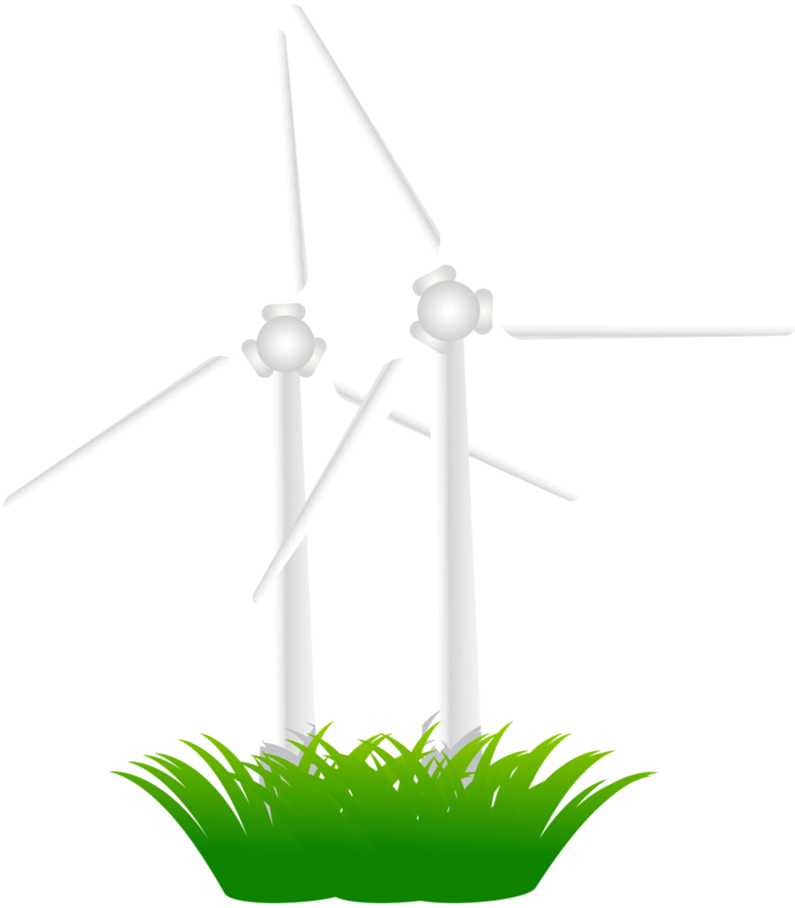
“European Energy Policy and Energy Efficiency”



Edited by
Akira ICHIKAWA
Associate Professor, Institute for Industrial Research
Kwansei Gakuin University

October 2, 2014
University Library Hall, Nishinomiya Uegahara Campus, KGU

Organizer: Institute for Industrial Research (IIR) of KGU

Co-organizer: Konrad-Adenauer-Stiftung, School of Economics,
School of International Studies (SIS)

Cooperation: EU Institute in Japan, Kansai (EUIJ-Kansai)

"European Energy Policy and Energy Efficiency"

Date: 2nd October 2014 (Thursday)
Venue: Library Hall, Nishinomiya Uegahara Campus (NUC) of Kwansei Gakuin University (KGU)
Language: English
Organizer: Institute for Industrial Research (IIR) of KGU
Co-organizer: Konrad-Adenauer-Stiftung, School of Economics, School of International Studies (SIS)
Cooperation: EU Institute in Japan, Kansai *(EUIJ-Kansai)*

"European Energy Policy and Energy Efficiency"
April 2015
Edited by Akira ICHIKAWA

Publisher
Institute for Industrial Research, Kwansei Gakuin University
1-155 Uegahara Ichibancho, Nishinomiya, Hyogo 662-8501 Japan
Tel +81-(0)798-54-6127
Fax +81-(0)798-54-6029
E-mail: euij-kansai@kwansei.ac.jp

"European Energy Policy and Energy Efficiency"

--≪Program≫--

Moderator ： Akira ICHIKAWA

(Associate Professor, IIR / Deputy Director, IIR / Advisor, EUIJ-Kansai)

15:10-15:15 Opening Remarks

Kikuo TAKABAYASHI (Professor, School of Economics / Director of IIR)

15:15-15:45

"Japan's Energy Efficiency－a European Viewpoint and Opportunities for Cooperation"

Gerhard FASOL (CEO, Eurotechnology Japan KK)

15:45-16:15 "Renewable Energy Development in Europe: the Case of Scandinavia"

Paul MIDFORD (Professor, Norwegian University of Science and Technology)

16:15-16:35 Q&A Session

16:35-16:40 Closing Remarks

Paul LINNARZ (Resident Representative for Japan, Konrad-Adenauer-Stiftung)

Dr. Gerhard Fasol
(CEO, Eurotechnology Japan)

Thank you all for coming and thank you very much for inviting us here to give us the opportunity to visit the "Stanford of Japan". I am extremely impressed by the deep discussion we had with your distinguished Faculty and Leadership over lunch, and by the beauty of your campus, and it is the first time I visited here, so thank you so very much.

My name is Gerhard Fasol. I am born in Vienna in Austria and I have lived 22 years in Japan now. At the moment I have two positions. I founded a company called Eurotechnology Japan KK about 17 years ago. With our company we perform a variety of technology business projects, for example we worked on NTT-Communications' strategy for Europe, or we helped a French pharmaceutical company acquire a Japanese pharmaceutical factory, or we worked on SIEMENS' entrance strategy into Japan's environmental technology markets. My second position is external, independent Board Director, *shagai torishimariyaku,* of the Japanese company GMO Cloud KK. It is an internet company with about 500 employees and GMO Cloud KK is traded on the Tokyo Stock Exchange. I have the function of a Board Director, so at the Board Meetings I have to discuss all major decisions of the company with the other Board Directors, and then we vote on each major management decision of the company such as financial plans, financial results, investments, or about entering major new business areas, and then I also help sections of the company to develop strategies and to grow faster.

Today I give a simple talk about three points:

1. Nature governs energy – and nature cannot be fooled
2. Where are we concerning our energy situation and why?
3. How do we go forward in the energy sector?

. I am physicist. I think most you are economists or lawyers, but energy is ultimately governed not by laws or economics, but by nature. For example, atoms and nuclei in a nuclear reactor are governed by nature. Atoms and nuclei do not listen to humans, so we need to understand nature in order to work with energy. Concerning the second point: the field of energy is extremely complex. I want to explain a little bit how we got to the situation we have today in Japan. Thirdly, I want to talk about options for future developments of the energy sector and how we can cooperate more between Japan and Europe.

As a physicist, I have three heroes:

1. Richard Feynman
2. Pierre-Gilles de Gennes, and

3. Ludwig Boltzmann

Richard Feynman, won the Nobel Prize for his work in Physics, but he is maybe most famous for his work as member of the Presidential Commission on the Space Shuttle Challenger Accident. Richard Feynman not only found the immediate technical cause for the explosion of Space Shuttle Challenger, but he also determined the deeper sociological causes, which lay in the disconnect between the engineers working directly on the technical construction and higher management. He summarizes his most important findings as follows “For a successful technology, reality must take precedence over public relations, for nature cannot be fooled”. Even if humans think they can fool nature, nature will not permit that. Nature governs electricity or energy or volcanoes. You need physics in order to understand energy.

For about 10 years I studied and worked at the University of Cambridge. First I was Ph.D. student and before I finished my PhD, I was awarded a faculty position, I became Fellow of Trinity College, which is one of about 30 Colleges, which are part of Cambridge University. Trinity College is an amazing institution, with about 30 Nobel Prize winners. As a Fellow of Trinity College, for about one year, I lived in a room next to the room of Sir Isaac Newton who created much of the fundamental understanding of nature. When we work with energy we need the laws that Newton created. Another physicist who created many of the basic laws of energy is actually my great grandfather. His name is Ludwig Boltzmann. At the Zentralfriedhof, the Central Cemetery in Vienna, you can find Ludwig Boltzmann’s honorary grave with a large grave stone. On this gravestone you see Ludwig Boltzmann’s name, and listed on the right hand side are the names of my grandfather and my grandmother. Towards the top of the gravestone, you can see the equation “S =k log W”, “S” stands for Entropy, and ‘W’ stands for “Wahrscheinlichkeit”, which is the German word for “probability”. I do not have time in this short lecture to explain all details of this very important equation, but I want to tell you that this equation is very, very fundamentally important for understanding energy, chemical processes, and for understanding information flow of the internet, and for information technology. This equation governs the probability of the state of matter.

In Ludwig Boltzmann’s honor I organize a conference once a year at the Austrian Embassy in Tokyo, the “Ludwig Boltzmann Forum”[1]. At the 6th Ludwig Boltzmann Forum 2014[2] the speakers included the President of Tokyo Institute of Technology, *Tokyo Kogyo Daigaku*, Professor Yoshinao Mishima[3], and the previous president of Tokyo Kogyo Daigaku, Professor Kenichi Iga[4], and Professor

1 http://www.boltzmann.com/forum/
2 http://www.boltzmann.com/forum/2014-2/
3 http://www.boltzmann.com/2014/03/educational-reforms-tokyo-institute-of-technology-president-yos

Kiyoshi Kurokawa[5], who was the Chairman of Fukushima Nuclear Accident Independent Investigation Commission by National Diet of Japan. I will talk a little bit about the results of this Commissions' investigation into the causes of the Fukushima nuclear disaster.

To illustrate that we need the laws of physics to understand energy I will mention the following. After the Fukushima nuclear disaster, quite a few Japanese people, including Medical Doctors working in the Hospital of Tokyo University, asked me what the radioactive materials raining down over Tokyo meant for their own health, and for the health of their patients, whether there would be any problems if they have children in the future, or they asked me, "Why is it not possible to turn radioactivity or radioactive materials into nonradioactive materials?". We need physics to answer such questions, laws or economics will not help us to find the answers to such questions. Nature governs what nuclei, and isotopes do at the reactors of Chernobyl or Fukushima. People cannot influence what nuclei and atoms do in Chernobyl or Fukushima-Dai-Ichi. Why is it not possible to turn radioactive materials into nonradioactive materials? That question in terms of physics is the same question as asking why we cannot turn lead into gold. Maybe you know that maybe 200 years ago scientists (chemists, alchemists) worked hard at trying to turn lead into gold, and today we understand that this is not possible (except maybe in very minute quantities with enormous effort). As we cannot turn lead into gold, we also cannot turn radio-active isotopes into non-radioactive isotopes. Radio-active isotopes are unstable, and they decay with a certain probability which leads to a "half-life". Each radio-active isotope has a certain half-life, and after let's say 10 times this half-life, almost all of the original radio-active isotope will have decayed into other isotopes, which maybe non-radioactive. Humans cannot influence this decay, except in very small quantities and with very complex laboratory machines.

(A) : Alchemists.

(Fasol) : Alchemists, were like precursors of today's chemists, they tried to turn lead into gold, because lead is cheap and gold is expensive, so they tried to earn money by turning lead into gold. It took science a long time to understand that this is not possible. If you want to know I can briefly explain it.

I am showing you here a graphic of all known atoms. The atoms are listed here by the number of neutrons and by the number of protons in their nuclei. As you know, a nucleus contains protons and neutrons and the name of the atom, for example gold or lead or hydrogen or magnesium, is determined by the number of protons. On the horizontal lines you have different variations of each atom, which differ by the number of neutrons. The atoms shown in blue here they are stable. They live forever and do not emit radiation. All atoms to the right or the left hand side of this blue row in the middle are

---

hinao-mishima/

4 http://www.boltzmann.com/2014/03/vcsel_kenichi_iga/

5 http://www.boltzmann.com/2014/03/kiyoshi-kurokawa-groupthink-can-kill/

unstable, are radioactive and decay with a certain probability and emit radiation when they decay. How and when and why they emit radiation, and which type of radiation they emit, is determined by the laws of Physics (the laws of nature), which we work so hard in Physics to understand. Sometimes we have to change this understanding when we find now results in our experiments. That is what physicist do, but physicists cannot persuade atoms to do something they do not want to do, except in very special cases. By irradiating nuclei with neutrons for example, you can with a certain probability, change some of nuclei into different nuclei, but it is impossible to do this on a magnitude as large as the Fukushima nuclear power plant.

Nature governs energy. Richard Feynman found that the cause for the space shuttle disaster was a badly designed O-ring. It would have been easy for Richard Feyman to stop his investigation there, and blame the engineer who chose this particular O-ring inappropriately. But Richard Feynman did not stop his investigation at this point, but he went much deeper with his investigation. He found that the fundamental reason for the Space Shuttle Disaster was not the O-ring, but bad communication between top management and the engineers working on the Space Shuttle design and construction and planning. The top management did not listen to "*genba*", to the engineers working on the ground. Some of the engineers knew about this problem, but the top management would not listen to them. He summarized these findings by saying, "for a successful technology reality must take precedence over public relations, for nature cannot be fooled".

The problem in the Space Shuttle case was that top management was mainly interested in what the press thinks or what the president thinks. They were interested mainly in the outside reaction or the public image of the space shuttle. They did not care about the technical problems enough, but in the end the success or the failure of the mission was determined by the technical situation, in Japanese we would say *genba*. The top management did not listen to *genba* that was the problem there.

When the Energy Minister of Canada, Mr Joe Oliver, visited Japan, the Canadian Embassy asked me to suggest Japanese experts on Japan's energy situation who the Minister could meet for discussion, so I was also invited to discuss Japan's energy situation with the Energy Minister of Canada. After the meeting I had the opportunity to discuss with Mr Nobuo Tanaka, today Advisor at the Institute of Energy Economics of Japan. From him I learnt that, after the September 11, 2001 terror attacks, the US Government decided to spend the necessary money to secure all of the US nuclear power stations against electricity cut-off. In addition, the US Government also asked all friendly governments, France, England, Canada, Germany and Japan to also harden or protect their nuclear power station against a failure of the electricity supply. Every friendly county invested in these safety measures, except Japan. Japan did not do this. I asked Mr. Nobuo Tanaka, how Japan explained, that Japan did not invest in this increased protection of Japanese nuclear power stations against electricity failure? Mr. Tanaka told me, that Japan's Government answer was that there is no terrorism in Japan. However, as you know, unfortunately home-grown Japanese terrorism does exist. We unfortunately all remember the terrible sarin poison attacks by Aum Shinrikyo, which injured and killed many people.

Kiyoshi Kurokawa, Chairman of the Parliamentary Commission for investigation of the Fukushima disaster arranged that the examinations and interviews of the Commission were videotaped and these videotapes, as well as the approximately 600-page report can be downloaded from the internet[6]. The main conclusion of Professor Kurokawa's Commission is that the underlying real cause, similar to the space shuttle disaster, were not technical issues, earthquakes or tsunami. The fundamental cause was human failure, according to the Commission of the Japanese Parliament, headed by Professor Kurokawa., it was an effect called 'regulatory capture'.

"Regulatory capture" may happen in regulated industries, for example the banking industry or the telephone industry, or the electricity industry, or the nuclear industry. In the unfortunate case of "regulatory capture" the industry captures or controls the regulator instead of the other way around. Normally the regulator must control the industry under its control. However, for the industry the regulation costs money, and the industry often would prefer that the regulators do what the industry wants and not the other way around.

Kurokawa-sensei's Parliamentary Commission found that Regulatory Capture was to blame for the Fukushima disaster. Regulatory Capture is not a Japanese phenomenon. Many cases of regulatory capture are known in many countries. For example, in England the Office of Telecommunications (OFTEL) was often criticized as being "captured" by BT, and OFTEL was dissolved in 2003, and OFTEL's regulatory tasks were transferred to OFCOM on December 28, 2003.

George Stigler, a key leader of the Chicago School of Economics, won the Sveriges Riksbank Prize in Economic Science in Memory of Alfred Nobel 1982 (the Nobel Prize in Economics) "for his seminal studies of industrial structures, functioning of markets and causes and effects of public regulation"[7]. One of George Stigler's main results is that industries have a tendency to capture their regulators. Regulatory Capture is clearly not a phenomenon particular to Japan, but Regulatory Capture has a tendency to occur in Japan as in all other countries.

Another Economics Nobel Prize winner's work is relevant to our discussion of energy and

---

6 http://www.shugiintv.go.jp/jp/index.php?ex=VL&deli_id=41488&media_type=
7 http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1982/stigler-facts.html

electricity markets, and to the factors which lead to the Fukushima-Dai-Ichi nuclear disaster, this is Daniel Kahneman. Daniel Kahneman won the 2002 Nobel Prize in Economics "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty". Someone tried to put a humorous twist on Daniel Kahneman's work, saying that Daniel Kahneman studied, why clever people make stupid decisions.

Another contributing factor is that politicians who want to push through some agenda, may repeat and repeat and repeat the same arguments, which might be flawed. Of course, by repeating a flawed argument many times, this flawed argument does not become true. In English, we call a statement that is many times repeated a "mantra". According to the Merriam-Webster Dictionary a mantra is "a mystical formula of invocation or incantation"[8]. Repetition of the same phrase can induce a trancelike state, making us forget this mantra might be flawed or even wrong in the scientific sense. For example, if we repeat many times that a particular technology is absolutely safe, then by repeating this statement many times, this statement will not become true. Instead of saying, we want to guarantee the safety of this technology I think we need a totally different approach. What we need to understand is what are the risks and how do we control the risks.

I think rather than repeating many times that nuclear power is absolutely safe, instead we need to understand the risks, and then the population needs to decide via the democratic processes, which level of risk is acceptable. We can cooperate between Japan and Europe and other countries to understand these risks, and to develop methods and technologies to reduce these risks, and improve our methods to deal with accidents, but I don't think we can ever eliminate these risks – even if we repeat many times that these risks don't exist.

We also need to make preparations for the case when accidents happen. Unfortunately we had a number of very tragic railway accidents in Europe, for example the German ICE accident of Enschede on June 3rd, 1998[9], or the Alvia high-speed train accident of Santiage de Compostela of July 24, 2013[10]. Accidents happen in many advanced countries. These disasters of technology are usually fundamentally due to human error on many levels of the hierarchy.

Now let us look at the energy situation in Japan today. First I will show you the flow of energy in Japan. On the left hand side we see the energy input, the primary energy. In the middle of the figure you see electricity or storage, the intermediate energy, in the future also hydrogen. On the right hand side you can see consumption. Now what has happened in Japan now is that the nuclear power was

---

8 http://www.merriam-webster.com/dictionary/mantra
9 http://de.wikipedia.org/wiki/ICE-Unfall_von_Eschede
10 http://en.wikipedia.org/wiki/Santiago_de_Compostela_rail_disaster

switched off very quickly and, essentially, the nuclear power is replaced by natural gas and coal, which increased the costs of fuel imports. So what can we do in the future in this situation? One possibility is to increase the primary energy input here on the left hand side of the figure, which is what has happened to a larger extent in Japan, so instead of nuclear power there is much more import of natural gas.

Then here on the right hand side, you see the consumption of energy. Not all primary energy is converted into electricity, some of the oil and some of the coal is used as raw material in the chemical industry and some of the oil or gas is used for freight transport or passenger transport. Only part of the primary energy is converted into electricity. Part of the electricity is used for transport and manufacturing and some is used by private business and private homes.

We do have several choices for the future:

1. we can increase the input of primary energy, e.g. import more oil or more gas or coal
2. we can increase the energy conversion efficiency, ie use our limited primary energy more efficiently, e.g. by introducing electricity co-generation which means producing electricity and heating in the same power station synchronously.
3. we can develop new sources of primary energy, e.g. renewable energy such as wind power, solar power, geo-thermal power
4. or, finally we can reduce consumption by using energy more efficiently, e.g. replacing incandescent lamps with LEDs, or improving the insulation of buildings to reduce or even eliminate the use of energy for heating or cooling.

When you convert primary energy into electricity, you always lose some energy. In some cases you can lose half of the energy. What you need to do is to make this more efficient and then reduce the consumption. Overall we have to improve the energy efficiency.

After the Fukushima-Dai-Ichi disaster, Japan suddenly had great pressure to introduce all these changes very fast. Europe on the other hand has had the luxury to introduce these changes with somewhat less external pressure. The European Union has created a law, the “Energy Efficiency Directive”, which orders all EU countries to make the whole energy system more efficient. It sets mandatory targets to reduce primary energy usage and it demands an increase of efficiency. In the electricity generation, for example, one way to increase the efficiency is electricity cogeneration: you create heat and electricity in the same plant instead having separate electrical power stations wasting heat, and producing heating independently in electrical, or oil or gas fueled heat generation systems. Cogeneration can increase energy efficiency quite dramatically.

On the right hand side, the consumption side of the energy flow diagram, both in Japan and also in Europe, there are many efforts under way to reduce the consumption. In housing, for example, this can be done by improving the insulation of the houses, there is much work on energy neutral or even energy positive houses, ie houses which instead of consuming electricity or gas, deliver electricity into the grid averaged over time.

Traditional statistics showing the energy-balance of countries, often overlook the potential of renewable energy to turn countries poor in oil, gas, or hydro-power into energy right countries. Renewable energy does not fit so well into the traditional picture of energy self-sufficiency, if it only includes hydro-carbons and nuclear power. In the traditional picture of energy self-sufficiency, countries show great variation. Russia, Canada or Norway produces far more energy than they need for consumption. Norway can satisfy almost all energy needs with hydropower. Canada produces about twice as much energy as needed, and therefore can export much energy. Russia also produces almost twice as much energy as they need so Russia can export energy, mostly in the form of natural gas to European countries, but on the other hand of the scale here you have Italy and Japan and South Korea and also Germany which have to import much of their primary energy, or electricity. Europe overall has about 50 countries, and every country has a different situation regarding energy. Some countries like Denmark and Norway are energy rich, and other countries like Italy or Germany or the UK are energy poor. Every country is different.

Now, Japan replaced the nuclear energy by liquid natural gas (LNG) and this liquid natural gas is almost all imported, but Japan pays about 10 times as much for natural gas as the prices inside the US, and Japan pays about twice as much as Europe pays for natural gas. When I heard this the first time, I was very surprised, so I spend quite a lot of energy trying to find out why this is. I found out it is not just one single reason, but several. In Europe also in US and Canada, natural gas is transported in pipelines and does not have to be liquefied. Natural gas imported to Japan is all liquefied so that adds to the cost. You have political reasons for energy pricing. Negotiation of energy prices is another factor. I have attended conferences which were about negotiating natural gas prices.

For these reasons, Japan now undertakes efforts to improve the energy pricing. For example, the Japanese Government started a national gas exchange, and Japanese energy companies combine their fuel purchasing to increase their pricing power during purchasing negotiations..

Japan has quite a lot of geothermal generation capacity. In this figure you can see how geothermal generation capacity was developed over the years in Japan, but development of geo-thermal power stopped in 1995. The development of geo-thermal power stopped in 1995 because of Japan's national policy to focus on nuclear energy.

You can see here that development of geothermal energy stopped in Japan around 1995. Pump power or hydropower development also stopped around 2000. This figure shows different scenarios for wind power development in Japan by the Ministry of Trade and Industry, also by wind power association, and other organizations. I would not go into the details, but these scenarios show that in principle Japan could cover all electricity needs with wind power – at least theoretically. Now, I am not saying that this is something I want or that should be done, but in theory at least it is possible to cover all Japan's electricity needs with off-shore wind power. It will take time and it could take big investments and developments in technology, but at least theoretically it is possible.

In April, the Government of Japan introduced a new government policy as required by the energy law of Japan. According to the Energy Basic Law, Japan's Government has a duty to prepare an energy strategy in five years intervals. The first sentence or the second sentence of this new energy policy of Japan is says Japan is poor in energy resources. I believe that this statement, that Japan is poor in energy resources is not absolutely true, because in principle at least Japan at least in theory could generate all electricity from wind. Another factor also is that Norway, which a far smaller population than Japan spends more money on oil and gas exploration than Japan does. Why is this?

I learned that 15 years ago Norway was also poor in gas and oil resources. Norway felt that Norway had no gas and oil. Today Norway is very rich in oil and gas sources, and exports oil and gas.

I learnt from Mr Masamoto Yashiro at a brainstorming event organized by the President of Tokyo University[11], that Japan has very little up-stream oil industry, which was surprising for me. Mr Masamoto Yashiro was Chairman of Exxon Japan, Chairman of Citibank-Japan, and Chairman of Shinsei Bank.

Finally, let us have a look at the potential for cooperation between Japan and Europe. Many people say Japan's electricity prices are very high. I compared electricity prices between Japan and Europe. My own electricity bill in Japan is 23 Euro-cents per kilowatt hour converting Yen to Euro at the current rate. This figure shows the electricity prices in Euro for consumers. You can see that Japanese electricity prices are about the same level as in France and in England and German electricity prices are about twice as high in Japan. In Ireland, electricity prices are about three times higher than in Japan. Every European country has a different energy situation and electricity prices can are very, very different between different European countries, and Japanese electricity price are in the middle range of

[11] http://www.fasol.com/2013/10/19/masamoto-yashiro/

European electricity prices. Two days ago we organized a conference in Tokyo about Energy efficiency, where I gave a similar talk as to you today, and we heard a talk by one of the officials from Ministry of Industry (METI) who is responsible for electricity market deregulation, and he said the electricity price in Japan is very high. Actually, you can see from this figure, that Japan's electricity prices are not that high – electricity prices in Germany are twice as high as in Japan! So studying the situation in Europe can help to put Japan's situation into context.

The European Union issues laws, which member countries of the European Union have to follow. In this image you can see the European Union Energy Directive, this is a law passed by the European parliament, which is in Strasbourg by the way, not in Brussels, where most EU offices are located. The EU Energy Efficiency Directive forces all member countries of the European Union to use energy more efficiently, and gives very detailed instructions on how energy efficiency must be achieved, and how the progress must be reported. In joining the European Union, member countries have agreed to follow such Directives, but of course the member countries also take part in creating such Directives.

I will now come to the conclusions of this talk I have mentioned opportunities for corporation between Europe and Japan. There are obviously many opportunities in the field of technology. Both Europe and also Japan own and develop many types of technology to use electricity and energy more efficiently in our society. Technology knows no nationality, almost any technology developed in Europe and also be used beneficially in Japan and vice versa. By joining our efforts and cooperating we can created more value and more benefits. For example, several Japanese companies produce very excellent filters and Japanese filters are used in Europe. There are many other types of technology which can be brought from Europe to Japan and vice versa. In addition, there are also many types of know-how on the political level, or on the systems level where Europe and Japan can learn much from each other. As an example, many European countries are so cold in winter that it is impossible to survive the winter without excellent insulation of houses and buildings. Therefore, Scandinavian countries, and also Austria, Germany and Switzerland over hundreds of years have development many different technologies to insulate and heat houses. Europe has also moved earlier and a bit faster from monopoly to liberalized, or partly liberalized markets in electricity, and other energy fields. Therefore Japanese companies and the Japanese Government are now studying the European experiences with deregulation of electricity, gas and energy markets. On the other hand, Japan has had great success in privatizing the National Railways, and Japan has a vibrant market of private railways. I think Europe can learn much know-how from Japan on how to run railways more efficiently in the private sector and with profit.

Europe has a Europe-wide electricity grid, and underwater long-distance electricity cables. There are now thoughts about electricity cables between North Africa and Europe to bring solar power from Africa to Europe. Japan could gain experience and know-how from Europe about electricity grid technology and management, and international cooperations regarding electricity grids.

Thank you again very much for inviting me to your wonderful University, and I hope that I will again have the opportunity to visit and meet you all! Thank you very much.

Paul Midford
(Professor, Norwegian University of Science and Technology)

Today's presentation is going to be based in a small part on this book that was just published by the NTNU Japan program, *The Political Economy of Renewable Energy and Energy Security*. It compares Japan, Northern Europe, so *hokuo*, or Scandinavia, and also China. There are a couple of flyers out on the reception table, so I hope you take a look at that.

Today I am going to talk about and give some ideas about how some of the Nordic region's experiences, particularly Norway, where I have been living for the last nine years, about Norway renewable energy, energy security, and what lessons and implications there might possibly be for Japan.

One thing that is worth noting of course is that ever since the Fukushima nuclear accident there has been a big change in Japanese public opinion such that the public in Japan now strongly favors the gradual elimination of nuclear power. We have a very strong stable majority in favor of the gradual phase-out of nuclear power in Japan. This is a stable long-term opinion since the earthquake and the Fukushima accident. We should not expect it to change easily. There is some tolerance, I think, in Japan for gradually – for some short-term restarts of nuclear power, but some tolerance by the public for some short-term restarts should not be confused with support for continuing nuclear power in a long run. The question is how can Scandinavia offer, and perhaps the rest of the world and Europe, offer some ideas about how Japan make this transition; the transition that former Prime Minister Naoto Kan declared in July 2011 that Japan should move toward being the society that does not need to rely on nuclear power? This is, interestingly, a position that even the LDP in its election manifesto in 2012 more or less repeated as well. I will talk more about that later.

I am going to look at these areas of renewable energy. First of all, talking about renewables globally, we see very strong growth. Renewables will increase from 18% to 44% of energy production by 2030 globally. The substitution of renewable energy, particularly now we are talking about wind and solar, and maybe a little bit of geothermal as well, also biomass will produce cost savings of between

$60 to $70 (00:47:53) per megawatt hour of generated electricity. This reflects the fact that solar and wind prices are falling rapidly, particularly solar. It also reflects the fact that there are not a lot of cost externalities, as economists say, to electricity produced by fossile fuels. Renewables do not produce CO_2 emissions that contribute to the global warming, and they do not produce other types of pollutions that lead to health consequences and increase costs for national health care systems.

Now Europe's renewable energy goals are quite ambitious. I just listed some for a couple of countries; Germany, in particular, has seen total energy consumption not just electricity, produced from renewables increase from just under 6% in 2009 up to 18% by 2020. Regarding electricity, in particular, the goals are ambitious: 25% of electricity now is produced from renewables. That should be 35% by 2020 and 80% by 2050, a very ambitious goal. A lot of this is coming in the form of wind and solar energy. The price of solar energy has already fallen down to 8 to 11 euro cents per kilowatt hour in Southern Germany, so renewables are making progress in terms of price reductions as well. The United Kingdom, Britain also has some ambitious goals. They are focusing on offshore wind power. Britain now has most of the world's offshore wind power. France has some goals too.

In Japan, by comparison, renewables remain a modest share of final energy consumption. Most of that comes from large scale hydro plants that were built in the 1950s, 60s, and into the 70s. Regarding other renewables we have some electricity generated by biomass and waste, and some from wind. As you can see, on the other hand, since the introduction of a new feed in tariff from 2012, we have witnessed a massive increase in PV solar or photovoltaic solar capacity seven gigawatts. In fact, this growth has become so rapid now that, if you read the newspaper – how many of you, particularly students, read the newspapers?

Good, I am glad to see that. Supposedly, young Japanese do not read newspapers anymore, but if you do, you know from reading the newspaper yesterday and over the weekend, in Asahi and Nikkei, that some power companies (*denryoku gaisha*) like Kyushu, Shikoku have just suspended applications for new photovoltaic solar electricity plants. The reason is because they claimed that there are so many, so massive in scale now that they cannot handle them in terms of absorbing this new capacity into the grid and balancing the energy supply, which is what I am going to talk about in a minute. There is a lot of growth in Japan, but in order to absorb all this solar energy and wind energy you need to able to balance demand and supply of smart grids, smart grid development, and also through storage of electricity.

In Scandinavia, Denmark is in lead with its wind power. Denmark produces more electricity, as a share of total generation, from wind power than any other country. It also produces a lot from biomass, and when you include biomass and wind power together, you can see nearly 40% of electricity production now comes from renewables. Denmark's wind industry has been so big it spawned the development of a large multinational corporation, Vestas, which is a leader in producing wind turbines. This is from a relatively small country of only about four million people. We also see some strong growth in PV solar there. Sweden also has some ambitious energy goals.

For Norway, about 60% of final energy consumption comes from renewables and there is the goal to increase that to two-thirds by 2020. That is a modest increase, but that is because Norway produces so much from renewables already. In Norway's case over 98% of the electricity generated comes from hydropower, large-scale hydropower, not small-scale hydro but large-scale. Now, of course, that is somewhat weather dependent. If you have a dry year, it might be somewhat less. In fact, Norway exports a lot of electricity to its neighbors as we will see. This is key to this concept of Norway as green battery for Europe and that it can possibly backup variable renewable energy sources such as wind and solar in other parts of Europe, which we will turn to in a moment.

There is also big room for growth in wind power in Norway because Norway uses so much hydroelectricity, its electricity prices are very cheap, 23 øre per kilowatt hour is what I pay, which is, I do not know, ¥4 per kilowatt hour. That does not include transportation costs. However, a typical wind turbine in Norway produces 1.5 times as much electricity as one does in Germany because of higher wind velocities, which means there is great potential to develop this resource

Now, wind power is spreading very rapidly in Europe, as you can see here, but also one area in particular, and that would be the red area here which is offshore wind power. Here you can see England is building massive offshore wind farms in the sea right now. Denmark and Norway are getting into that as well.

This is one contribution I want to bring up in particular, which is Norway's development of the first fully floating operational wind turbine. This is called 'Hywind' (pronounced 'high wind') and Norway's multi-national oil company, Statoil, developed this. It is derived from offshore oil rig technology. Why does this relate to oil apart from this technology? First, because Statoil wants to use it actually to pump up oil and gas in an environmentally friendly way using wind power instead of burning oil and gas to pump it up from below the seabed. That is one reason.

Also, offshore wind turbines, it is important to know, are 50% more efficient and produce more power than do onshore turbines because the wind is steadier out on the ocean. It does not vary as much and it tends to be stronger. It is a good place to build wind turbines. They are far-removed from populated areas and they are easier to build. Wind turbines today have become massive. A single blade could be a couple of a hundred meters long. Imagine carrying that on a truck. On the other hand floating wind turbines are relatively easy to build in a port, the same way you build a ship. You tow them out. You deploy them, and if they need repair, you can even tow them back to port.

There is a huge potential, as you can see here [pointing to slide 9]. The red dot is the Ormen Lange gas field that can produce 125 terawatt hour equivalent of electricity per year. The same amount can be produced from a wind farm using 2009 Hywind technology in the square area which is 70 kilometers by 70 kilometers that amount forever, so there is a huge potential.

The implications for Japan: Japan has one of the largest deep offshore wind fields laying off the East coast of Japan here [pointing to slide 10]. Japan has a huge resource in this area. I will not spend too much time, but based on Hywind's 2009 technology, a 700 kilometer by 700 kilometer wind farm off the coast would produce more electricity than Japan needs. Japan currently uses about 1000 terawatt hours, this would produce 25% more just from building this wind farm. That would be, of course, a massive project, but the point is that it is definitely possible with today's technology.

Next, I want to talk about Nord Pool. This is a regional electricity market. In the early 1990s the Nordic Region deregulated the power sector. We started to see the separation of generation and the transmission of power into different units to create a regional electricity market allowing trading of electricity among the countries of the region. The idea is that this will enhance supply security. It facilitates expanded use of renewable energy and it allows us to balance the variable wind and solar power by integrating these sources over a wider geographical area. The wind might be high in Finland, but it might be low in Norway. The sun might be shining in Denmark (well that sounds unlikely) but it might not be shining in Sweden. Therefore, you can use renewables from these various places and balance them off against each other to reduce supply fluctuations Also you just have more energy supplies to call on to adjust supply if you have sudden spike in wind power or a sudden reduction.

This is just something I copied off the web. This from Statnett, the Norwegian grid company, and it shows the flow of electricity. On this day two weeks ago you had Norway sending electricity to Netherlands and to Denmark. Sweden was sending electricity to Central Norway where I live. Norway was sending some electricity to Russia and to Finland. Russia was sending electricity to Finland and Estonia was exporting to Russia and Lithuania. Electricity can be sold and transported throughout the entire region, although it depends on the capacity of the pipes or the wires connecting them.

Now, of course, storage is really the key for promoting renewables. Pumped hydro storage,

storage has been the leading way. Japan has the largest pumped hydro storage capacity in the world, but it needs more storage capacity than it currently has on pumped hydro to absorb fully all of these new renewables. There are a couple of ways. One is flywheel kinetic storage where you have a spinning top in a vacuum tube and you connect it to generator when you need to produce electricity. That technology is now operated commercially in the US. We have hydrogen storage where you use electricity to break down water into hydrogen and oxygen and then you can recombine them later to make energy again in a fuel cell. There has to be more work done to improve the efficiency of hydrogen as a means for storing energy, but this is another way to store electricity.

Norway can be Europe's green battery and in that way it can contribute also to expanding the use of renewables in the short run. It can do this using conventional hydro for electricity storage, so not pumped hydro, but conventional hydro. The idea is that when the wind blows in Germany or when the sun shines in the United Kingdom, Norway can just turn off some hydro plants and not run water through them, and use wind and solar power instead, but then when the sun sets and the wind dies down, Norway can turn on these hydro plants and make up for the power that has been lost due to the reduction of wind and solar. That is the basic idea. Now, one drawback is, in some years there is less hydro power available than others, but this can be one way in which we can expand the use of renewables by having Norwegian hydro as a backup.

One problem, however, is that there is the need to increase the grid interconnections between Norway and other countries. Currently there are plans to build like 6.7 gigawatts of new connections between these countries. Already you have a lot of connections that I have already showed, Sweden, notably has a lot. Finland and Russia have some on-land interconnections. Then with Denmark you have three underwater cables and a new cable is being built right now, which will give a total of approximately 1.7 gigawatts when this new line is finished.

Now the Netherland, this is really important to note here. You have the NorNed cable built and opened in 2008 between Norway and the Netherlands. It is 580 kilometers long. This is very long and it cost €600 million. Nonetheless it has been a great commercial success. The Norwegian electricity companies and Dutch electricity companies make a lot of money by shipping power back and forth on this line, so this has been very economical. When it was opened this was the world's longest undersea power cable. As I will discuss in a moment, one of the implications of this cable is that Japan can do the same thing with a far shorter, less ambitious cable.

Then we have this new one NordLink cable under construction now; 500 kilometers in length and 1.4 gigawatts capacity. It is going to be finished in 2018, about €1.5 to €2 billion in cost, and, again, this will help Germany to promote renewable energy because it can rely on Norwegian hydro as a backup and vice versa. Also, Norway can buy electricity from Germany when it is cheap to do so and vice versa.

Again the same concept can be seen with this new undersea electric cable proposed to be built between Norway and the UK, but notice that this one would be 711 kilometers long, the world's longest by far, 1.4 gigawatts, and it should be completed by 2020. Therefore, these are quite long ambitious, even somewhat expensive lines, but they should nonetheless pay for themselves quickly and they very much help to create a larger grid that allows renewables to really take off.

Relevance for Japan: Japan currently does not have any electric lines or tie lines connecting it with its neighbors. Japan lives in electricity isolation from its neighbors, and changing that would be arguably worthwhile. It would enhance energy security, perhaps reduce prices, by diversifying supply, and then would allow Japan and its neighbors to expand and rely on some wind and solar power. South Korea has already proposed doing just this, stringing an underwater cable across the Tsushima/Korea straits, but Japan has not yet responded positively to that.

We can also imagine electricity connections with the Russia, which has a lot of hydropower, and possibly even China. An electrical cable linking China and Japan would be a bit further away, but it would be a shorter line than the line that will link Norway with Britain. Again, however, currently there are no electricity connections linking Japan and its neighbors.

It is important to emphasize that there are no technical or economic barriers to laying power cables. If you lay the Tsushima/Korean straits cable it will only be 200 kilometers long, versus the current 570 kilometers for the undersea cable linking Netherlands and Norway. It is very technically possible and economically feasible. The main reasons why I think we have not seen movement on this so far: Japan's *denryoku gaisha*, the EPCOs have not really had much interest in building these tie lines. They have frankly been more focused on promoting nuclear power.

For the same reason we also have a relative lack of national grid development in Japan. Japan does not have a national grid yet, and then we have the related problem with two different power frequencies in Western and Eastern Japan, which I think you probably all know about.

Another way to promote renewable energy is by the development of smart grids. These are grids have two-way communications, so the electricity companies sends power related messages to consumers and consumer send information back to the power company. It allows the management of supply and demand. For consumers, this means the power company installs smart meters in your house to send information about your electricity usage back to the power company, and maybe have smart appliances that, when electricity demand goes up on hot sunny afternoon, your appliances turn off automatically, like maybe your dishwasher, and then they turn back on later in the day when power is cheaper and less in demand. In that way you can avoid building new electricity capacity that you only need on hot summer days, say in August. Smart grids are also increasingly important for managing variable power supply such as, again, wind and solar.

Now another issue about grid development is that they have to be relatively sustainable. Grids are social infrastructure. To develop them you need the participation and support of citizens, communities, and customers. In some places in the United States customers have said no to smart grids because they think they it is not to their interest and that they are giving away too much information. They do not understand the value and feel they are not getting anything from it. Also you have a lot of new grids being built, electric wires being built in places where local communities object. That is the traditional solution for expanding renewables, which is to build more transport cables, but if you have smart grid, you can make better use of the grid line capacity you already have.

I will skip over most of this [see relevant power point slides] except to say that this is a major area of research in Europe today. One other thing I would mention is that Norway was relatively late in unifying its national grid. It only started doing this in the 1960s when we had regional grids and started to integrate them. That only was completed in 1990, which means that Norway has some experience with doing this relatively late that might be relevant for Japan as it integrates regional grids together to a national grid.

Also, the new law on electricity market regulation/deregulation in Japan; liberalization calls for the creation of a single national regulatory authority that will be created next April to manage the grid, ensure stability, and give all producers equal access to the grid, grid neutrality. This new regulator is actually based on the Nordic model, so again there the Nordic region can offer something to study when promoting smart grids.

Japan has also been a leader in developing very simple so-called 'social grids.' I remember here two years ago, Kansai Denryoku was sending out advertisements asking people to register their cell phones. If your power usage got too high, you would get a message saying, "Turn off your appliances. We are running out of power capacity". That is a very innovative kind of social smart grid that we have not yet seen anywhere else in the world, and I think that Japan should get a lot of credit for coming up with this idea.

I would also just mention finally that Japan is a world leader in terms of technology related to smart grids as well. Therefore, there is also a commercial opportunity here as well for Japanese companies as smart grids spread throughout the developed and developing world.

Somehow I get the impression that I am probably out of time. Maybe, I should not spend too much talking about electric cars, except to note that in big cities, and currently in Norway they are becoming very common.

You just see them everywhere now because they come with huge incentives, which we can talk about more later. Also, you have charging stations that allow charging of an electric car in only thirty minutes, and they are put along major highways like that running between Trondheim and the Baltic coast of Sweden, so that allows long distance travel now conveniently even with electric cars.

The incentives are so big that even yours truly even decided to buy one. As you can see, the penetration of electric cars in Norway is now far beyond most of the rest of the world, the next closest being Denmark, but I am out of time. Thank you very much for listening and I look forward to your questions.

Profiles

Gerhard Fasol

Gerhard Fasol (http://fasol.com) is entrepreneur, physicist and Board Director in Tokyo. He is Founder and CEO of the company Eurotechnology Japan KK, and he is independent Member of the Board of Directors of the Japanese company GMO Cloud KK, a provider of Cloud and internet security services with about 500 employees and traded on the Tokyo Stock Exchange (TSE Code 3788). Fasol's company helps Japanese companies globalize and he build foreign technology business in Japan. He is curator of the Ludwig Boltzmann Forum as a leadership platform. Gerhard worked as Associate Professor of Tokyo University in Electrical Engineering, and was leader of Japan's Elite "Sakigake" research projects. He was manager of Hitachi's Cambridge Laboratory, tenured faculty member of Cambridge University, and Fellow of Trinity College, Cambridge. Gerhard graduated with a PhD in Physics from Cambridge University, and as Diplom-Physiker from Ruhr-University Bochum.

Paul Midford

Paul Midford is Professor, and Director of the Japan Program, at the Norwegian University for Science and Technology (NTNU) in Trondheim. Midford received his PhD. in Political Science from Columbia University in 2001. His research interests include Japanese foreign and defense policies, the impact of public opinion on policy, renewable energy and energy security, and East Asian security multilateralism. He has published in International Organization, Security Studies, Pacific Review, Asian Survey, Japan Forum, and International Relations of the Asia-Pacific. Midford is the author of Rethinking Japanese Public Opinion and Security: From Pacifism to Realism? (Stanford University Press, 2011).

Editor's Profiles

Akira Ichikawa

(Associate Professor, Institute for Industrial Research, Kwansei Gakuin University)

Keio University, Ph.D. (Media and Governance). Prior to accepting current position in 2012, he taught at Keio University, Nagoya University of Commerce and Digital Hollywood University as a part-time lecturer. He also worked at Keio Institute at SFC as a visiting senior researcher and Tokyo Institute of Technology as a research fellow. His field of specialty is the regional study in the enlarged EU and global environmental governance.

EU Institute in Japan, Kansai

Project funded by the European Union

Konrad Adenauer Stiftung

K.G.