Building a new energy network in North East Asia - a perspective from post-Fukushima Japan

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Abstract: The accident at Fukushima Daiichi Nuclear Power Station (NPS) has accelerated Japan's drive for less dependence on nuclear and fossil energy and more green renewables, which inevitably require a new energy strategy. In this paper, a new strategic scenario for moving "beyond a single economy" is proposed to incorporate Japan with the North East Asian (NEA) energy market in regards to its electricity grid and natural gas pipeline network while preserving nuclear power by strengthening safety. Suggestions are also made that Japan should open more doors for new comers in a manner of open-access towards member economies of NEA. However, there are persistent geopolitical constraints and risks in NEA. The connection of Japan's energy network to its regional neighbors would avoid the tendrils and tentacles of geopolitics that wrap around NEA, and subsequently provide opportunities to build on common energy interests.
Keywords: electricity grid; pipeline network; geopolitics; Asia-pacific; energy network

1 Introduction

The accident at Fukushima Daiichi Nuclear Power Station (NPS) on March 11, 2011 has had a serious influence on the electric power supply-and-demand situation of Japan. Before the accident, Japan was the 3rd largest nuclear power country in the world after the U.S.A. and France with its 54 nuclear power plants (total output 48.8 GW Gross) [1]. However after the accident, the restart of any nuclear power plant which had finished inspection on annual shutdown maintenance became very difficult because of the high momentum for "Datsu-Genpatsu" (nuclear phase out) that has arisen in Japan. [2-4]

On May 5, 2012, Japan had virtually phased-out nuclear power plant by the stoppage of the Tomari No. 3 unit. This was widely expected to bring about a critical shortage of electric power throughout Japan. Among all the districts in Japan, the largest shortage of 15.8 % was estimated for the Kansai district area, where Kansai Electric Power Co. ltd (KEPCO) supplies the electric power. Therefore, both KEPCO and the Japanese Government requested local governments of Fukui prefecture to agree to the restart of KEPCO's Ohi Nuclear Power Station's Units 3 and 4. (Ohi NPS is located in Ohi-town, Fukui prefecture.) This request and consultation process started in February 2012 when the Nuclear Safety Commission approved the Nuclear and Industrial Safety Agency (NISA)'s evaluation report that KECPCO's Ohi Unit No.3 and 4 passed the stress test criteria set by Japanese Government.

After hectic political rituals and negotiations among not only the Prime Minister's cabinet and Fukui Prefecture's local governments but also involving many other local governments surrounding Fukui prefecture in the Kansai district, the restart of the both units was at last approved in the middle of June. So the Ohi No.3 unit began its restart from July 1, followed by the subsequent restart of the Ohi No.4 unit. This alleviated the planned power supply restrictions in Kansai district for this hot summer season (July – September), although the number of citizens protesting to stop nuclear power in the country grows day by day in front of the Prime Minister's Office in Tokyo. Although some nuclear power plants will follow Ohi No.3 and 4 Units in the short-term, a decrease of nuclear power is inevitable in Japan after the Fukushima Daiichi accident.

Looking back to the time before the Fukushima Daiichi accident, because of Japan's scant fossil energy resources, the Japanese government had long promoted their nuclear power program, which seemed to be superior in regards to constructing a

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self-sufficient energy supply system to ensure the nation's energy security. The Atomic Energy Commission of the Japanese Government formed an aggressive energy strategy in 2005 of increasing the ratio of nuclear power generation up to 50% of the total production of electricity by 2030 [1]. However, the accident at Fukushima forced a reconsideration of Japan's energy strategy including nuclear power generation, although nuclear power still maintains an important role in the electric power supply until some time in the future.

This paper examines many issues encompassing the Japanese energy situation that have been brought on by the Fukushima Daiichi accident and discusses future scenarios of energy supply in Japan from the viewpoint of the international situation, particularly in North East Asia (NEA). Consideration is also given as to how new energy networks might open the door for new comers in ways such as open-access policies for member economies of NEA.

In the ensuing work, Chapters 2, 3, 4 and 5 introduce the reconsideration of Japanese energy policy, the energy trends in NEA considered through statistics, the concept of an energy network in NEA, and the geopolitical constraints and risks in NEA, respectively. Finally, chapter 6 discusses the future of energy in Japan and NEA.

2 Reconsideration of Japan's energy strategy

On May 28, 2012 the Fundamental Issues Subcommittee of the Ministry of Economy, Trade and Industry (METI) Advisory Committee on Energy and Natural Resources set forth four possible energy mix scenarios in its report as shown in Table 1 [5]. Although the final approval should be made at the ministerial level meeting in August 2012, in the long run Japan is almost certain to pursue a policy of lessening dependence on nuclear energy to between 25 and zero percent, while renewable energy will be increased to between 35 and 25 percent (compared with 11% actual in FY 2010). In this case, the future energy scenario of Japan for 2030 would be selected from among options A, B, and C in Table 1.

Table 1 Draft energy mix scenario for 2030

(Unit: percentage)

Option	Nuclear	Renewable	Fossil	Co-generation
A	0	35	50	15
B	15	30	40	15
C	20-25	25-30	35	15
D	35	25	25	15
Current (FY2010)	26	11	57	6

However, with today's critical technological and economic situation, the uncertainty behind the energy mix scenarios is growing, and it may be too early to work-out any reasonable forecast of the medium/ long-term energy outlook. The author of this paper thinks that it would be a better stance for the government not to determine the ratio itself, but to leave market mechanisms to determine it. To enable this, Japan should open the doors more for newcomers to enhance open-access and to interconnect with the NEA market.

3 Energy trends in NEA considered through statistics

The overall energy situation in NEA (China, ROK, Russia and Japan) in 2010 and 2011 is indicated in the statistical reviews of world energy compiled by British Petroleum (BP) in June 2011 and 2012 (see Table 2) [6]. In Table 2, not only consumption but also production rates of fossil energy (natural gas, oil and coal) are indicated for each country.

Table2 Key Indicators for 2011

Unit; Million tonnes oil eqivalent

By Fuel		China	Japan	ROK	Russia
Nuclear Energy	Consumption	19.5	36.9	34	39.2
Natural Gas	Production	92.3	–	–	546.3
	Consumption	117.6	95.1	41.9	382.1
Oil	Production	203.6	–	–	511.4
	Consumption	461.8	201.4	106.1	136.1
Coal	Production	1956.1	0.7	0.9	157.3
	Consumption	1839.4	117.7	79.4	90.9
Hydro Electricity	Consumption	157.1	19.2	1.2	37.3
Renewable Energy	Consumption	17.7	7.4	0.6	0.1
Primary Energy	Consumption	2613.2	477.6	263.1	685.6

Notes; Renewable Energy includes wind, geothermal, solar, biomass and waste

Source; BP Statistical Review of World Energy June 2012

The influence of the Fukushima Daiichi accident can be readily understood from Table 2. In 2011, Japanese nuclear energy consumption dramatically decreased to 36.9 Million Tonnes oil equivalent (MTOE) from 66.2 MTOE in 2010. Both natural gas (95.1 MTOE) and renewable energy (7.4 MTOE) sharply increased and have considerably met the

consumption burden of the deficit nuclear energy. Total primary energy consumption fell to 477.6 MTOE in 2011 by 4.6 % from 500.9 MTOE in 2010.

In Table 2, China remains the primary driver of energy demand growth, which increased to 2,613.2 MTOE or 7.4 % more in 2011 than the 2432.2 MTOE in 2010, although this growth rate has dipped from 11.2 % in the previous year. Production of natural gas, coal, nuclear energy and renewable energy all increased remarkably. ROK also increased its primary energy consumption by 3.1 % in 2011 against 2010. Russian primary energy consumption in 2011 fell to 685.6 MTOE or 0.7 % decrease from 690.9 MTOE in 2010.

The three countries of China, ROK and Japan are net-importers of oil and natural gas, and they constantly attempt to increase their self-sufficiency and diversify import sources, which reduces dependence on hydrocarbons from the unstable Persian Gulf. On the other hand, Russia is the holder of the world's largest gas reserves and the third-largest oil exporter after Saudi Arabia and Iran. An increasing share of Russian exports go eastwards to China, ROK, Japan and other Pacific Rim economies.

Russian energy surplus is reasonably expected to fill the deficits in Japan's current energy balance. Further additional imports of oil and natural gas are expected to rise remarkably as demand growth outpaces regional supply in the NEA market. Natural gas in particular is anticipated to be imported from Australia, Malaysia, Canada and the United States. With extensive shale gas resources in place, the United States will overtake Qatar as the world's largest LNG exporter around 2020, according to BP statistics as shown in Ref. [6].

In NEA, coal maintains a stable base-load position for power generation, while renewable energy accounts for only a small percentage with a marginal supply ratio in 2010 as shown in Table 2.

4 Concept of an energy network in NEA

This chapter introduces the concept of an energy network for electric power and natural gas advocated for the countries in NEA.

4.1 Electricity grid option

4.1.1 Constraints of the electricity grid in Japan

Japan has no cross-border electricity grid, and its isolated electricity grid is further divided into two regions by power frequency: three electric power companies in eastern Japan utilize 50 Hz, whereas seven electric companies in western Japan have adopted 60 Hz [7]. A transmission line interconnects the main island Honshu and Hokkaido island in Japan using 42km long submarine cables carrying 250kV direct current with a capacity of 600MW. For power exchange between eastern and western parts of Japan, frequency conversion stations have been set up by three utilities with a total capacity of 1,000 MW. Therefore, the electricity market in Japan is divided into two independent regions in a single economy; one is the eastern Japan market; another is the western Japan market. This unique structure of the electricity grid is a critical barrier and makes it more complicated to deal with the prevailing electricity shortage problems after the Fukushima accident.

4.1.2 Two proposals for an Asian power grid link with Japan

Looking at the critical electricity shortage situation throughout Japan, some Japanese proposed new planning efforts for a grid interconnection strategy in Asia, similar to the grid network in Europe.

One proposal is the "Asia Super Grid". On September 13, 2011, the Washington Post reported that one Japanese business leader had outlined plans to shift Japan to renewable energy, and that investment could lead to Asian electricity grid. He has already invested one billion yen ($13 million) of his own money to create the foundation, and announced that his company would invest a further 10-20 billion yen ($130-260 million) in a new renewable energy business. The drivers were that although renewable energy technologies are often capital-intensive, they have environmental benefits and minimal fuel costs. He proposed that the 2,000

km nationwide electricity grid could eventually be expanded to all of Asia, in a massive grid that would run 36,000km and link Japan with countries including India, China, and Russia. He also advocated that his proposal would meet such requirements as demand leveling of peak-shift (by operating across time-zones and climate differences), stable supply and fair electricity prices as shown in Fig.1 [8].

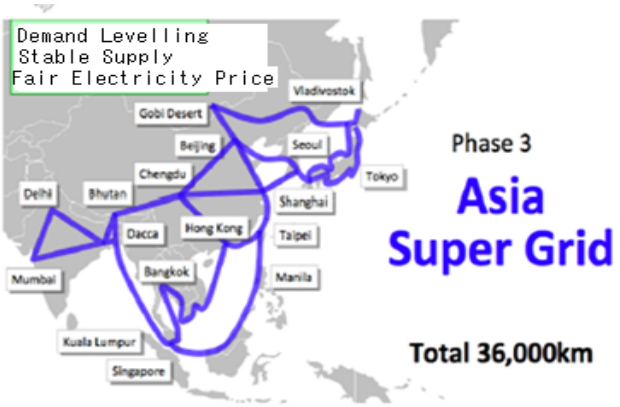

Fig. 1 Concept of the Asia Super Grid
proposed by Mr. Masayoshi Son, SoftBank.

Another interesting option is the "Nihon Sousei Kaigi" (Japan Creation Council) proposal. On October 8, 2011, the Japan Creation Council proposed the grand design that "Japan should take the lead in building an electricity grid that extends from Japan through Southeast Asia to Australia in order to seek a new path in the post-Fukushima era", again taking the EU network model as a prototype.

In the author's view, these projects with a broad-area electricity grid would enable exchanges of renewable energy across national borders and serve as an energy equivalent of the Trans-Pacific Partnership (TPP) free trade agreement now under discussion in Japan. It would also necessitate cross-border cooperation is most badly needed in the domain of energy, to end Japan's reliance on nuclear power in the long term.

4.1.3 The Korea Peninsular-Japan electricity grid plan

From other quarters, experts of the Seoul National University in ROK had already proposed the "Power system interconnection scenario and analysis between the Korean Peninsula and Japan" in July 2003 [9]. This report provides for the interconnection of the electric power grids of ROK and Democratic People's Republic of Korea (DPRK), with further expansion from ROK to Japan. The first scenario involves the interconnection of the 765 kV HVAC power transmission system between the Kyungin area in the northwest part of ROK and Shinpo in the eastern part of DPRK. The second scenario involves the interconnection of the HVDC power transmission system between the Busan area in the southeast part of ROK and the Kyushu area in the northwest part of Japan.

4.1.4 ASEAN power grid model

The proposals described in 4.1.2 and 4.1.3 could in the long run be interconnected with the ASEAN Power Grid (APG) program [10]. This program has advanced further than those in Japan and Korea. According to ASEANWEB, the Heads of ASEAN Power Utilities/Authorities (HAPUA) Council, being responsible for the effective implementation of the APG, will initiate the formation of an APG Consultative Committee (APGCC). According to APG survey, 9 projects are listed to be commissioned before and by 2015, with 4 projects after 2015 and 2 projects newly proposed. The 6 interconnection links already in operation are shown in Fig.2, according to the report of the APGCC held at Danang Vietnam, 23 June 2011.

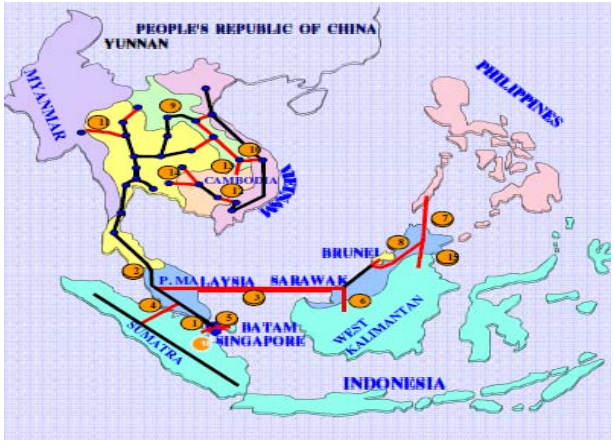

Fig. 2 ASEAN Power Grid programme.
Source: APGCC, June 20, 2011.

4.2 Proposed natural gas pipeline network in NEA

4.2.1 Russian Eastern Gas Program

Russia is the holder of the world's largest gas reserves and third-largest oil exporter. An increasing

share of Russian exports will go eastwards to Asia, providing Russia with a diversity of markets as Russia's focus moves to the East. Russia's bargaining capacity has received a boost from its Eastern customers as further competition to its European customers.

For the Japanese to date, a Russian oil and gas deal has been seen as a "wild card" due to lack of political trust in Russia among the Japanese since the end of the Second World War in 1945. Russian President Vladimir Putin's "Eastern Gas Program" as early as July 2002 virtually dictated a "resource nationalism", and in 2006 when the state-owned Gazprom unilaterally took over the majority shares of the Sakhalin-2 project which was partly owned by Japanese stakeholders, this further exacerbated the perceived lack of reliability of energy investment in Russia.

However, the accident in Fukushima and the new "shale gas revolution" have brought both Japan and Russia into new negotiations on energy investment and trade.

4.2.2 Russia-Japan gas pipeline deal prospects

In a post-Fukushima energy market, Russian oil and gas accounts for 8% and 10% respectively of total Japanese imports in 2011, both of which significantly contribute to reducing dependence on the Middle East, and largely fill the shortage of power generation fuel to replace nuclear energy.

A grand design for a NEA circular natural gas pipeline was once launched by prominent experts from ROK and Japan in the mid-2000s [11], and under today's changing circumstances around NEA, a pre-feasibility study on the project is again to be revived. Under the plan, supply of natural gas would be from Yakutsk/Sah in the Russian Far East, Irkutsk in East Siberia and North Sakhalin, to markets in the north eastern/central provinces of China, DPRK, ROK, and as far as Japan with a circular pipeline network in NEA.

In September 2011, Gazprom completed a 1,350 km pipeline from the Sakhalin Island to Vladivostok via Khabarovsk, and Gazprom and Japanese companies are engaged in a feasibility study for constructing an LNG plant in Vladivostok. This trunk-line will be extended to DPRK/ROK, and as far as Japan, where north Sakhalin gas will be transported to Hokkaido and Honshu of Japan by another trunk line as shown in Fig. 3.

Both ROK and Japan are considering the laying of a gas pipeline as an alternative to additional LNG shipments, especially following the recent completion of the Russia-Germany natural gas pipe line known as the "Nord Stream" pipeline project [12].

4.2.3 Korean Peninsula prospects

Russia's huge resources and geographical proximity, would be the key partner to initiate trilateral negotiations over the trans-Korean Peninsula pipeline construction project among Moscow, Seoul and Pyongyang. In August 2011, both the Russian President and the DPRK leader agreed on a memorandum supporting this initiative, according to the Korean Central News Agency in Pyongyang on August 28, 2011 [13].

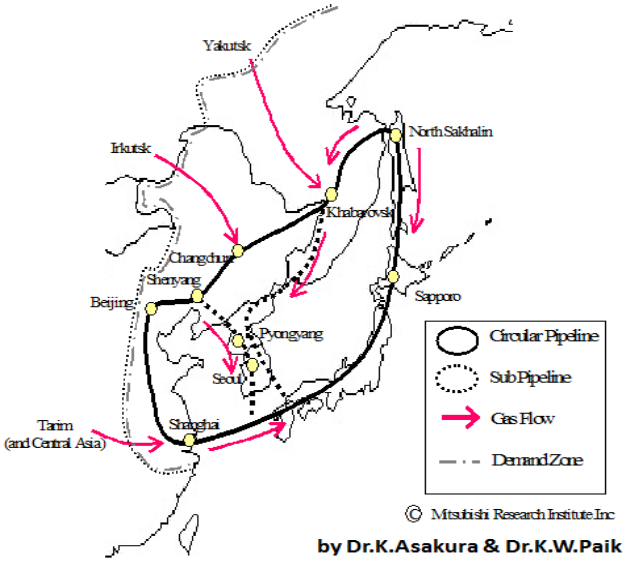

Fig. 3 Concept of NEA natural gas pipeline proposed by Dr. K. Asakura and Dr. K.W. Paik.

The proposed 1,100 km pipeline would have a capacity of 10 billion cubic meters (bcm) of gas per year. Some 700 km of the pipeline would be built on North Korean territory, according to Russia's Energy News website [14]. Both Gazprom and Korea Gas Corporation (KOGAS), a state-owned corporation in ROK, initially signed a deal in June 2009. Should

issues of transit risks be solved and economic feasibility be assured, the trans-Korean gas pipeline plan, at the next stage for the future, is anticipated to be extended to Kyushu in Japan.

4.2.4 Choice of natural gas pipeline

Generally speaking, in deciding which elements of the proposed electric power grids should be built, at least where new power lines would largely be used to transport the output of gas-fired power plants, it is important to assess whether it would be most cost effective to transport gas by pipeline as an alternative. Thus we must determine which is better in terms of a least-cost assessment, in selecting an electricity grid or a natural gas pipeline.

Industry experts generally agree that expansion of power transmission grids is more cost effective than expansion of gas pipeline unless very large amounts of gas are being moved. That is because gas pipelines have relatively high fixed costs and relatively low variable costs per km or per cubic meter. The practical implications can be seen in Fig. 4. If less than 2 GW of power interconnections are contemplated, electric grid expansion will almost always be more cost-effective than gas pipeline expansion. As the planned distance for moving gas increases, the floor above which a gas pipeline makes sense increases. For moving gas 3,000 km, a gas pipeline makes economic sense for capacities of 3 GW or more. To move gas 5,000 km, a gas pipeline makes economic sense for capacities of 4 GW or more, according to the report compiled by Asia-Pacific Energy Research Centre (APERC) in 2004 [15].

The analysis result to reduce Fig.4 is based on average lifetime costs of electric transmission lines and natural gas pipelines on direct (non-branched) overland routes. Gas flow equivalents are calculated on the basis of a combined-cycle gas turbine with 55 % efficiency, and the energy content of the gas being 37.2 MJ/Nm^3 (LHV).

Therefore, should less than 2 GW of power interconnections be constructed, for example between South Korea and Japan or between Russia and Japan, an electricity grid will be more cost-effective than a

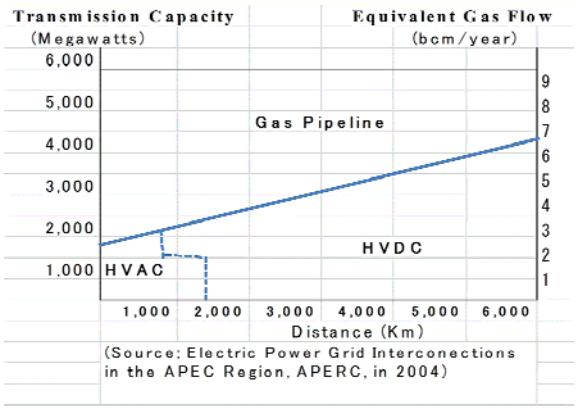

Fig. 4 Comparative Economics of Electric Transmission Lines and Gas Pipelines for Different Assumed Transmission Line Capacities and Distances.

gas pipeline, according to the simulation studies. However, a gas pipeline may be more cost-effective than an electricity grid at larger rates of gas transmission.

5.2.5 Shale gas revolution

A coming "Golden Age of Gas" may provide a bridge for maintaining energy supply in Japan as well as in the NEA market, but the gas glut may end sooner than expected due to low supply margins, if shale gas LNG exported from North America does not become available before around 2015.

The American Gas Association, in conjunction with the Colorado School of Mines, estimated in April, 2012 that the size of the USA shale gas reserves could be approximately 100 times greater than current annual consumption. Recent technological break-throughs by USA energy companies have made it possible to tap this abundant but previously inaccessible source of natural gas.

In the US market, natural gas from shale gas with a very low price of less than $2 per MMBTU is now the fastest-growing contributor to the total primary energy mix. The Financial Times published on April 16, 2012 reported that the USA government decision to lift a gas export ban is a potential first step in what could be a profound upheaval in global gas markets, including the NEA market. The Alaskan shale gas LNG export option for the NEA market is being considered by the USA government, according to the Japan Oil, Gas and Metals National Corporation

(JOGMEC) symposium held on February 7, 2012 in Tokyo [16].

Japanese LNG imports reached record levels in 2011-12, reflecting the effects of all 50 nuclear units going offline by May 2012. In the winter of 2012 Japan paid more than $20 per MMBTU to import LNG, which is more than 8 times the current international spot price, and is the largest reason why Japan recorded its highest deficit in its international trade balance since the first oil crisis in 1973, according to the Trade Statistics of Japan published by Ministry of Finance [17].

Therefore, the coming shale gas LNG in the future would particularly help plug Japan's energy deficit as well as the trade imbalance. Further cheap shale gas LNG imports from Alaska would act as leverage for price negotiation with Russia and Qatar, and also contribute to the diversification of gas supply sources. Australia, with giant gas resource in place, is anticipated to overtake Qatar as the world's largest LNG exporter around 2020, which will significantly mitigate Persian Gulf risks, according to the bulletin released by Japan Oil, Gas, and Metals Corporation (JOGMEC) on May 6, 2011 [16].

According to the BP's "World Energy Outlook 2030" published in January, 2011, gas production in China is expected to grow 6% p.a. Coal bed methane (CBM) and shale gas are likely to contribute 41% to this growth, but still leave a rising need for imports in China in 2030 [18].

5 Geopolitical constraints and risks in NEA

This chapter considers the geopolitical restrictions and risks when actually building the infrastructure of the international energy networks introduced in the preceding chapter.

5.1 Persistent geopolitical risks

Recently concern has been growing over sea lane security in the Strait of Hormuz, an entrance to the Persian Gulf. With 60 % of the petroleum proven reserves in the world, the Middle East region is strategically vital to the world economy as well as NEA economies. The Strait of Hormuz links the Gulf - and the oil-producing states of Iran, Iraq, Bahrain, Kuwait, Qatar, Saudi Arabia and the United Arab Emirates (UAE) - to the Indian Ocean. About 40 % of the world's tanker-borne oil passes through it. As a chokepoint of sea traffic, the Strait of Hormuz is vulnerable to political disruption. The Iranian nuclear program has triggered a series of international sanctions, and has led to the declaration by Iran on December 21, 2011 that it may close this vital oil-trade route if the West imposes more sanctions on it.

The Strait of Malacca, the busiest sea trade route in the world, also faces a growing dilemma between safety of maritime traffic due to piracy, and the subsequent use of security vessels, which may conflict with the sovereignty of coastal states.

In March 2012, Vladimir Putin, whose "Eastern Gas Program" caused political uproar over the Sakhalin 2 project, was elected to another six-year term as president of Russia. Japan is currently attempting to use an energy package deal including LNG infrastructure and equity shares of Sakhalin Three oil/natural gas and other energy related projects, as leverage for political negotiations on the return of four northern islands occupied by Russia.

5.2 NEA response

NEA economies as net-importers of oil/natural gas (apart from Russia) intend to increase self-sufficiency and diversify energy sources, and lower dependence on the Persian Gulf hydrocarbons. Unlike European and North American energy markets, which already have well developed trunk oil/natural gas pipeline systems, the Asian natural gas market (excluding the Turkmenistan-China continental pipeline) relies mostly on LNG tankers.

On the multilateral stage in NEA, the interconnecting grids and natural gas trunk-line projects in NEA are expected to complement supply reliability, to mitigate the risk of market tightness, natural disaster risks (in light of the Great Eastern Japan Earthquake and Christchurch Earthquake of 2011), and also unconventional risks (piracy, terrorism, strikes, pollution and pandemics). Moreover, nuclear power

stations should be safeguarded against terrorism attack.

5.3 Market-oriented approach

So far geopolitical concerns have been invisible barriers within the business environment in NEA. After the Fukushima accident, the regional situation including the political circumstances have been rapidly changing. Shaping the grand design of interconnection initiatives in the NEA grid and natural gas pipeline are vital for identifying a preferred choice, in light of the issues of energy security, resource availability and geopolitical concerns. From another perspective, it is also becoming more dependent on market mechanisms and business operations, which should reduce geopolitical risks.

To this end, the APEC summit to be held in Vladivostok in September 2012 will provide key momentum for regional energy cooperation.

6 Discussion of future energy in Japan and NEA

The international discussion on the cooperation around energy and environmental problems in NEA had already started before the Fukushima accident. On May 2006, the first forum on comprehensive energy conservation and environment between Japan and China was held in Tokyo, followed by dialogues on energy at the ministerial level in Beijing. Governing bodies of the Asia-Pacific Economic Cooperation (APEC), the East Asia Summit (EAS), and the ASEAN plus Three (China, ROK and Japan) have intensively facilitated energy dialogue since the early-2000s using a multilateral approach.

This chapter discusses the concepts which the author has raised from a viewpoint of the cooperation on energy and environmental problems with the countries in NEA and Japan in the post-Fukushima age [19]. Viewpoints are (i) Beyond a single economy (*i.e.*, self–sufficiency not limited to the economy of one country), (ii) Level playing field (*i.e.*, promotion of fair play), and (iii) Seeking for new bonanza (*i.e.*, finding new profit).

6.1 Beyond a single economy

In a post-Fukushima soft landing scenario, Japan faces enormous economic and geopolitical risks whose solution entails a regional agenda in NEA/Asia-Pacific rim, which includes several issues to be tackled. These issues are:

- Energy supply in NEA requires diversified sources, such as oil, natural gas, renewables, cleaner coal and safer nuclear under sustainability constraints,
- A green growth path by efficiency, decentralized renewables, Low Emission Vehicles (LEVs), energy saving companies (ESCO) and smart grids with new technologies including co-generation, hydrogen, methane-hydrate, shale gas, super-conductive grids, *etc*.,
- Oil emergency preparedness (including joint stock-drawing schemes) for NEA economies,
- NEA economies should develop unconventional shale gas resources and LNG infrastructure,
- For coal to remain the backbone of power supply, NEA should enhance CCS readiness and highly efficient power plants, and
- Soft business infrastructure of energy futures and exchange markets to mitigate volatility risks of oil and natural gas prices should be constructed, by use of innovative IT.

To this end, given the excellent geographical location of Japan, as a key hub which could reach beyond a single economy, energy transmission networks which interconnect the Pacific Rim economies with the Asian-Eurasian continent should be discussed and constructed, which would consequently contribute to reducing volatile geopolitical risks and stabilizing the energy market in NEA in the future.

6.2 Level playing field

Japan should promote the establishment of bilateral/multilateral cooperation schemes with NEA economies which conceptually would be categorized into two stages: until 2020 and until 2030 as described in Table 3 [20].

By 2020, Japan should carry out deregulation and reform policy of the domestic electricity/gas sector which is currently controlled by a monopoly franchise. Japan should enhance the principle of a level playing field in energy reform, which enables

end-users to select energy sources, and also Japan should proceed with a liberalization policy, with a view to sustaining international competitiveness, and more green renewables with feed-in-tariffs (FIT). A level playing field is a concept about fairness, not that each player has an equal chance to succeed, but that they all play by the same set of rules like in a soccer game.

Concretely, assured quality standards for bio-energy and other renewables should be enforced in practice, and affordable merge and acquisition (M&A) and foreign direct investment (FDI) should be fairy approved in the energy sector, especially in the gas and power industry. Safer nuclear power and LEVs, in favor of low carbon, should be adequately introduced.

By 2030, Japan should initiate a common energy market in NEA, like the EU energy network model, and pursue a low carbon society and sustainability. In NEA, equal partnership is a priority issue to seek for business opportunities. As a fore-runner, Japan should deploy a transfer of innovative technology with low carbon, such in co-generation and hybrid vehicles.

Concretely, NEA members should agree to set forth common tariffs in such open-access manners as the TPP/FTA/EPA framework. Japan should tackle a joint oil stockpiling program and LNG procurement scheme together with ROK and other importing economies. In NEA, a number of cross-border grids and gas pipelines should start between 2020 and 2030, to interconnect Japan with ROK and even Russia.

Table 3 Japan and North East Asian Energy Market Concept

Time-Span	2020 (transition period)	2030 (long-term goal)
Objective	- Deregulation/ reform - A level playing field - Post-Kyoto protocol	- Common market - Low carbon society - Sustainability
Principle	- Market-oriented - Competitiveness - Greener renewable	- Equal partnership - Fair trade - Technology innovation
Outlines	- Assured quality standard - Affordable M&A and FDI - Safer nuclear and LEVs	- Common tariff - Joint oil stockpiling - Cross-bordering transit protocol

Source; Energy Geopolitics Limited of Japan (EGLJ)

6.3 Seeking for a new bonanza

Figure 5 shows the summary of the author's idea in matrix form [20]. This is a rough idea for further study to be placed as the core of the Japanese energy strategy for NEA. In Fig. 5, the column in the upper row means "business and private" sector. This sector is further divided into two menus of bilateral (right hand side) and multilateral (left hand side) relations between NEA members which involve Japanese industries. The lower row of Fig.5 is the "government and public" sector which is also divided into bilateral and multilateral relations, respectively.

Multilateral	Bilateral
Business	
Asia Super Conductivity Grid	Clean Coal Technology & LEVs
Cross-Border Gas Pipeline	Co-Generation & ESCO
Gas and IPP/BOT	Green CDM
Shale Gas/LNG Infrastructure	Decentralized Renewables
Coal and CCS Techonology Transfer	Patent/License Property Protection
ASEAN Grid Model	Nuclear Safety & Export Agreement
Hormuz & Malacca Strait and Sea Lane Security	Nuclear Accident Compensation Fund
Pipeline Transit Protocol	Oil & Gas Joint E&P Agreement
Acid Rain, Oil Polution Compensation Fund	Emergency Oil Stock Drawing
Disaster Information Exchange	Capacity Building & Trainning
Government	

(Source) Energy Geopolitics Limited of Japan (EGLJ)

Fig. 5 Matrix of energy cooperation in North East Asia.

Firstly, in the "business sector", for an example of "bilateral" relations between Japan and China, clean coal and LEV technology transfer, ESCO, green clean development mechanism (CDM)/decentralized renewables and patent/license protection issues are the main subjects. In the "government" sector, both Chinese and Japanese governments have touched on the issues of nuclear safety, acid rain prevention mechanisms, capacity building (training), and joint gas field development programs in the East-China Sea, which is currently on the negotiation table. An inter-governmental nuclear disaster compensation pact is also a keen issue in NEA economies after the Fukushima Daiichi accident.

Secondly, in the "business sector" on the "multilateral" relations menu, Japanese industry should initiate Asian electricity grid and natural gas pipeline projects in NEA, which are vital to energy security as well as business development.

In the "government sector", the Japanese government shows interests on enlarging ASEAN grid plans including Greater Mekong River projects, sea-lane security/safety in the Malacca Strait and South China Sea, shale gas/LNG infrastructure in Australia, US and Canada, clean coal/CCS technology, city gas and IPP/BOT projects and an oil pollution compensation fund, all of which will be listed on menu.

7 Conclusions

In order to overcome the problem of energy security, Japan has promoted nuclear power generation and so far has focused on the single, isolated-country type energy supply system. The accident at the Fukushima Daiichi NPS has forced Japan to change its medium-long term energy strategy drastically to seek less dependence on nuclear energy and more on renewables. From another perspective, it paradoxically suggests a new way of thinking which should lead to the working-out of multiple options in making a future energy scenario, "beyond a single economy".

This paper has discussed the state of the future energy supply of Japan in the restrictions of the framework of the international environment centering on NEA. Next, it opened an examination of neighboring countries and viewed the direction of reconstruction of the energy network which carries out interconnection of neighboring countries. Japan's energy network projects would help overcome the tendrils and tentacles of geopolitics that wrap around NEA, and subsequently provide opportunities to build on common energy interests.

Nomenclatures

APERC	Asia-Pacific Energy Research Centre
BOT	Build-Own-Operate Transfer
CCS	Carbon Capture Storage
CDM	Clean Development Mechanism
EPA	Economic Partnership Agreement
ESCO	Energy Saving Company
FDI	Foreign Direct Investment
FIT	Feed-in-Tariff
FNCA	Forum for Nuclear Cooperation in Asia
FTA	Free Trade Agreement
HVAC	High voltage of alternative current
HVDC	High voltage of direct current
IAEA	International Atomic Energy Agency
IPP	Independent Power Producer
LEV	Low Emission Vehicle
M & A	Merge and Acquisition
MTOE	Million Tonnes oil equivalent
NEA	North East Asia
NPS	Nuclear Power Station
TPP	Trans-Pacific Partnership

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