628兆円（2010年比＋97兆円） ［自然体比▲8兆円］	634兆円（2010年比＋123兆円） ［自然体比▲2兆円］	634兆円（2010年比＋123兆円） ［自然体比▲2兆円］
	大阪大学・伴教授			624兆円	608兆円（2010年比＋117兆円） ［自然体比▲15兆円］	611兆円（2010年比＋100兆円） ［自然体比▲13兆円］	614兆円（2010年比＋103兆円） ［自然体比▲10兆円］
	慶應義塾大学・野村准教授			625兆円	609兆円（2010年比＋98兆円） ［自然体比▲17兆円］	616兆円（2010年比＋105兆円） ［自然体比▲10兆円］	617兆円（2010年比＋106兆円） ［自然体比▲9兆円］
	地球環境産業技術研究機構（RITE）			609兆円	564兆円（2010年比＋53兆円） ［自然体比▲45兆円］	579兆円（2010年比＋68兆円） ［自然体比▲30兆円］	581兆円（2010年比＋70兆円） ［自然体比▲28兆円］

※1 新規プラントの発電コストについては、コスト等検証委員会報告の試算結果を活用。既設プラントは同報告書の運転費等から試算。発電コスト、系統対策コスト、省エネ投資の詳細は国家戦略室ホームページに根拠データを含めて公開。
※2 経済成長等の一定のマクロ経済条件は事務局で設定した慎重シナリオ（2010年代は1.1%、2020年代では0.8%の実質GDP成長率）の想定に基づいている。
※3 2020年の原発依存度については、2030年と2010年の原発依存度を機械的に結んでその大まかな経過点として算出している。
※4 価格の上昇効果と節電の効果の双方を勘案したもの。また、経済モデル分析では、省エネに伴う経済的負担を全て炭素税で表現しており、エネルギー価格にはその炭素税が含まれている。この表中の電気代もそのような炭素税を加味した金額となっていることに留意が必要。
※5 経済影響を分析した各機関のモデルの特徴は概ね以下のとおり。モデルの詳細については総合資源エネルギー調査会基本問題小委員会（http://www.enecho.meti.go.jp/info/committee/kihonmondai/）、中央環境審議会地球環境部会（http://www.env.go.jp/council/06earth/yoshi06.html）の資料等を参照。
①価格弾力性

Appendix 2

<Three options in terms of four aspects in detail>

Four aspects	Evaluation points	2010	zero scenario	15scenario	20～25scenario
		nuclear power 26% renewable energy10% fossil fuels 63%	nuclear power 0% renewable energy35% fossil fuels 65%	nuclear power15% renewable energy30% fossil fuels 55%	nuclear power20-25% renewable energy 30-25% fossil fuels 50%
		Energy conservation（outlet）about 1.1T Kwh	about 1Tkwh	about 1Tkwh	about 1Tkwh
		<Energy conservation> All three options expect more than a 20% increase in the GDP by 2030 with 10% below energy conservation			
(1) Safety (reduction of risks in the future)	Dependency on nuclear power	about 26%	0%（zero in 2030）	15%（to revise in 2030）	20～25%（keep after 2030）
		<Dependency on nuclear power> Before 3.11, 26% of electricity was from nuclear plants but all three options will reduce this ratio. However, the situation after 2030 will be different.			
(2) Energy Security	Dependency on fossil fuels	about 63%	about 65% (current level)	about 55%	about 50%
	Import amount of fossil fuels	17T yen	16T yen (current level)	16T yen	15T yen
		<Fossil fuels> The lower the ratio of nuclear power, the higher the ratio of fossil fuels. The higher the ratio of fossil fuels, the higher the cost and amount of imports.			
(3) Countermeasure against global warming	Energy conservation (final energy consumption)	about 0.39 B Kl	about 0.3 B Kl	about 0.31 B Kl	about 0.31B Kl
		<Final energy consumption> All three options try to implement 20% higher energy conservation.			
	Ratio to renewable energy	about 10%	35%	30%	30%～25%
		<Ratio of renewable energy> The ratio of renewable energy was 10% in 2010, we will try to increase it by 35% by 2030.			
	Ratio to non-fossil fuels	about 37%	35%（current level）	45%	50%
		<Ratio of non-fossil fuels> The higher the ratio of nuclear power, the lower the dependency on fossil fuels, which emit little CO2.			
	thermal（coal-gas ratio）	1:1.2	1:1.8	1:1.5	1:1.5
		<Ratio of coal and gas in thermal power> If the dependency on nuclear power is low, we will need to rely on fossil fuels. Because we need to reduce CO2 emissions, the ratio of natural gas will increase.			
	Amount of greenhouse effect gas	—	▲23% (needs strict regulation and economic cost)	▲23%	▲25%
		<Reduction ratio of greenhouse gas emission> All options try to cut greenhouse gas emission by 23-25% compared to the 1990 level by the use of energy conservation, and the introduction of renewable energy and natural gas. However, the “zero scenario”			

		requires additional restrictions and economic costs.				
(4) Cost	Power generation cost	8.6 yen /kwh		15.1 yen/kwh	14.1 yen /kwh	14.1 yen /kwh
	Cost for Grids 1	—		5.2 T yen	3.4 T yen	3.4 T yen - 2.7 T yen
		< Costs for grids> For the diffusion of renewable energy, we will need to invest in infrastructures such as grids. That is, the options that involve a lower dependency on nuclear plants will require investment costs.				
	Four research institutes have calculated the economic effects of the three options. A: National Institute for Environmental Studies, B: Professor Ban of Osaka University, C: Professor Nomura of Keio University, D: RITE.					
	Real GDP （609T yen in 2030） *2 *5	511T yen	A	628T yen ＊3 （ compared to natural growth, - 8T yen ）	634T yen （compared to natural growth, -2T yen ）	634T yen （compared to natural growth, -2T yen ）
			B	608T yen （compared to natural growth, -15T yen ）	611T yen （compared to natural growth, -13T yen ）	614T yen （compared to natural growth, -10T yen ）
			C	609T yen （compared to natural growth, -17T yen ）	616T yen （compared to natural growth, -10T yen ）	617T yen （compared to natural growth, -9T yen ）
			D	564T yen （compared to natural growth, -45T yen ）	579T yen （compared to natural growth, -30T yen ）	581T yen （compared to natural growth, -28T yen ）
		< Effect on economy (real GDP)> When we look at the GDP, an economic indicator to measure the economic growth rate, there is 20% increase in all three options at the 2010 level (511 T yen). However, When we calculate it with “natural growth” as 1.1% in 2010 and 0.8% in 2020, the GDP will decrease by about 28T to 45T in all scenarios.				
	Residential electricity price （in 2030） *5	10000 yen/month	A	14000 yen/month	14000 yen/month	12000 yen/month
			B	15000 yen/month	14000 yen/month	12000 yen/month
			C	21000 yen/month	18000 yen/month	18000 yen/month
			D	20000 yen/month	18000 yen/month	18000 yen/month
		<Economic burden (monthly electricity cost> Electricity cost will increase in all three scenarios. There are gaps among models from A to D but they are not so large.				

Appendix 3

原子力発電比率について

2030年断面		稼働年数					
		40年		50年		60年	
		発電電力量（億kWh）	割合（%）	発電電力量（億kWh）	割合（%）	発電電力量（億kWh）	割合（%）
（1）新増設無し	稼働率70%	1,302	13%	2,180	22%	2,830	28%
	稼働率80%	1,488	15%	2,492	25%	3,234	32%
（2）新増設1基	稼働率70%	1,394	14%	2,272	23%	2,922	29%
	稼働率80%	1,593	16%	2,597	26%	3,339	33%
（3）新増設2基	稼働率70%	1,486	15%	2,364	24%	3,014	30%
	稼働率80%	1,698	17%	2,702	27%	3,444	34%

（注1）表中の割合（%）は、総発電電力量（1.0兆kWh/慎重シナリオ（実質GDP成長率の想定：2010年代年率1.1%、2020年代年率0.8%）における2030年度の見通し（資料5参照））に占める割合を表す。

（注2）発電所の出力に関して、既設炉については、2030年断面における稼働年数が上記場合分けに応じてそれぞれ40年以下、50年以下、60年以下のものを機械的に足し上げて算出。新増設炉については、仮に1基当たり150万kWと想定して試算。

（注3）発電電力量＝2030年断面の発電所の出力×24時間×365日×想定稼働率

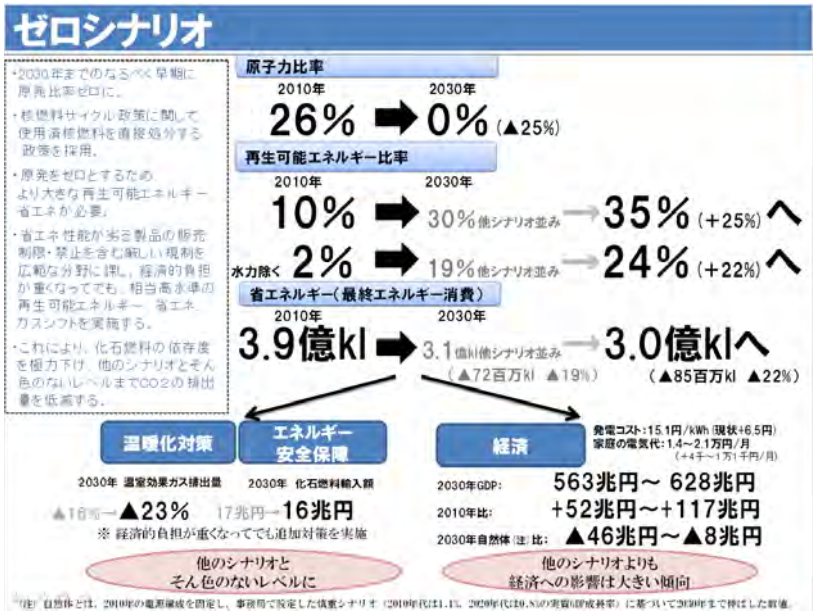
参考1：現行エネルギー基本計画（2030年において稼働年数60年、稼働率90%、新増設14基を想定）
5,366億kWh、45.4%（自家発・コジェネ含む全発電電力量に占める割合）

参考2：2010年の全発電電力量に占める原子力の割合
2,882億kWh、26.4%（自家発・コジェネ含む全発電電力量に占める割合）

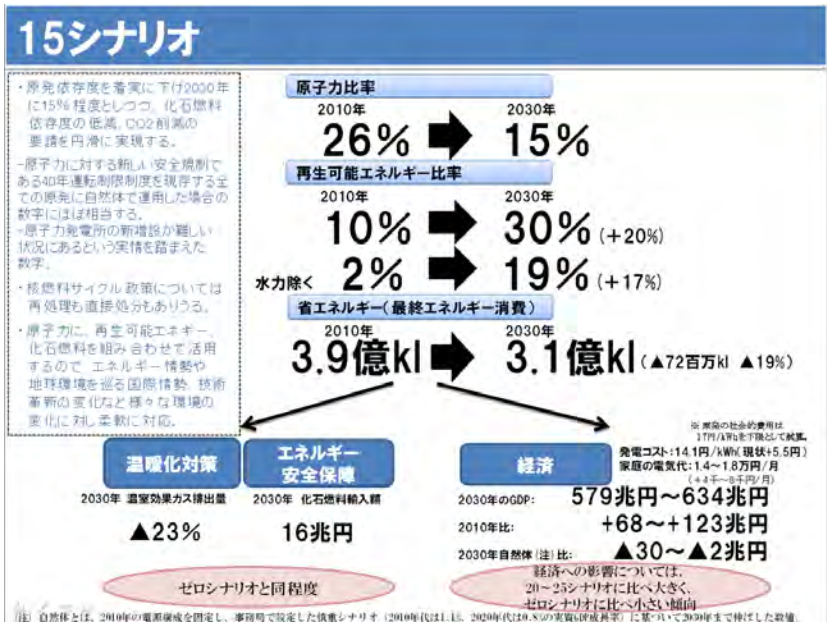
Appendix 4

＜Appendix 4-1＞

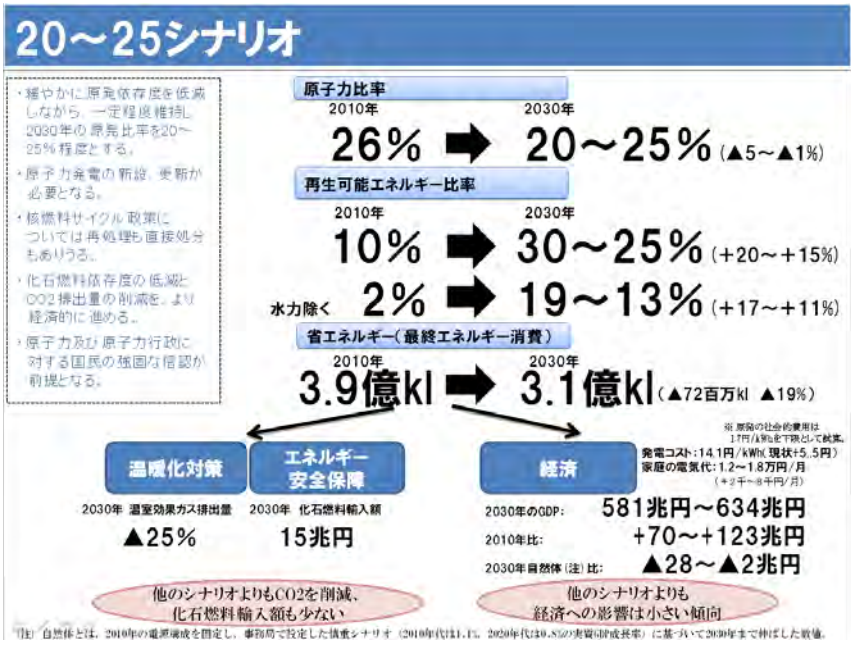
＜Appendix 4-2＞



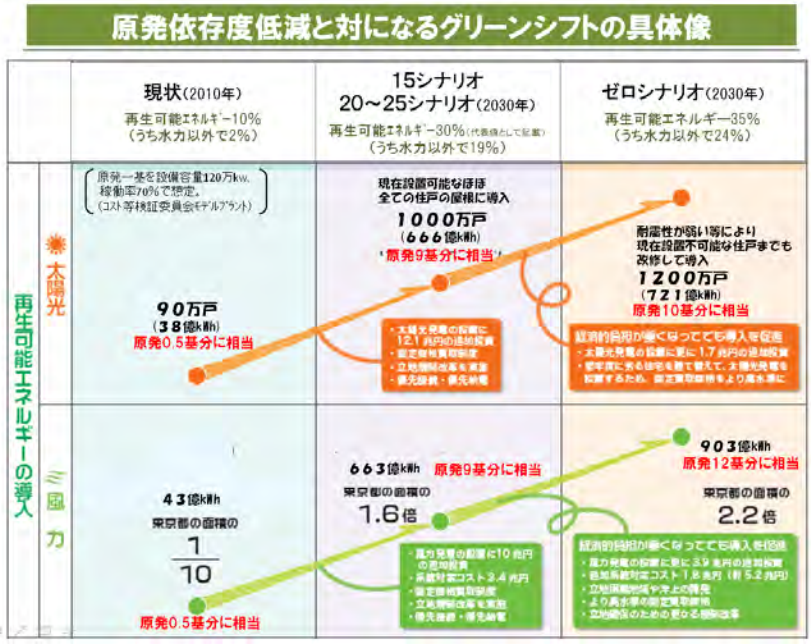
＜Appendix 4-3＞



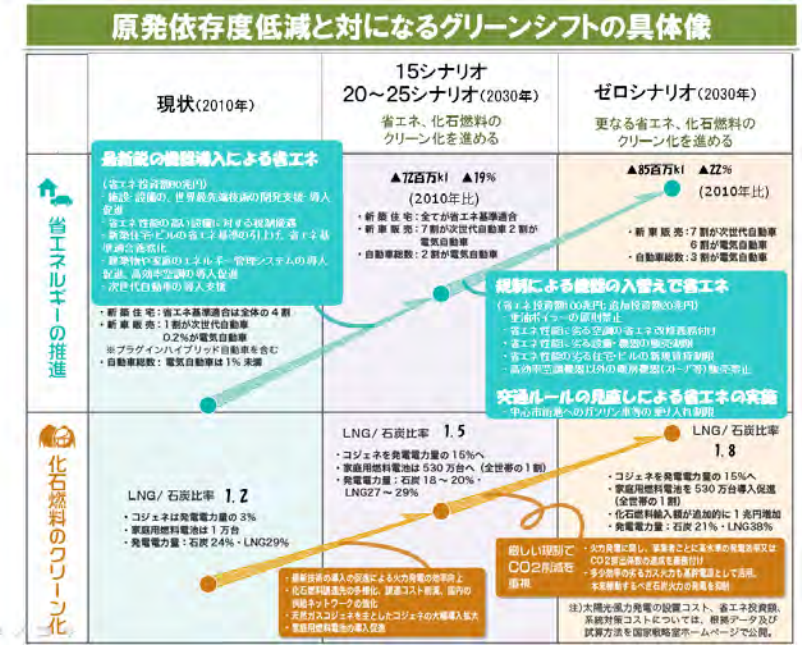
＜Appendix 4-4＞



＜Appendix 4-5＞



＜Appendix 4-6＞



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