

Concerning the Actions Japan Should Take for the Expansion of Nuclear Energy Use in the World as a Measure against Global Warming

March 13, 2008

Atomic Energy Commission

The Atomic Energy Commission (AEC) decided the Framework for Nuclear Energy Policy in 2005, in which, a portfolio of actions for developing safe and secure nuclear energy across three different time frames; near-term, medium-term and long-term are presented under the recognition that such development does and will contribute to global energy security, while simultaneously addressing the climate change challenge.

In recent days, due to steady increase in the primary energy consumption worldwide, energy security is becoming a major global concern. Simultaneously, it has been recognized that a major reduction in greenhouse-gas emissions is required to combat climate change. In May 2007, Japanese government presented to the world an initiative to address global warming entitled "Invitation to Cool Earth 50," under which a target of cutting global emission of greenhouse-gases by 50% from the current level by the year 2050 was proposed. In the Heiligendamm G8 summit 2007 declaration, "Growth and Responsibility in the World Economy," it is mentioned that the decisions made by European Union, Canada and Japan which include at least a halving of global emissions of greenhouse-gases by 2050 will be considered seriously in setting a global goal for emissions reductions.

Considering such circumstances, AEC set up in June 2007, Round-table Conference on the Vision for Nuclear Energy Policy for Global Environmental Protection and Security of Energy Supply, chaired by Dr. Ryoichi Yamamoto, Professor of Institute of Industrial Science, the University of Tokyo, to discuss about 1) role of nuclear energy in secure energy supply and a halving of greenhouse-gas emissions by 2050, 2) international approaches for the promotion of peaceful use of nuclear energy, 3) development and commercialization of nuclear energy technologies that contribute to the reduction of greenhouse-gas emissions.

In March, 2008, AEC received from the Conference a report entitled "Actions Japan Should Take for the Expansion of Nuclear Energy Use in the World as a Measure against Global Warming," which is attached to this sheet. The AEC holds the contents of the report in high regard and considers that the relevant administrative organizations should take actions proposed in this report.

**Actions Japan Should Take for the Expansion of Nuclear Energy Use in the World as a
Measure against Global Warming**

March 13, 2008

Round-table Conference on the Vision for Nuclear Energy Policy
for Global Environment Protection and Security of Energy Supply

1. The role of nuclear energy as a measure against global warming

The Intergovernmental Panel on Climate Change (IPCC) concluded in its Fourth Assessment Report (AR4) released in 2007 that warming of the global climate system is unequivocal, and that most of the observed increase in global mean temperature since the mid-20th century is very likely due to the increase in global atmospheric concentration of anthropogenic greenhouse-gases. The AR4 then projected various impacts associated with projected increase in average temperatures on water resources, ecosystems, food, coasts and human health, and presented several stabilization levels for the atmospheric concentrations of greenhouse-gases that should be achieved with mitigation efforts to reduce, delay and avoid such impacts. It stated that the most stringent level (stabilizing at 445–490 ppm CO₂-eq) could limit global mean temperature increases to 2.0 - 2.4°C above pre-industrial, requiring emissions to peak within 10 years and to be around 50% of the 2000 level by 2050.

It is stated in the G8 Summit Heiligendamm declaration entitled “Growth and Responsibility in the World Economy” published in June 2007 that the head of the States will seriously consider the decisions made by the EU, Canada and Japan, which include at least a halving of global emissions of greenhouse-gas by 2050, in setting a global goal for greenhouse-gas emission reductions, and commit themselves to achieving these goals as well as invite the major emerging economies to join them in this endeavor.

This January, Prime Minister Yasuo Fukuda stated in his special address at the Annual Meeting 2008 of the World Economic Forum (the Davos Meeting) that the issue of climate change is top priority of the Hokkaido Toyako G8 Summit to be chaired by Japan in July this year. He then announced the “Cool Earth Promotion Programme,” designed to promote the “Cool Earth 50”

initiative proposed by Japan last year, and stated that Japan will, along with other major emitters, set a quantified national target for the greenhouse-gas emissions reductions to be realized. He proposed setting a global target of a 30% improvement in energy efficiency by 2020 and mentioned the establishment of a new financial mechanism (Cool Earth Partnership), on the scale of US\$10 billion, to cooperate actively with developing countries' efforts to reduce emissions, such as enhancing energy efficiency, as well as to extend the hand of assistance to developing countries suffering severe adverse impacts as a result of climate change. The Prime Minister also stated that breakthroughs in technological innovation will be critical in order to halve greenhouse-gas emissions by 2050, and that Japan will be emphasizing investment in research and development in the fields of the environment and energy.

Although it will be extremely demanding for humans to halve global greenhouse-gas emissions by around 2050 while each country pursues economic development, it is a challenge to which we must rise. In order to achieve this, in addition to thorough efforts in energy conservation, it will be necessary to introduce rapid and drastic innovations in the global energy system, taking urgent measures to develop, deploy and promote technologies with high efficiency and low carbon intensity in the areas of energy supply and usage.

To illustrate the magnitude and urgency of the challenge, the International Energy Agency (IEA) made an estimate of a combination of measures that would achieve the stabilization of atmospheric concentration of greenhouse-gases at the lowest level mentioned above. The estimate includes restraint of growth in the use of conventional fossil energy as well as rapid expansion in the use of renewable energy, nuclear energy and CO₂ capture and storage (CCS) technology for fossil energy uses, in addition to significant energy conservation and energy efficiency improvement (World Energy Outlook 2007, "450 Stabilization Case"). In this case, world primary energy demand in 2030 is around 120% of the current level (as of 2005), and the conventional use of fossil energy without CCS decreases slightly from the current level. On the other hand, world electricity demand in 2030 is about 160% of the current level and electricity generated by hydro, biomass, wind and solar increases dramatically, to about 2.2, 9, 22 and 135 times the current levels, respectively. The total amount of electricity generated from renewable energy, including geothermal and others, reaches about 3.5 times the current level and the total use of renewable energy including biomass fuels for transportation is about 2.1 times the current level in 2030, accounting for about 21% of the total primary energy demand in the year. In line with this trend, the amount of nuclear power generation also increases significantly to about 2.4 times the current level, accounting for about 12% of the total primary energy demand. It is a serious challenge to achieve these figures, and will require a great deal of effort.

Nuclear power has been consistently producing about 16% of the world's electricity since 1986. As of 2006, there are 435 reactors in operation in 30 countries, with a total capacity of about 370GWe. Nuclear power emits no CO₂ during electricity generation, and its emission of CO₂ throughout the lifecycle is as small as electricity generation by renewable energy such as wind and solar. Hence, if nuclear power generation of this scale was replaced by fossil power generation, global CO₂ emissions would increase by 1.1 billion tons (4% of the global emission as of 2005), even if LNG combined cycle power generation, which emits the least amount of greenhouse-gases among fossil fuel power plants, was used.

In addition, considerable expansion and new introduction of nuclear power generation are currently being planned and considered for the future in various parts of the world. The number of nuclear power plants planned and considered totals about 350 (approx. 330GWe). If all of these are realized, the total capacity of the world's nuclear power generation facilities will reach a level of 700GWe and they will reduce CO₂ emission of 2 billion tons per year compared with the case of power generation by LNG combined cycle power plants of such capacity. Therefore it is quite reasonable to expect that nuclear energy will significantly contribute to the stabilization of atmospheric concentration of greenhouse gases at lower levels.

Globally speaking, CO₂ emissions in power generation sector are larger than other sectors, and are increasing at a fast rate. Also, the energy resource situation is severe, with fossil fuels prices soaring remarkably and international competition to obtain resources intensifying. Considering these circumstances, including the fact that 30 countries around the world are currently using nuclear energy and still more are aiming to use it, nuclear energy based on nuclear power plants that, once constructed, are able to stably and economically generate electricity, emitting practically no greenhouse-gases, for 40 to 60 years by refueling once every one or two years and ensuring appropriate maintenance should be one of the essential measures to achieve a low-carbon society, along with such measures as energy conservation, energy efficiency improvement and the use of renewable energy.

Based on this recognition, Japan should take the following six principal actions from the perspective of further promoting the peaceful use of nuclear energy on a global scale, while ensuring nuclear nonproliferation, safety and security, in parallel with actions to promote energy conservation, energy efficiency improvement and the use of renewable energy.

2. Principal Actions for the expansion of peaceful use of nuclear energy on a global scale as a measure against global warming, while ensuring nuclear nonproliferation, safety and security

Principal action 1. Build a global consensus that the expansion of the peaceful use of nuclear energy is an essential measure against global warming, and develop international frameworks for the expansion.

In order to achieve a significant reduction in global greenhouse-gas emissions towards 2050 while ensuring secure supply of energy, the expansion of the peaceful use of nuclear energy is essential, along with the maximum implementation of other effective measures such as energy conservation, energy efficiency improvement and the use of renewable energy. Thus, Japan should actively propose the international community to agree to;

- (i) Build a global consensus that the expansion of the peaceful use of nuclear energy, while ensuring nuclear nonproliferation, safety and security, is an essential measure against global warming, along with such measures as energy conservation, energy efficiency improvement and the use of renewable energy.
- (ii) Include nuclear energy into Clean Development Mechanism (CDM) and Joint Implementation (JI).
- (iii) Consider the establishment of the schemes that can encourage investment in the construction of nuclear power plants and other related activities for countries trying to promote the peaceful use of nuclear energy while ensuring nuclear nonproliferation, safety and security.
- (iv) Recognize the peaceful use of nuclear energy as an effective measure against global warming in the post-Kyoto Protocol framework beyond 2012, after the end of the first commitment period.

Principal action 2. Reinforce international efforts to ensure nuclear nonproliferation, safety and security, which is the prerequisite for the peaceful use of nuclear energy.

For ensuring nuclear nonproliferation, safety and security, which is the prerequisite of the peaceful use of nuclear energy, the related international approaches promoted by the International Atomic Energy Agency (IAEA) are extremely important. As it is essential to reinforce these international approaches along with the global expansion of the peaceful use of nuclear energy, Japan should actively contribute to them in cooperation with countries across the world. The specific activities to be promoted will be, among others, to;

- (i) Appeal the international community to strengthen the IAEA's human and financial resources, so that measures assigned to the IAEA by international treaties including the Nuclear Non-Proliferation Treaty (NPT) and the Convention on Nuclear Safety are

implemented sufficiently.

- (ii) Enhance cooperation towards further advancement of the activities of the IAEA and the Nuclear Energy Agency of Organization for Economic Co-operation and Development (OECD/NEA) in formulating relevant technical standards and recommendations, based on Japan's unique experience as only non-nuclear weapon state that is promoting large-scale nuclear energy use, employing advanced technology systems.
- (iii) In order to prevent nuclear proliferation, continuously contribute to reinforcing the IAEA safeguards, actively supporting its effort to universalize the IAEA Additional Protocol as well as actively participating and contributing to multinational discussions about the development of nuclear fuel supply assurance mechanisms to reduce the growth of nuclear proliferation risks.

Principal action 3. Positively cooperate in the efforts of various countries to build and strengthen infrastructure for the promotion of the peaceful use of nuclear energy.

In order to provide the international community with the opportunity to utilize Japan's advanced energy and environmental technologies, Japan should actively cooperate with international institutions such as the IAEA as well as developed countries in supporting to build infrastructure for nuclear power utilization such as human resources, laws, regulations and the management of radioactive waste in countries considering the promotion of peaceful use of nuclear energy while ensuring nuclear nonproliferation, safety and security. The specific activities are to;

- (i) Actively offer cooperation to the IAEA's support activities in this category, dispatching experts who can utilize knowledge cultivated in Japan's advanced infrastructure for the peaceful use of nuclear energy in such activities, and actively support independent activities to build infrastructure in countries, mainly those in neighboring Asian regions, that are considering introduction or expansion of the nuclear power generation capability, through bilateral and multilateral cooperation frameworks, including the Forum for Nuclear Cooperation in Asia (FNCA).
- (ii) Positively utilize financial and insurance systems and other means, so as to be able to make an effective contribution to the expansion of the peaceful use of nuclear energy in various countries, applying Japan's advanced technology bases for design, construction, and operation and maintenance of nuclear power plants.

Principal action 4. Strengthen research and development activities in Japan, aiming to innovate the performance of nuclear energy technologies with a view to contributing to the global expansion of the peaceful use of nuclear energy.

In order to contribute to the further expansion of the peaceful use of nuclear energy in the

world, Japan should strengthen its research and development activities aiming to innovate the performance of nuclear energy technologies. In specific, Japan should actively promote the following activities, clarifying roadmaps for each activity.

- (i) To develop, demonstrate and deploy innovative technologies for diversifying and advancing nuclear energy use, such as next-generation light water reactors with world-best safety and economy, small and mid-sized reactors with sizes, functions and economic competitiveness that can meet diverse needs, and hydrogen production technology using high-temperature gas reactors.
- (ii) To implement research and development of fast reactors and its fuel cycle technology, aiming to achieve an advanced fuel cycle system that can make it possible for global community to utilize nuclear energy over a long time.
- (iii) To implement research and development of nuclear fusion, with the aim of realizing a permanent energy supply technology in the future.

Furthermore, to promote these research and development activities in effective and efficient ways, international cooperation should be even more actively pursued through multilateral frameworks such as the Generation IV International Forum (GIF), Global Nuclear Energy Partnership (GNEP), cooperative research and development frameworks of the IAEA and other international organizations and the ITER Project, as well as various bilateral frameworks for nuclear research and development cooperation.

3. Actions to assure steady promotion of nuclear energy use in Japan

Principal action 5. Reinforce actions to tackle the nuclear energy policy issues related with the assurance of sound promotion of nuclear energy use in Japan.

In order to implement principal actions 1 to 4 above, Japan should take the lead in tackling global warming and aggressively promote the shift to a low-carbon society. To this end, it is necessary to implement any and all effective measures to the maximum extent, including those for energy conservation, energy efficiency improvement and the use of nuclear and renewable energies. In this context, Japan must promote the use of nuclear energy in an exemplary style in the international community, as it is the largest single source of base-load electricity that effectively contributes to the reduction of emission of greenhouse gases, not only in Japan but also in North America and Europe. Keeping this requirement in mind, relevant organizations should reinforce the activities listed below to tackle the issues that should be addressed with particular urgency, while steadily promoting the research, development and utilization of nuclear technology in line with the

Framework for Nuclear Energy Policy, including steady implementation of countermeasures to the aging of nuclear power plants, steady construction of nuclear power plants, promotion of activities related with recycling of nuclear fuel and research and development of a fast breeder reactor and its fuel cycle technology.

- (i) The government and industry should strengthen comprehensive risk management activities, including the reflection of new knowledge on natural disasters in safety assurance efforts without delay, while placing top priority on the confirmation of the seismic safety of existing nuclear energy facilities.
- (ii) The government, Nuclear Waste Management Organization of Japan and electric utilities should markedly improve communication with local authorities and the general public, so as to make steady progress in the approaches to the disposal of high-level radioactive waste, while enhancing activities for improving mutual understanding with them about the related topics such as the safety assurance mechanism of the disposal, the public benefit of the location of disposal sites and public appreciation and support for the sustainable development given to municipalities that accept the disposal site, under the recognition that it is a task with which all the people are concerned and the current generation should establish the ways of the implementation without leaving the issue to future generations.
- (iii) The government and industry should pursue the power uprating and the improvement of the capacity factors of existing nuclear power plants by gaining public understanding of the safety of such endeavor to be implemented by permission of a scientifically rational safety regulation system, as these are already being realized in other countries, and will have immediate effects on the limitation of greenhouse-gas emissions.

Principal action 6. Reinforce efforts for mutual understanding with the public on approaches for safe promotion of nuclear energy use.

Japan should further reinforce its efforts in establishing mutual understanding with the public that the national system for safe use of nuclear energy is reliable, and that such use is an effective measure against global warming. In specific, the country should focus its efforts to;

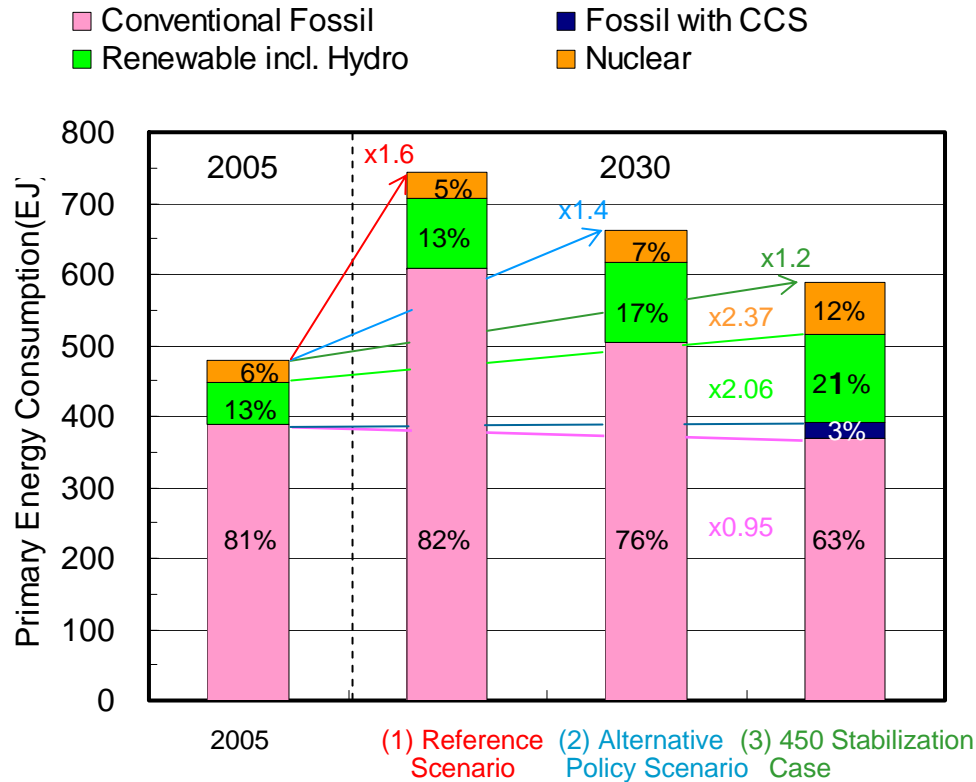
- (i) Enrich the education and dissemination of information to the public on the global warming issue and the role of nuclear energy as a measure against it, along with such measures as the energy conservation, energy efficiency improvement and the use of renewable energy.
- (ii) Ensure the transparency and openness of the efforts taken to assure safety in nuclear energy use, provide opportunities for the general public to participate in discussing the soundness of such efforts, and endeavor to improve such efforts through constantly reviewing the schemes and appropriately reflecting the results of such discussion on the efforts.
- (iii) Reinforce scientific communication and risk communication regarding nuclear energy by

further improving the quality and quantity of dialogue on energy issues among the public, local authorities, utilities, the national government and other relevant parties, with a view to sharing a broad range of information including the characteristics of various types of energy and the role of nuclear energy as a measure against global warming, in particular.

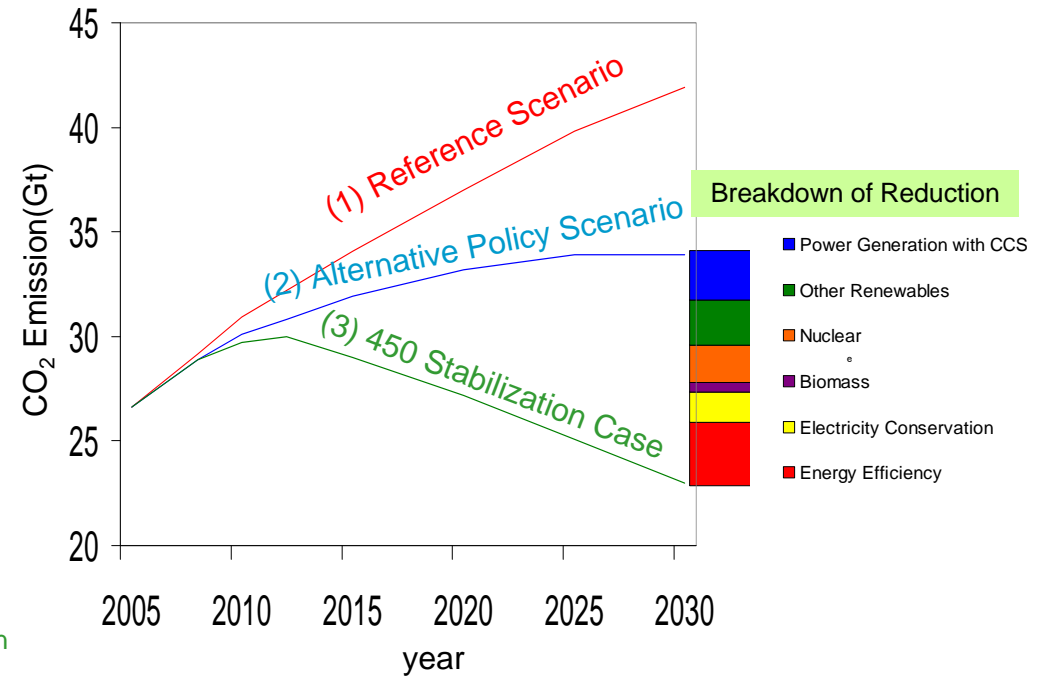
Calculations of World Energy Consumption and CO₂ Emission

(ref. World Energy Outlook 2007)

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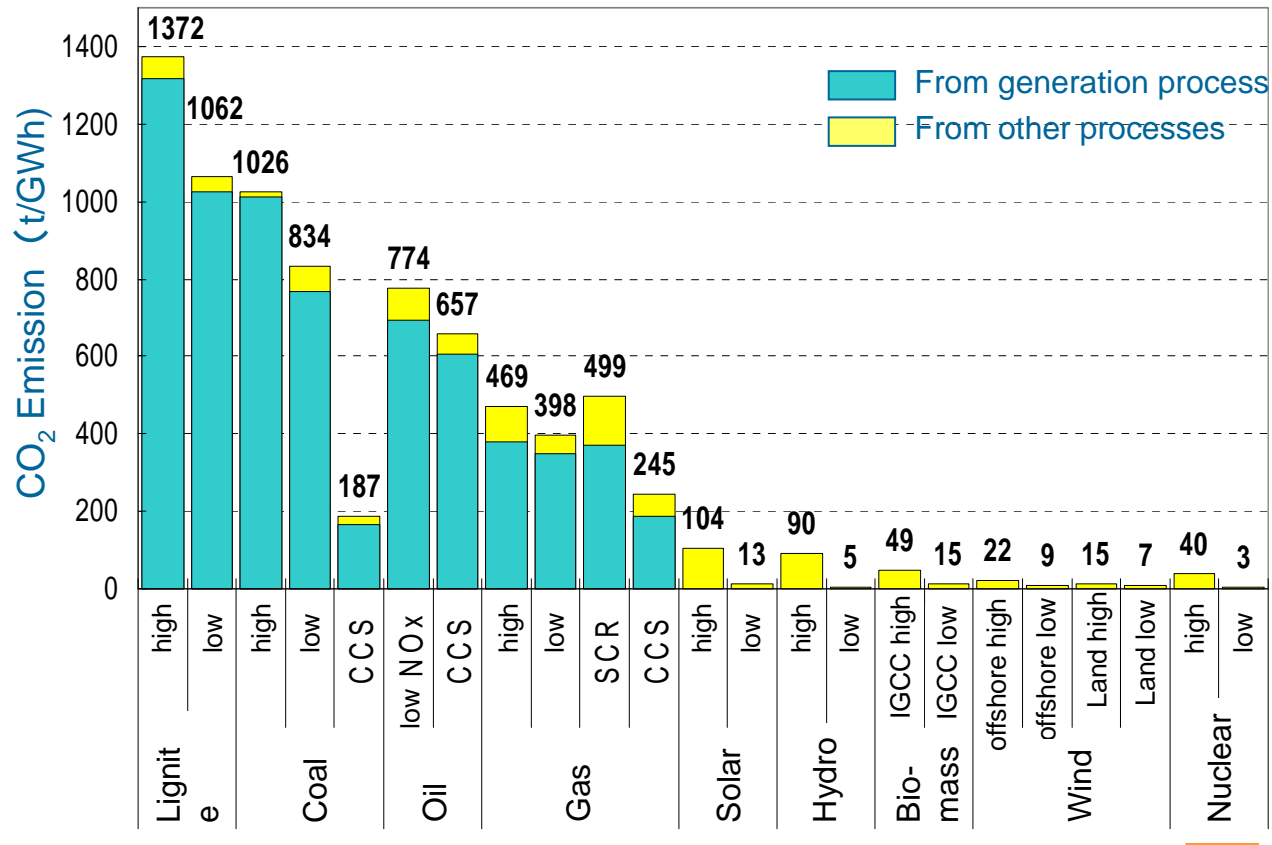
World Energy Consumption



World CO₂ Emission

- (1) Reference Scenario: Government policies are assumed to remain unchanged from now.
- (2) Alternative Policy Scenario: Implementation of currently considered policies and measures by governments are assumed. (Example measures; Energy Conservation, Energy Efficiency, Use of Renewable Energy, Use of Nuclear Energy)
- (3) 450 Stabilization Case: One possible pathway to halving greenhouse gas emission by 2050 (Greenhouse Gases Stabilization Level = 445-490ppm CO₂-eq, Global Mean Temperature +2.0-2.4C)

Lifecycle CO₂ Emission from Alternative Electricity Sources



Greenhouse gases emissions from alternative electricity production systems

(Tonnes of carbon dioxide equivalent per lifecycle for electricity generation of GWh.
 high, low: highest or lowest result in the category.
 CCS: Carbon dioxide Capture and Storage, SCR: Super Critical)

Ref. Comparison of Energy Systems Using Life Cycle Assessment, WEC, 2004

Contribution Potential of Nuclear Power to CO₂ Emission Reduction

- CO₂ Emission from 1-year operation of 1GW plant with 80% capacity factor:

<u>CO₂ emission</u>		Ratio to total Japanese emission(1,275Mt, 2006)
Nuclear	0.15 Mt	0.01%
LNG combined	3.04 Mt	0.24%
Coal	6.52 Mt	0.51%

- Emission corresponds to 2658TWh, world total nuclear generation in 2006 by 435units approx.370GW:

<u>CO₂ emission</u>		Ratio to world total emission(28.2Bt, 2006)
Nuclear	0.06 Bt	0.2%
LNG combined	1.15 Bt	4.1%
Coal	2.47 Bt	8.8%

⇒ To meet growing world electricity demand and to achieve emission reduction, introduction of nuclear power is needed.

- Capacity of nuclear power under construction or planning is approx. 330GW. When this is realized, total nuclear power will be approx. 700GW and contribute to CO₂ emission reduction in a scale of a few Bt/year.

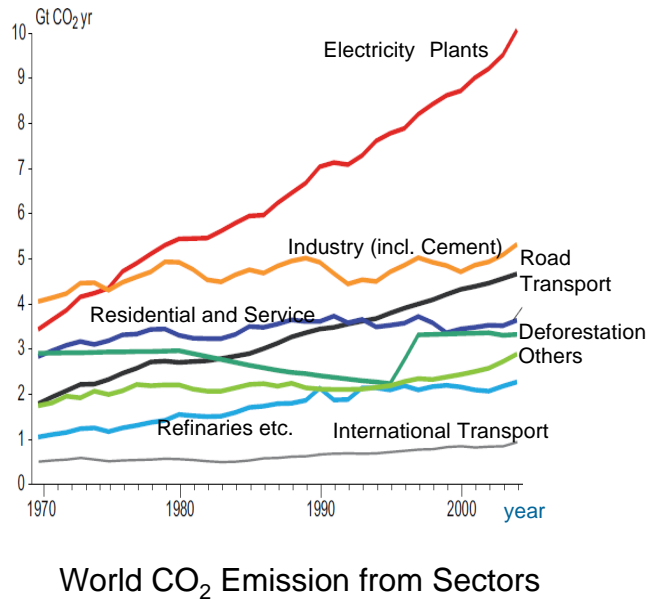
- Emission from 1-year operation of 700GW plant with 80% capacity factor:

<u>CO₂ emission</u>	
Nuclear	0.11 Bt
LNG combined	2.13 Bt
Coal	4.56 Bt

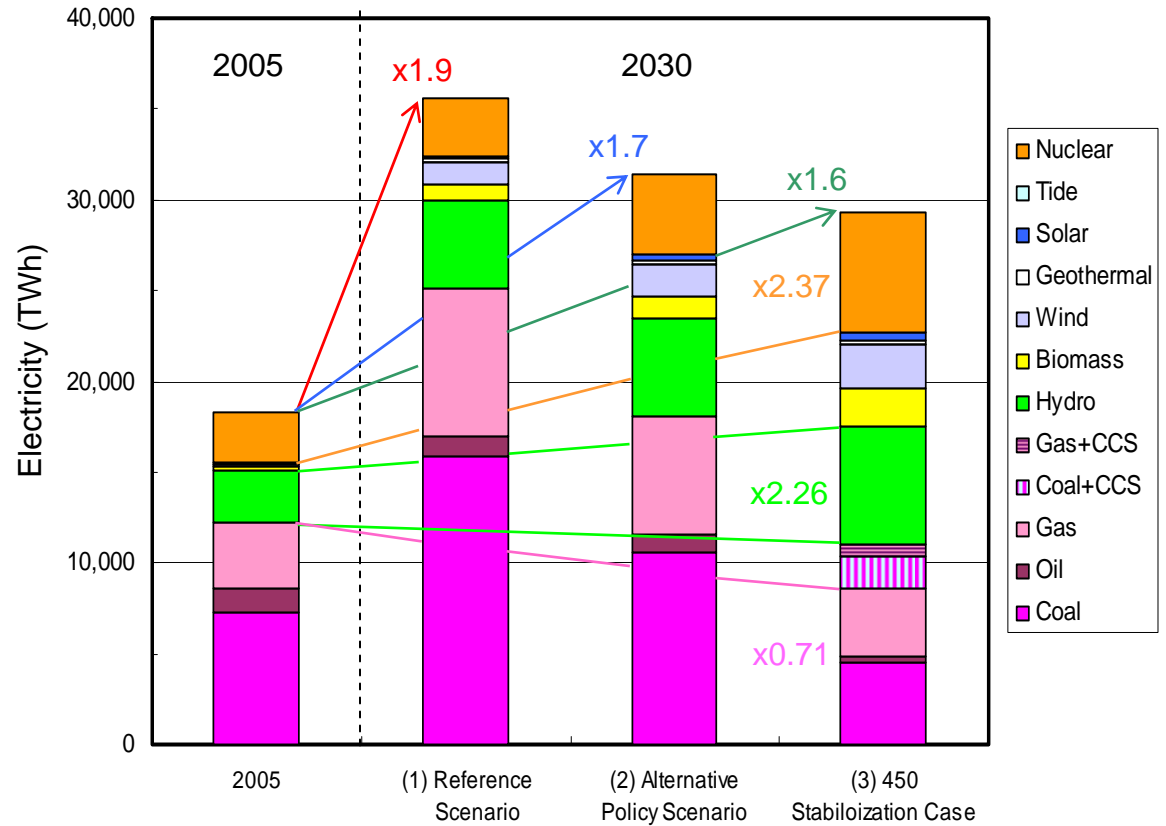
CO₂ emission: based on the data in the previous sheet
Nuclear power data: taken from World Nuclear Association homepage

World Electricity Generation

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Ref. IPCC AR4 WGIII



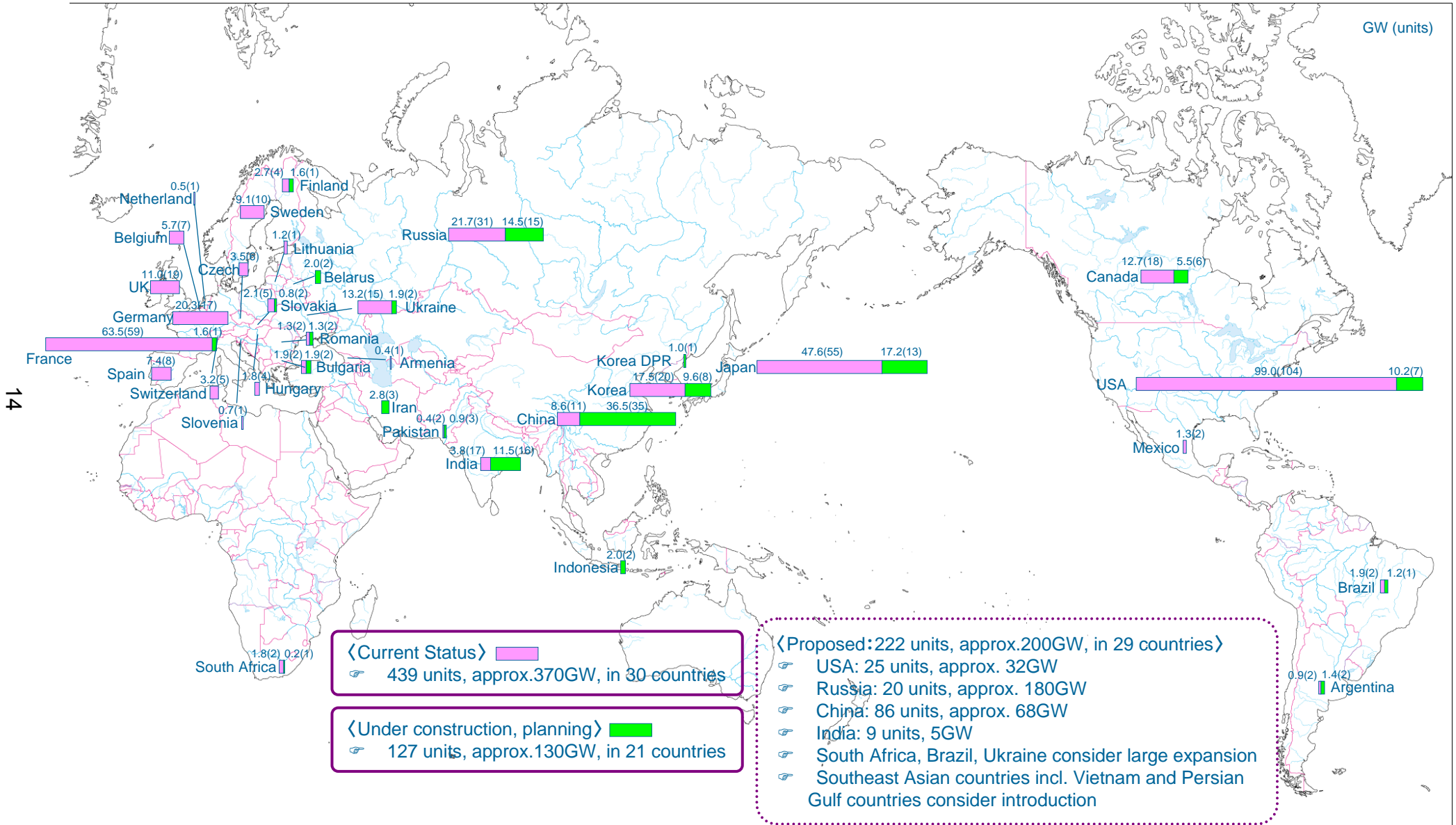
Projection of World Electricity Generation

(ref. World Energy Outlook 2007)

Actions Japan Should Take for the Expansion of Nuclear Energy Use in the World as a Measure against Global Warming (Reference data)

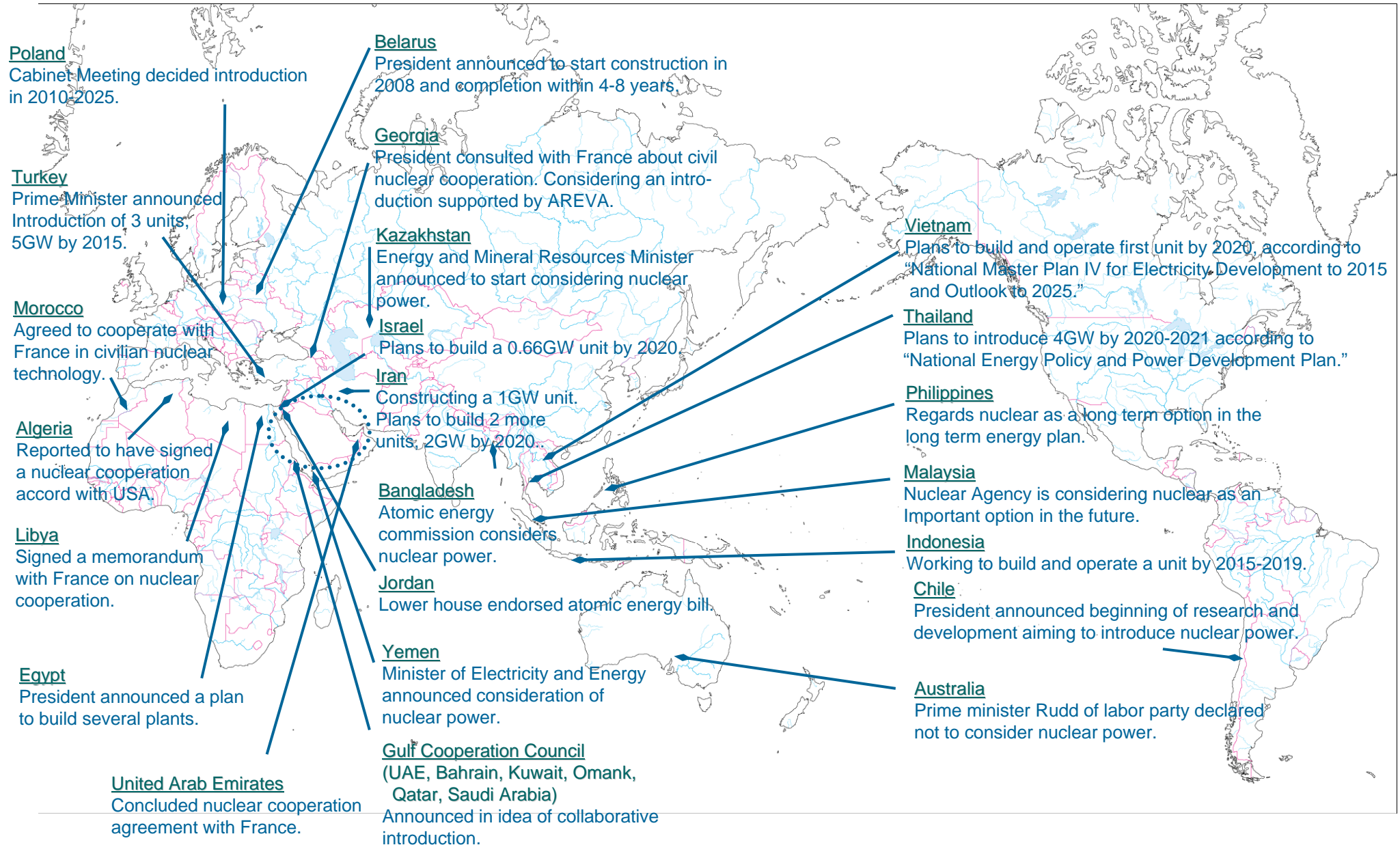
Nuclear Power Plant in the World

Ref. World Nuclear Association, 2007 December



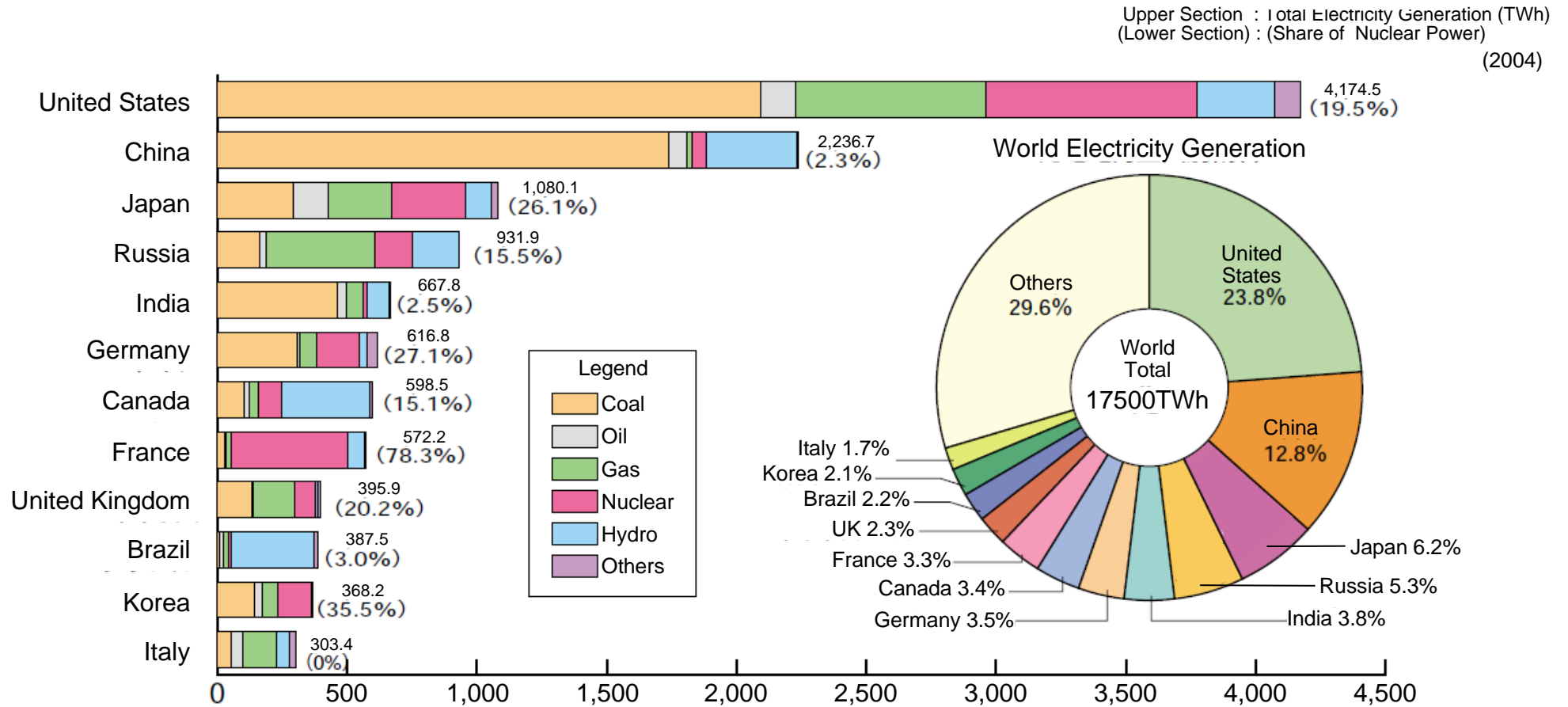
Countries and Regions Considering Introduction of Nuclear Power

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Electricity Generation and Share of Nuclear Power in Various Countries

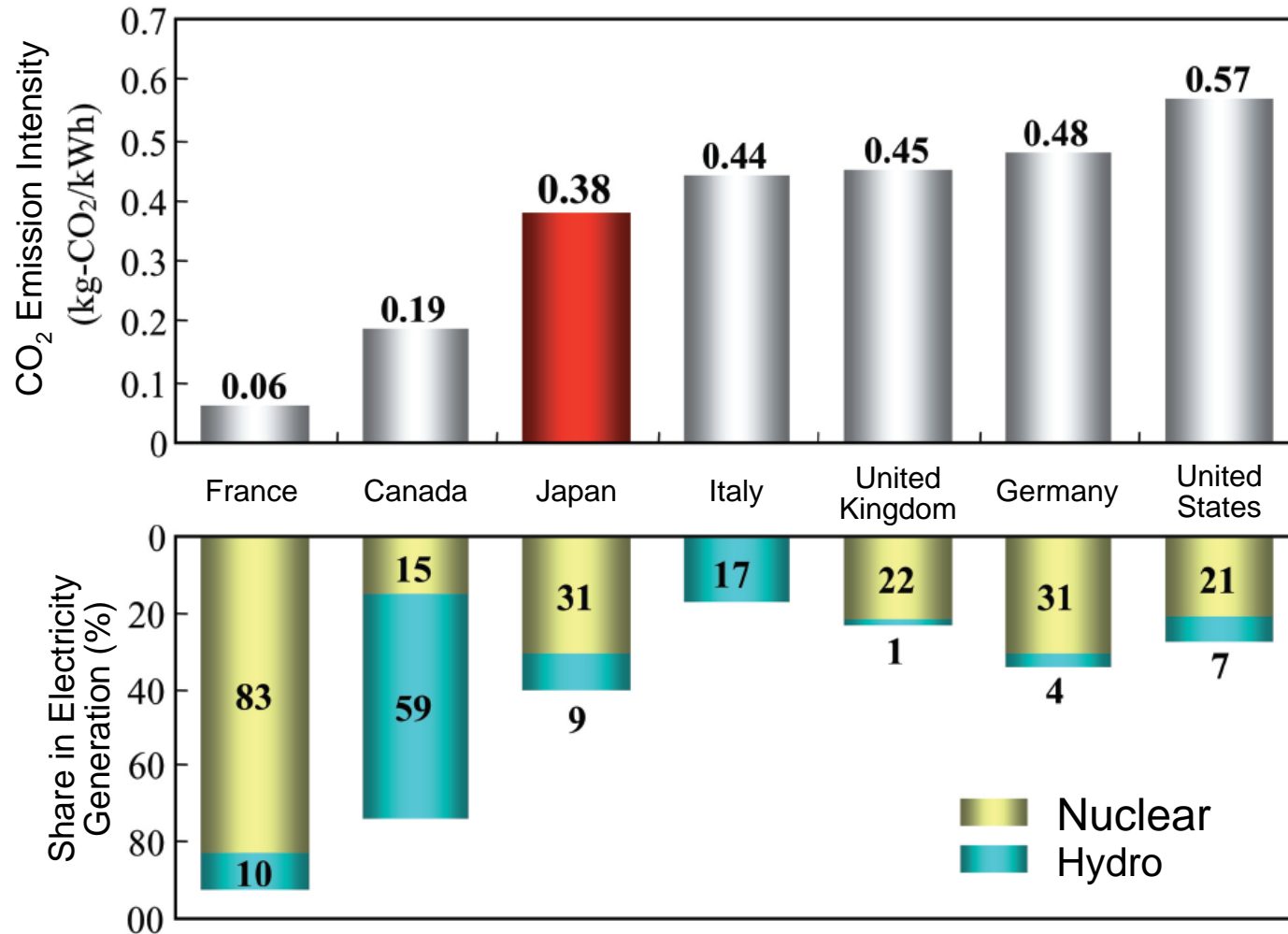
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Ref. IEA Electricity Information 2006 Edition

Actions Japan Should Take for the Expansion of Nuclear Energy Use in the World as a Measure against Global Warming (Reference data)

CO₂ Emission Intensity of Various Countries



*Source : Energy Balances of OECD Countries 2004-2005
 (Japan data: calculated by FEPC)
 *FEPC : Federation of Electric Power Companies of Japan

Ref. Action Plan of Environmental Conservation in Electricity Utilities, FEPC, 2007.9

Actions Japan Should Take for the Expansion of Nuclear Energy Use in the World as a Measure against Global Warming (Reference data)