Energy Efficiency - Opportunities for Japan and Europe

Dr. Gerhard Fasol, Eurotechnology Japan KK

TABLE OF CONTENTS

ABSTRACT

The Fukushima-Dai-Ichi nuclear accident was a traumatic event with global impact on energy and electricity markets, risk management and regulations of the nuclear industry. The "National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC)" created by Japan's National Parliament and chaired by Professor Kiyoshi Kurokawa, found that the Fukushima-Dai-Ichi nuclear disaster was primarily caused by human factors including "regulatory capture": capture of the regulator by the same industry the regulator should regulate.

This report summarizes the major reasons for the Fukushima-Dai-Ichi nuclear accident and its impact, e.g. the accelerated introduction of renewable energy in Japan via feed-in-tariffs, and electricity market reform and liberalization.

Energy efficiency first of all requires us to avoid catastrophic impact on our environment, therefore we all have to learn as much as we can from the reasons which caused the Fukushima-Dai-Ichi nuclear accident. Secondly, we have to learn how to reduce our consumption of energy, and how to procure and use the energy we do need in the most efficient way.

This report also introduces opportunities for cooperation, joint business, investments and acquisitions between Europe and Japan in the field of energy, electricity generation, efficient use of energy, and proper management of the risks associated with energy - there are many more opportunities for cooperation between Japan and Europe, beyond this report.

1. INTRODUCTION: ENERGY EFFICIENCY IN JAPAN AND EUROPE

The Fukushima-Dai-Ichi nuclear disaster has shaken up the world, and has created enormous impact globally. Many countries have revised their risk management and regulatory framework for nuclear energy, and have invested in safety equipment and "in-depth-defense"[1] against nuclear accidents. The Fukushima-Dai-Ichi nuclear disaster also caused Germany to decide to end the use of nuclear energy in the near future, terminate all nuclear power plants and execute the "Energiewende" (the Energy Transformation) towards a much stronger use of renewable energy sources.

Japan's energy and electricity architecture has seen effectively no changes between 1951 and the day of the Fukushima-Dai-Ichi nuclear disaster on 11 March 2011. Japan is now transforming the energy and electricity sector to take account of the lessons learnt from the Fukushima-Dai-Ichi nuclear disaster, and learning from best practices all over the world in addition to home developed technology and products. At the same time, it seems that the Japanese people have not found consensus concerning the future of nuclear energy in Japan: there are Japanese people in political and intellectual leadership positions speaking out vehemently for nuclear power and others equally vehemently against nuclear power. No consensus is in sight as far as the present author can observe.

This report is based on presentations given by the present author most recently as part of the Konrad-Adenauer-Stiftung Conference Series in Japan on Energy Efficiency in Tokyo, in Kyoto at the Ritsumeikan University and in Kobe at the Kwansei Gakuin University. The present author has also given several lectures on Japan's energy sector[2] at the Embassy of Sweden in Tokyo organized by the Stockholm School of Economics, and presentations to the Trade Minister of Sweden, Dr Ewa Björling, and to the Minister for Energy and Natural Resources of Canada, Mr Joe Oliver. The present author's company has also worked with several investment funds and industrial customers on business development and on investments in Japan's energy sector. The present author has continuously lived and worked in Japan since 1991, and was in Tokyo all through the nuclear crisis in March and April 2011.

---

[1] http://www.iaea.org/ns/tutorials/regcontrol/assess/assess3213.htm

[2] http://www.fasol.com/2013/06/05/japans-energy-myths-vs-reality-stockholm-school-of-economics-at-the-embassy-of-sweden/

2.1 Risk management versus the "safety myth"

Every technology is unfortunately associated with risks and side effects: cars, trucks, trains, airplanes, ships and bicycles cause deadly accidents, dams for hydropower can break and cause sudden flooding, coal and LNG fired power stations cause CO_2 emission contributing to global warming, and emission of other harmful gases and substances, windmills kill birds and may break in a storm, and nuclear power stations can suffer accidents which spill radioactive pollution into the environment, and in the extreme case, as in the Fukushima-Dai-Ichi disaster, require sudden evacuation and a very long lasting and expensive clean-up and decommissioning.

These risks need to be understood and managed skillfully, using the tools of science, technology and logic, and cannot be ignored. Ultimately, in a democracy, a dialogue between the people and the government needs to establish which level of risk is acceptable, and independent, competent and strong regulators need to regulate to this level of risk[3].

Previous to the Fukushima-Dai-Ichi disaster, many decisions in Japan were based on the assumption that a nuclear accident in Japan is completely excluded – the "nuclear safety myth". There were two motivations for this narrative:

- one motivation was that even considering the possibility of a nuclear accident would reduce Japanese people's trust in the safety of nuclear installations in Japan and increase resistance against nuclear power
- the second motivation was cost reduction.

2.2 The causes of the Fukushima-Dai-Ichi nuclear accident

The Japanese Parliament created the first ever "National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC)" with Law No. 112[4] [5] enacted on October 7, 2011 and appointed Professor Kiyoshi Kurokawa as the Chairman of the Commission. While senate commissions, parliamentary investigation commissions are very frequent in the USA, UK and other countries, this is the first independent parliamentary commission ever for Japan, underlining the extreme seriousness of the Fukushima-Dai-Ichi nuclear accident. Commission Chairman Professor Kurokawa opened most of the interviews to the public and posted video records on the internet. The reports and records can be downloaded from the Web Archive Site of the National Diet of Japan in Japanese[6] and in English[7] and videos of the interviews can be viewed online. Professor Kurokawa gave a talk summarizing some key results and conclusions at the 6th Ludwig Boltzmann Forum[8] in Tokyo on 20 February 2014, where he also showed YouTube movies, which summarize the results in simple terms both in Japanese and in English[9].

The key result of the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) is that the Fukushima-Dai-Ichi accident was not primarily a natural disaster caused by the earthquake and tsunami, but the accident was primarily caused by "Regulatory Capture": Japan's "Nuclear Village" had captured and absorbed the regulator, which in Japan was an integral part of the Ministry of Economy, Trade and Industry (METI). METI was both promoting the nuclear industry and at the same time regulating the same industry. The term "Nuclear Village" (原子力村)[10] is used in Japan to describe the community of electrical power companies, nuclear equipment producers, university professors and experts, mass communications, politicians, regulators, ministry officials, and other more colorful sectors of Japanese society who cooperated to realize nuclear power in Japan.

---

[3] http://www.eurotechnology.com/2014/10/08/charles-casto-nuclear-safety/

[4] http://www.shugiin.go.jp/internet/itdb_housei.nsf/html/housei/17820111007112.htm

[5] 東京電力福島原子力発電所事故調査委員会法

[6] http://warp.da.ndl.go.jp/info:ndljp/pid/3856371/naiic.go.jp/

[7] http://warp.da.ndl.go.jp/info:ndljp/pid/3856371/naiic.go.jp/en/

[8] http://www.boltzmann.com/forum/2014-2/

[9] http://www.boltzmann.com/2014/03/kiyoshi-kurokawa-groupthink-can-kill/

[10] http://ja.wikipedia.org/wiki/原子力村

"For his contribution to society by his remarkable stewardship of an independent investigation into the causes of the Fukushima nuclear catastrophe" and "for his courage in challenging some of the most ingrained conventions of Japanese governance and society", for exposing the regulator capture and other human errors which caused the Fukushima-Dai-Ichi nuclear accident, Professor Kiyoshi Kurokawa was awarded the AAAS Scientific Freedom and Responsibility Award[11] by the American Association for the Advancement of Science at the 179th AAAS Annual Meeting in Boston, MA, on 15 February 2013.

As soon as the severity of the Fukushima-Dai-Ichi nuclear accident became clear, the President of the United States of America sent a group of about 150 of the USA's best nuclear industry experts and practitioners to Tokyo. This group of 150 US nuclear experts worked for 11 months with the Prime Minister of Japan and his Cabinet Ministers, meeting almost every day. The leader of this group of 150 US nuclear industry experts was Dr Charles "Chuck" Casto, and he recently gave a press conference summarizing his lessons learnt from this work in Tokyo[12].

Dr Chuck Casto explained that five crises caused the Fukushima-Dai-Ichi accident:

1. the earthquake
2. the tsunami
3. the nuclear event
4. a societal crisis, and
5. a policy crisis.

Dr Chuck Casto stated that Japan's nuclear power stations cannot - or at least should not - be restarted before the societal crisis and the policy crisis are solved, which according to Dr Casto is not yet the case.

2.3 Regulatory capture

Regulatory capture is in no way a phenomenon particular to Japan. There are many cases of regulatory capture in many countries, and Chicago-School Economist George Stigler was awarded The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 1982 "for his seminal studies of industrial structures, functioning of markets and causes and effects of public regulation" [13] [14]. George Stigler concluded that "as a rule, regulation is acquired by the industry and is designed and operated primarily for its benefit", thus, George Stigler affirms that regulation generally benefits the regulated industry, rather than the idealistic view that regulation would benefit the public.

To give one example: After the September 11, 2001 terror attacks, the US Government decided to invest in protecting nuclear power stations against terror attacks and in particular against electricity cut-off which would stop cooling and lead to core melt-downs, and the US Government asked all friendly countries to invest in the same protection. All countries friendly with the US complied with this request, except for Japan. Why did Japan not follow the US advice to invest in protecting Japan's nuclear power stations against electricity cut-off and the resulting interruption of cooling leading to core melt-down? Japan's Government replied that such investments are not necessary in the case of Japanese nuclear power stations because there is no terrorism in Japan. The opposite is true of course, since there are unfortunately many cases of home-grown Japanese terrorism including the Japanese red army[15], and Ohm Shinrikyo[16], which is still active in Japan today. Japanese police stations regularly have posters on display, warning the population to be careful of bombs, depicting images of explosive devices made by Japanese terrorists in Japan. Of course there is no certainty, but if Japan would have followed US advice to invest in protecting nuclear power stations against electricity

---

[11] http://www.aaas.org/news/fukushima-investigator-kiyoshi-kurokawa-wins-aaas-scientific-freedom-and-responsibility-award

[12] http://www.eurotechnology.com/2014/10/08/charles-casto-nuclear-safety/

[13] George J Stigler, "The Theory of Economic Regulation", The Bell Journal of Economics and Management Science, Volume 2, Issue 1, (Spring 1971), p 3-21

[14] http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1982/

[15] https://en.wikipedia.org/wiki/Japanese_Red_Army

[16] https://en.wikipedia.org/wiki/Aum_Shinrikyo

and cooling cut-off, there is a possibility that the Fukushima-Dai-Ichi accident could have been mitigated or even prevented.

2.4 The Jogan Earthquake of July 9, 869 and the 1896 Sanriku Earthquake and Tsunami

Another serious consequence of regulatory capture is that several previous serious earthquakes and Tsunami's of comparable intensity as the March 11, 2011 earthquake and tsunami, and warnings by geologists and seismologists and other experts, were not taken into account for the design of the Fukushima-Dai-Ichi nuclear power station and their protection against strong earthquakes and tsunamis.

The Jogan Earthquake[17] took place on July 9th, 869, causing flooding of the Sendai plain up to 4 km inland, with an estimated magnitude of 8.6 compared to the 2011 Tohoku Earthquake with a magnitude of 9.0. The epicenter was very close to the epicenter of the March 11, 2011 earthquake.

The 1896 Sanriku earthquake[18] on June 15, 1896 had magnitude 8.5, and the Tsunami waves reached a height of 38.2 meters, and led to 22,000 deaths. The epicenter was very close to the epicenter of the March 11, 2011 Tohoku earthquake.

These earthquakes were not taken into account in the design of the Fukushima-Dai-Ichi nuclear power station, despite warnings from several Japanese geologists whose warnings were ignored. The Fukushima-Dai-Ichi nuclear power station was not designed to withstand a 38.2 meter high Tsunami such as the Tsunami caused by the 1896 Sanriku earthquake.

2.5 Nature cannot be fooled

Richard Feynman was awarded the Nobel Prize in Physics 1965 "for fundamental work in quantum electrodynamics, with deep-ploughing consequence for the physics of elementary particles", and he is one of three heroes of physics for the present author.

Richard Feynman was member of the US Presidential Commission responsible for investigating the Space Shuttle Challenger disaster and submitted the "Rogers Commission Report"[19] on 9 June 1986 to President Ronald Reagan. Richard Feynman found the primary reason for the space shuttle accident (a badly designed O-ring), and also the underlying fundamental cause of the disaster: insufficient communication and insufficient trust between the engineers and scientists doing the actual work and the top-level program managers.

Richard Feynman submitted an "Appendix F" to the Rogers report, entitled "Personal observations on reliability of shuttle". Richard Feynman concludes this Appendix F with the words: "**For a successful technology, reality must take precedence over public relations, for nature cannot be fooled**"[20]. The same truth holds for the planning, construction, operation and regulation of nuclear power.

2.6 The science of decision making, the psychology of crowds: "Groupthink can kill"

It was established knowledge that very violent earthquakes and tsunamis of similar intensity, and epicenters in the same area as the Tohoku Earthquake and Tsunami of March 11, 2011 occurred roughly once per 1000 year period[21], but this known fact was ignored in the planning, construction and management of the Fukushima-Dai-Ichi nuclear power station, despite warnings from scientists.

The people who planned, constructed, operated and regulated the Fukushima-Dai-Ichi nuclear power station are highly educated, graduated from Japan's top elite universities and certainly worked hard and diligently. Still, they did not take

---

[17] https://en.wikipedia.org/wiki/869_Sanriku_earthquake

[18] https://en.wikipedia.org/wiki/1896_Sanriku_earthquake

[19] http://history.nasa.gov/rogersrep/genindex.htm

[20] http://history.nasa.gov/rogersrep/v2appf.htm

[21] although it is sometimes reported that earthquakes occur in specific time cycles, the present author has reached the conclusion that earthquakes are essentially "chaotic" phenomena, chaotic in the mathematical sense of this term, and therefore cannot be predicted and do not occur in regular intervals. "Once per 1000 years" should be understood as an indication of the time frame. The present author is convinced that the prediction of earthquakes is not possible. A large amount of scientific literature covers this topic.

earlier earthquakes and tsunamis, which were known to occur from time to time in the Tohoku region, into account when planning the Fukushima-Dai-Ichi nuclear power station, and they rejected US advice to protect against cut-off of power and cooling.

Why is it that highly gifted and educated people take decisions in this way?[22] This and similar questions are studied by the science of decision making.

Daniel Kahneman was awarded The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2002 "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty"[23].

Another factor arises from group dynamics: people behave differently in a group than if they are on their own, as studied in the classic work "Psychologie des foules"[24] [25] by Gustave Le Bon (English translation of this title: "The Crowd: a study of the popular mind").

In his keynote at the 6th Ludwig Boltzmann Forum[26] on 20 February 2014 in Tokyo, Professor Kiyoshi Kurokawa summarized the potentially detrimental impact of crowd psychology on decision making: "Groupthink can kill"[27].

2.7 Risk management and defense in depth

One approach to address the problem of nuclear safety is the construction of particular technical solutions, such as the construction of a containment vessel encapsulating the reactor to contain radioactive substances.

"Defense in depth" has been developed in the USA in the 1960s and presents a different approach to nuclear safety. Defense in depth[28] includes five levels:

- First level: prevention of abnormal operation and failures
- Second level: control of abnormal operation and failures
- Third level: control of accidents within the design basis
- Fourth level: control of severe plant conditions including prevention of accident progression and mitigation of severe accident consequences
- Fifth level: mitigation of radiological consequences of significant off-site release of radioactive materials.

In a recent press conference at the Foreign Correspondents Club Japan on 15 October 2014, the Governor of Niigata Prefecture who hosts the world's largest nuclear power station, Kashiwazaki-Kariwa, expressed the opinion, that in Japan at this point of time, the fourth level and the fifth level of the defense in depth recommended by the International Atomic Energy Agency (IAEA) are not yet sufficiently implemented[29].

Defense-in-depth is necessary, and recommended by the IAEA, to cover the possibility that the engineering solutions such as confinement vessels or back-up power supplies are breached by an accident.

---

[22] There are a number of articles discussing the related question: "Why smart people make stupid decisions"

[23] http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2002/

[24] http://fr.wikipedia.org/wiki/Psychologie_des_foules_(livre)

[25] http://classiques.uqac.ca/classiques/le_bon_gustave/psychologie_des_foules_Alcan/foules_alcan.html

[26] http://www.boltzmann.com/forum/2014-2/

[27] http://www.boltzmann.com/2014/03/kiyoshi-kurokawa-groupthink-can-kill/

[28] http://www.iaea.org/ns/tutorials/regcontrol/assess/assess3213.htm

[29] http://www.eurotechnology.com/2014/10/15/nuclear-safety-hirohiko-izumida/

2.8 Regulating the nuclear industry

Any technology has risks. In a democratic society, the government and society leaders need to determine in a dialogue with the population which level of risk is acceptable. Once the acceptable level of risk has been determined in democratic dialogue, it is the regulator's duty to regulate the industry to this risk level[30].

As a consequence of the Fukushima nuclear disaster, the previous nuclear industry regulator, which was an integral part of the Industry Ministry METI, was dissolved, and a new independent Nuclear Regulatory Authority (原子力規制委員会)[31] [32] was created.

Japan's Government under Prime Minister Abe states that the safety standards created by the new NRA are the strictest in the world.

At a recent press conference, the Director General of the International Atomic Energy Agency (IAEA), Mr Yukiya Amano, was directly asked whether he thinks that Japan's new nuclear safety standards are the strictest in the world. IAEA-DG Mr Yukiya Amano avoided a direct answer by stating that it is not the responsibility of the IAEA to rank countries[33].

The same question was also asked to the Governor of Niigata, Mr Hirohito Izumida. Governor Izumida's answer was far more negative[34]. Governor Izumida stated that in his opinion, the new Nuclear Regulatory Commission was shrinking its responsibility and limiting its regulatory work to technical reactor construction issues rather than regulating all issues comprehensively. In particular, Governor Izumida stated that the current NRA does not fully address the fourth level of in-depth-defense (control of severe plant conditions including prevention of accident progression and mitigation of severe accident consequences), and does not address the fifth level of in-depth-defense at all (mitigation of radiological consequences of significant off-site release of radioactive materials).

The US Expert Group leader, Dr Chuck Casto, expressed an almost identical opinion at his Press Conference on 8 October 2014 at the Foreign Correspondents Club of Japan in Tokyo[35]. Dr Casto stated that he believes that the technical aspects of Japan's nuclear safety standards are probably ok, although he has not checked them personally in detail. However, in almost the same words as Governor Izumida, Dr Casto explained that the society issues, the emergency planning, evacuation plans, sheltering plans (i.e. the 4th level and 5th level of in-depth-defense) are equally important, and Dr Casto implied that these are not sufficiently addressed yet.

3. WHERE ARE WE AND WHY? JAPAN'S ENERGY SITUATION TODAY

3.1 Energy self-sufficiency - there is more than one way to look at it

The following Figure 1 shows the traditional view of energy self-sufficiency, where Japan's very considerable potential renewable energy resources are not included. In fact, several different scenarios have been prepared where off-shore wind energy alone could supply all of Japan's energy needs.

Figure 1 shows the conventional view, that Japan needs to import 96% of energy (in case nuclear energy is switched off as it is at present) or 82% of energy with nuclear power at pre-Fukushima-Dai-Ichi levels. Actually, as we will show below, if renewable energy would be fully developed in Japan, several proposed scenarios show, that Japan could be self-sufficient with wind-energy alone.

---

[30] http://www.eurotechnology.com/2014/10/08/charles-casto-nuclear-safety/

[31] http://www.nsr.go.jp/

[32] Note that in Japan the Japanese language is exclusively used for official functions, and only the Japanese name of this Commission is fixed. Several different English translations and abbreviations such as NSR, NRC, NRA can be found

[33] http://www.eurotechnology.com/2014/03/17/fukushima-nuclear-yukiya-amano-iaea/

[34] http://www.eurotechnology.com/2014/10/15/nuclear-safety-hirohiko-izumida/

[35] http://www.eurotechnology.com/2014/10/08/charles-casto-nuclear-safety/

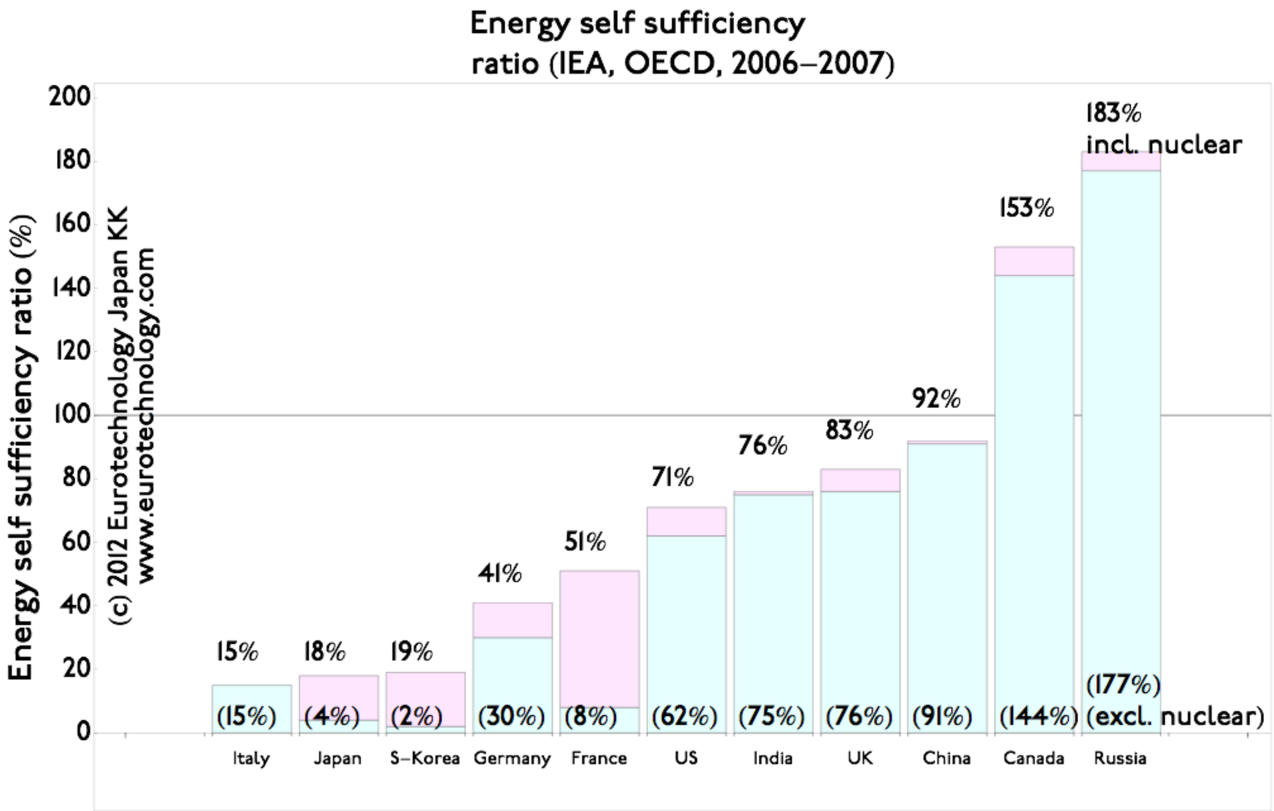

Figure 1: The traditional view of energy self-sufficiency shows that Japan has to import 96% of energy (if nuclear power is switched off), or 82% with nuclear power generation at pre-Fukushima-Dai-Ichi levels. This traditional view does not include Japan's potentially very large renewable energy resources, especially wind power, which are largely undeveloped at this time.

3.2 Japan's current official energy strategy

Japan's "Basic Energy Policy Law" (エネルギー政策基本法)[36], Law No. 71 of 14 June 2002 (Section 12 Item 4) requires Japan's Government to produce an "Energy Basic Plan" (エネルギー基本計画) at regular intervals. The Energy Basic Plans are[37]:

1. First Energy Basic Plan: October 2003
2. Second Energy Basic Plan: March 2007
3. Third Energy Basic Plan: June 2010
4. Fourth Energy Basic Plan[38]: April 11, 2014.

The current Government's official energy strategy starts with the statement that

- **"Japan has almost no primary fossil fuel resources, which are the dominating energy source, and needs to import almost all primary energy, and therefore is vulnerable to changes in the situation in other countries"[39]**

---

[36] http://law.e-gov.go.jp/htmldata/H14/H14HO071.html

[37] http://www.enecho.meti.go.jp/category/others/basic_plan/

[38] http://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf

as one of the fundamental observations/assumptions on which the current official energy strategy of Japan is based. Actually, this statement does not describe Japan's true situation correctly in the opinion of the present author, if read with scientific precision! The following statement would describe Japan's true situation more accurately:

- **"Japan has a very rich potential for different forms of renewable energy, however, Japan has few known fossil energy resources. When Japan's potential renewable energy resources are fully developed, Japan has the potential to achieve self-sufficiency in energy. Until that point in the future, Japan has to import almost all primary energy".**

3.3 Japan's primary energy input

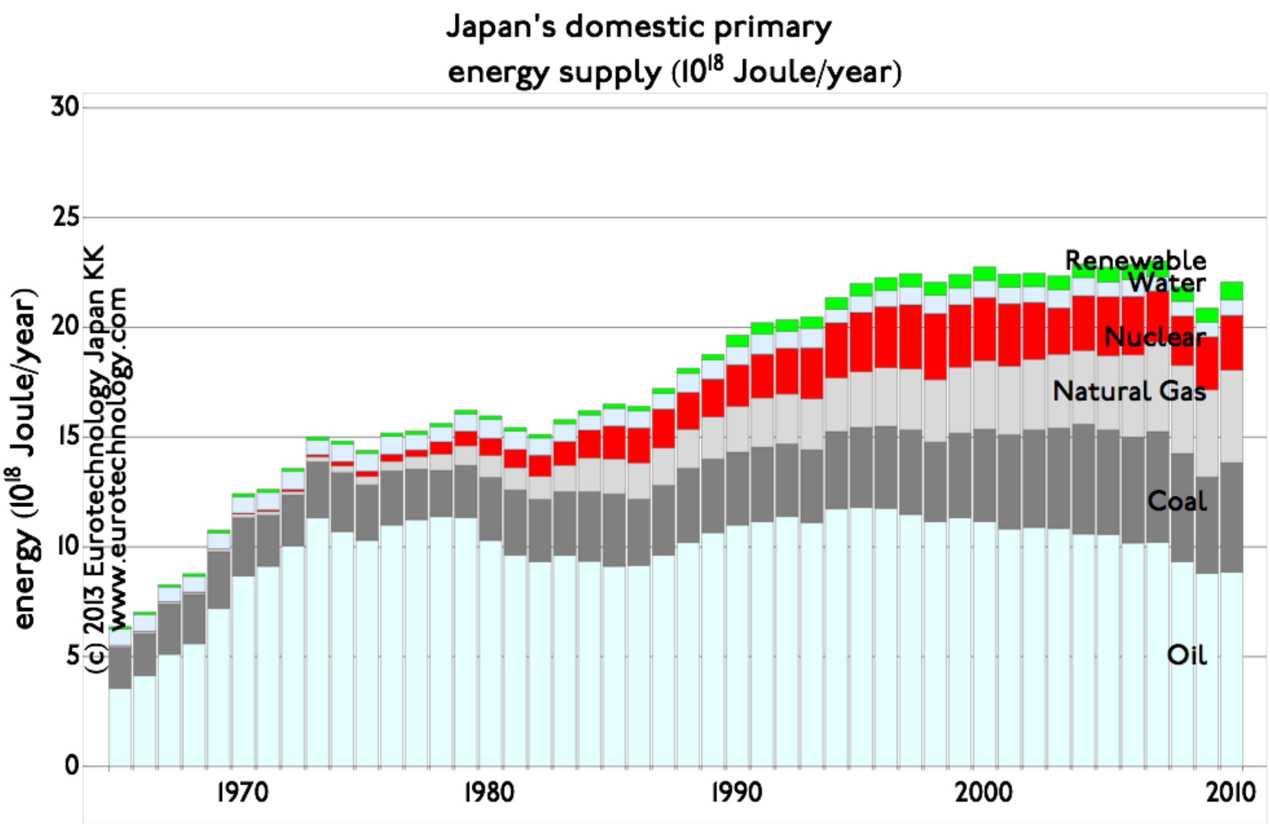

Figure 2 shows the development of Japan's primary energy mix over the years. Nuclear energy generation is currently totally switched off.

---

[39] The preceding is this author's translation of the Japanese version of the Fourth Energy Strategy Plan. METI's "provisional translation" reads "Japan has little domestic fossil fuel which plays a center role of energy source, and has the vulnerability to depend on import from abroad"

3.4 Japan's energy import costs

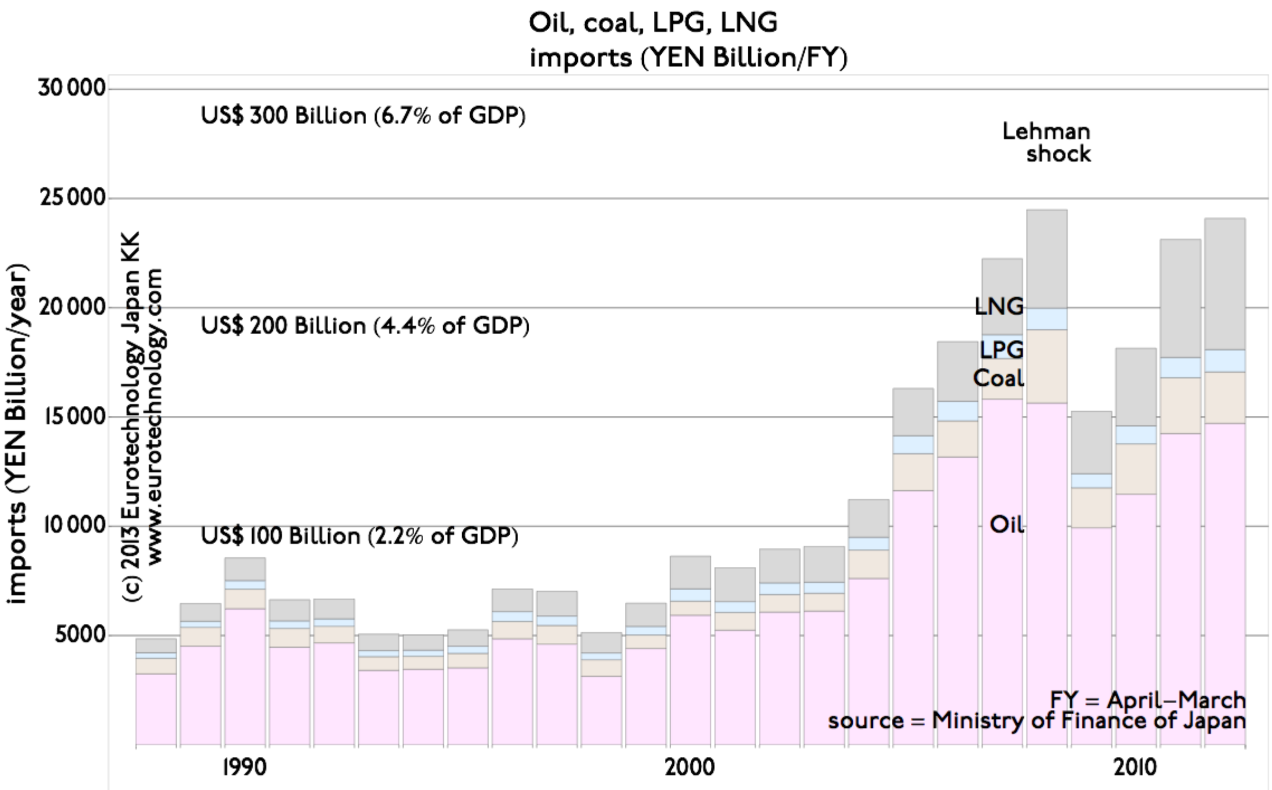

Figure 3: Japan's energy import costs currently are on the order of about YEN 25,000 billion/year (= US$ 250 billion/year) which corresponds to about 5% to 6% of GDP. Note that not all of the primary energy imports are used for electricity production, part of the imported oil, coal and gas is used as raw material for the chemical industry, for heating and for transportation.

3.5 History: why is Japan's electricity industry where it is today?

Year	action
February 15, 1883	Tokyo Dentou KK receives Government license, starts business in July 5,1886
1893	Tokyo Dentou KK introduces 50Hz equipment from AEG (of Germany) Osaka Dentou KK introduces 60Hz equipment from GE (of USA)
1896	33 electricity utility companies
	700 electricity utility companies
1938-1939	Japan's electricity industry nationalized as part of the war effort
March 1942	Nihon Hassouden KK (Nippatsu) created (generation + transmission) 9 distribution companies (Tokyo Dentou dissolved March 1942)

Year	action
May 1, 1951	US occupation government orders dissolution of Nihon Hassouden KK (Nippatsu), 9 regional electricity monopolies created,1972 + Okinawa Power Company
May 1, 1951 - March 11, 2011	essentially no changes in Japan's electricity industry structure for almost 60 years
March 1, 1961	construction of first Japanese nuclear power plant (Tokai Nuclear Power Plant, UK Magnox type) starts (power generation starts 1966, decommissioned in 1998)
March 11, 2011	Fukushima-Dai-Ichi disaster

Table 1: Historic development of Japan's electricity industry

Electrification of Japan started in 1883 in Tokyo, and in 1893 the first electricity generators went online in Japan. Tokyo Dentou KK selected 50Hz generation equipment from AEG of Germany, and Osaka Dentou KK selected 60Hz equipment from General Electric (GE) of the USA. At that time compatibility of the grid frequency in Osaka and Tokyo were not a consideration, and this split in grid frequency remains today: Japan has two separate electricity grids, in the West of Japan with a frequency of 60Hz, and in the East of Japan with 50Hz. The 50Hz and the 60Hz grids are only very weakly linked via three frequency conversation stations.

Japan's electricity industry thrived, and before the Second World War about 700 electricity utility companies were active. As part of the war effort, Japan's electricity industry was nationalized in March 1942, and a single national company Nihon Hassouden KK (abbreviated Nippatsu) was created with the monopoly for generation and transmission of electricity, and nine regional monopoly distribution companies. Japan's first pioneering electricity company, Tokyo Dentou KK was dissolved in March 1942.

General McArthur's military Government of Japan after the end of World War II ordered Japan to end the monopoly of Nihon Hassouden KK; Japan needed to comply with the military Government's orders, created 9 regional electricity monopoly companies, dissolved Nihon Hassouden KK and created the Electricity Law of Japan on May 1, 1951. With the return of Okinawa to Japan in 1972, a tenth regional monopoly company, the electricity company of Okinawa joined.

For almost 60 years, between May 1, 1951, and March 11, 2011, there was no significant change in the structure of Japan's electricity industry, which had essentially been imposed by General McArthur on Japan.

During these 60 years, Japan's ten regional monopoly companies, although private companies listed on the stock exchange, had a guaranteed business model, where all costs and expenditures of the companies were added up, a fixed percentage of profits was added, and from this formula the electricity price was determined and approved by the Industry Ministry (MITI, and later METI). This method of calculating electricity prices had the peculiar consequence, that it was in the interest of the electricity companies to have as high costs as possible. Since profits were calculated as a fixed percentage of costs, the higher the costs, the higher the achieved profits.

There were attempts by the Industry Ministry METI to reform and liberalize the electricity industry, but no major reforms could be realized until the Fukushima-Dai-Ichi disaster occurred.

The Fukushima-Dai-Ichi disaster shook the population's trust in Japan's monopoly electricity companies, and also undermined their financial strength and political influence. Thus the power balance between the Ministry for Economics, Trade and Industry (METI) and the electricity companies was changed in favor of METI, and enabled METI to now finally realize liberalization of Japan's electricity markets.

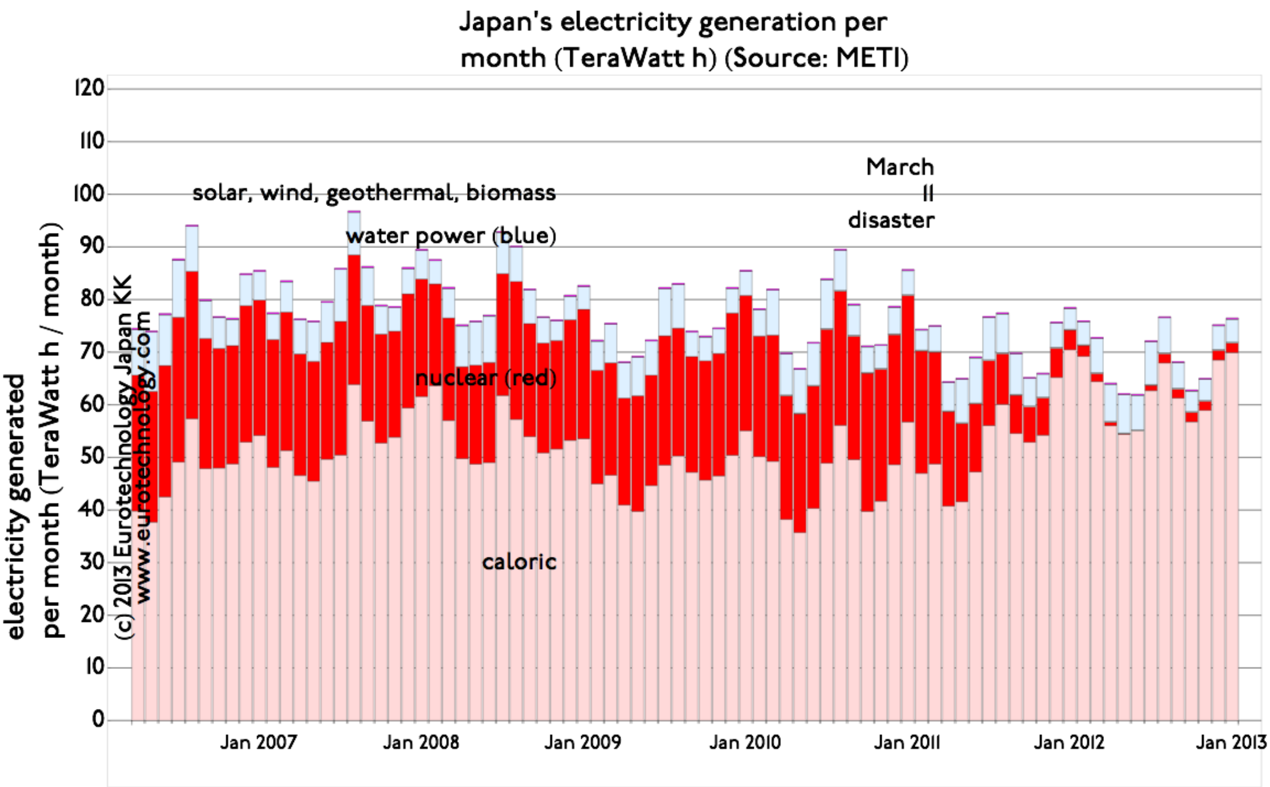

Figure 4: This figure shows the electricity generated per month in Japan, and clearly shows how electricity from nuclear power stations was replaced by electricity from fossil fuel - mainly LNG. This figure also demonstrates the very low contributions from water power and non-hydro renewable energy.

3.6 Fukushima-Dai-Ichi impact

The Fukushima-Dai-Ichi disaster has lasting global impact and has caused a revision of nuclear policies and nuclear safety procedures in most countries. In particular, Germany decided to phase out nuclear energy generation totally in the near future as a direct consequence of the Fukushima-Dai-Ichi disaster, and has initiated the "Energiewende" (energy transformation).

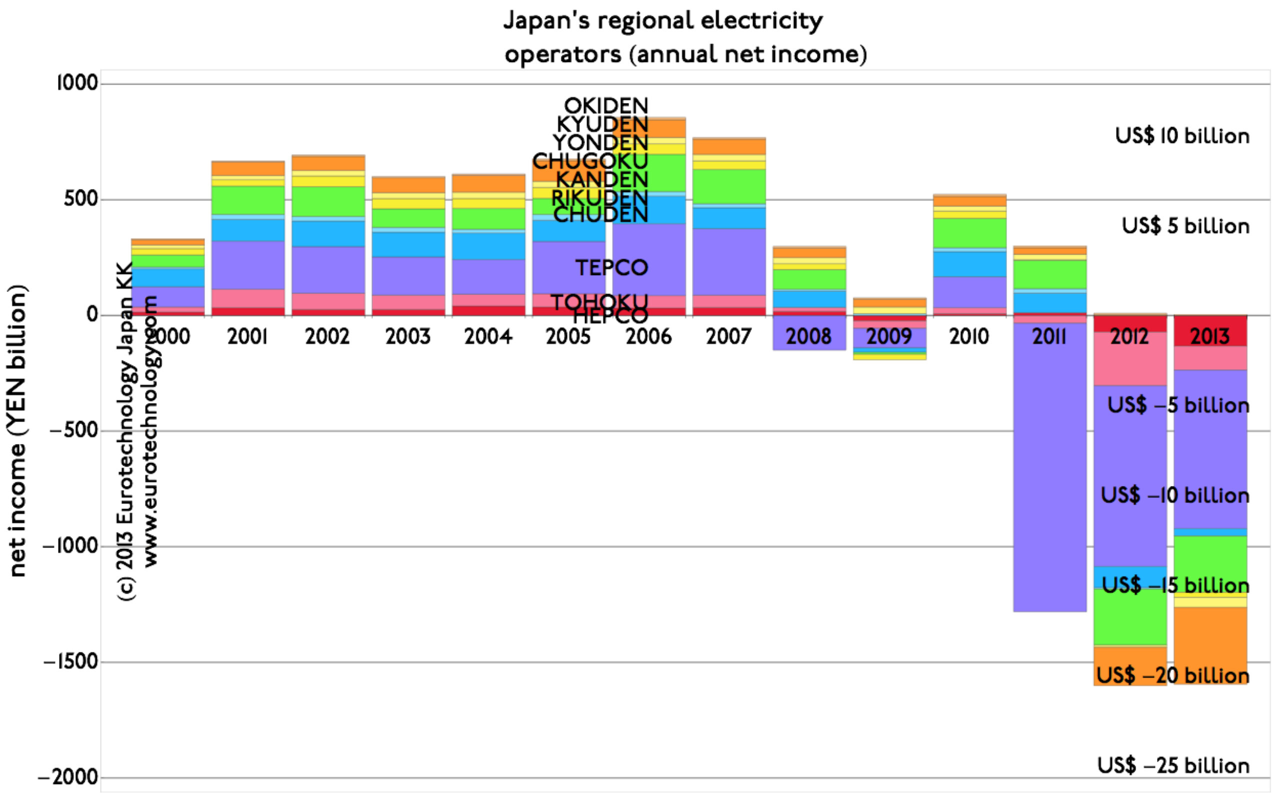

Figure 5: Currently all Japanese nuclear reactors are switched off, and as a consequence the annual net income (profits) of the ten regional electricity operators has deteriorated dramatically.

The Tohoku earthquake[40] occurred on Friday 11 March 2011 at 14:46 Japan time. The present author spent the time before and since the Tohoku earthquake continuously in Tokyo, therefore the following descriptions include first-hand observations. From Friday 11 March 2011 for several weeks the present author spent about 1/2 of his time observing and analyzing accessible information and data, and in discussions with experts, including one of the top officials of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT), which is responsible for part of Japan's nuclear program and in particular also for most of Japan's radiation monitoring.

Although most global attention is on the main earthquake on Friday 11 March 2011 at 14:46, a huge number of aftershocks occurred for several months after 11 March 2011, in particular during March and April many aftershocks occurred per day, and some aftershocks were strong enough to cause substantial additional damage. At certain periods, the ground felt as if one was standing or walking on jelly; the ground was wobbly.

As a consequence of the March 11, 2011 earthquake and tsunami a large number of conventional and all nuclear power stations in many parts of Eastern Japan were damaged or switched off for safety reasons. The Fukushima-Dai-Ichi nuclear disaster developed within a very short time after 14:46, and it is now known that the core melt-downs occurred already during the evening of March 11, 2011 a few hours after the water cooling supply was interrupted, and the unprotected backup cooling system was washed out into the sea by the Tsunami.

---

[40] https://en.wikipedia.org/wiki/2011_Tōhoku_earthquake_and_tsunami

There were widespread power cuts throughout eastern Japan, however in the central Tokyo region the author did not experience one single power cut - not even right at the time of the strongest earthquake. The electricity supply was completely continuous at all time on and since March 11, 2011 in central Tokyo. Power black-outs were announced, but although announced, they were not carried out, and electrical power was continuously connected through all of 2011 and beyond.

This continuity of electrical power at least in the central areas of Tokyo was achieved in several ways:

- self restraint, voluntary reduction of electricity consumption by most consumers - both private and commercial
- enforced power reduction by large scale electricity users
- power cuts at the periphery of Tokyo and in the country side, while electricity supply was maintained in the core areas in central Tokyo
- retired and decommissioned fossil power stations - mainly gas and coal power stations - were brought back online as quickly as possible
- unscheduled improvised gas turbine powered power stations were rapidly built
- liquid natural gas (LNG) was purchased and imported via short-term arrangements

Within about 13 months all non-damaged nuclear power stations were switched off according to their regular maintenance cycle of 13 months. With the exception of the Oi nuclear power station, which was brought back online for a limited period, at this time all Japanese nuclear power stations are switched off without exception, and it is currently unclear when the first nuclear power stations will be brought back online.

3.7 How can Japan cut 30% of electricity input and no lights go out?

Nuclear power amounted to approximately 30% of installed electricity generation capacity, and is currently switched off without exception - still there are no black-outs and electricity supply is continuous. How is this achieved?

Essentially three factors:

- reduction of electricity consumption: partly voluntary, and partly enforced during certain periods
- decommissioned old fossil power stations were brought back online at an accelerated speed
- emergency power stations were built rapidly, all using LNG

Essentially, the nuclear electricity corresponding to 30% of Japan's electricity generation was replaced by LNG produced electricity, as shown in the figure above.

Of course this replacement of nuclear energy by caloric power stations using LNG causes a large increase of CO_2 emission by Japan, with the resulting impact on global warming, and a large increase in LNG cost, as explained in the next section.

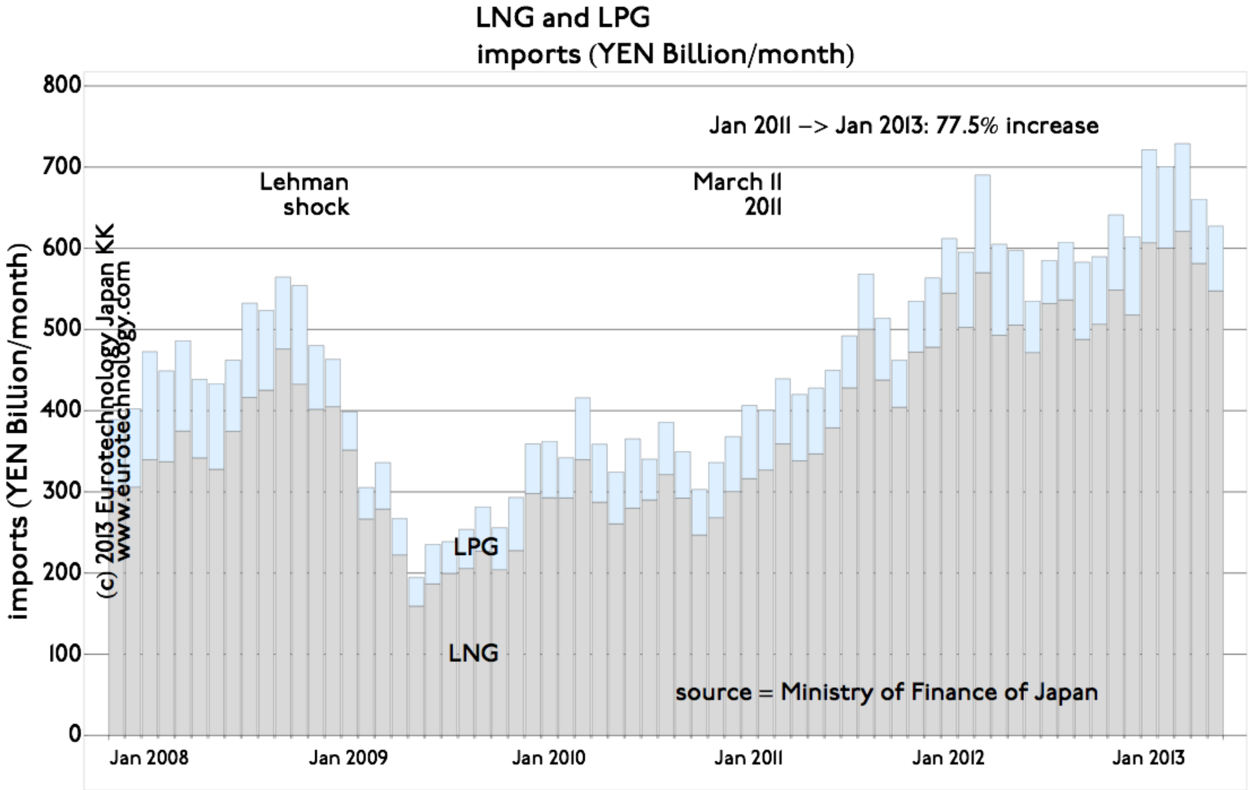

Figure 6: This figure shows the increase of import costs for liquid natural gas (LNG) and liquid petroleum gas (LPG) and demonstrates the rapid cost increases following the upturn once the Lehman shock was overcome, and a particularly strong increase after switch-off of nuclear power electricity generation. Currently the natural gas importation costs are close to 2% of GDP of Japan.

3.8 LNG and why does Japan pay so much more for LNG than anyone else?

Japan currently pays substantially higher prices for liquid natural gas than any other country:

- approximately 60% higher prices than EU
- and approximately five to six times higher prices than the USA (Henry Hub prices).

Why does Japan pay substantially higher prices for liquid natural gas than any other country? There is not one single reason but several:

- additional costs for liquefaction and transport (LNG inside continental USA and continental Europe is largely transported in gaseous state through pipelines, thus liquefaction and transportation by ship is not required)
- political reasons
- timing: the rapid need for additional purchases caused purchase at higher prices. Most gas contracts are very long-term, so if a short- term delivery is needed typically much higher prices are incurred.
- negotiation know-how
- competition reasons: Japan has many competing gas companies and electricity generation companies, with little cooperation. Thus each company buys relatively small quantities increasing the cost for each, and increasing overheads
- project management costs and investments. e.g. for some planned gas purchases it is necessary to build pipelines of harbor equipment, or acquire ships

Currently Japanese companies and the Japanese Government are working on many of these factors aiming to reduce the price paid by Japanese companies for imported natural gas.

4. ENERGY EFFICIENCY OPTIONS FOR THE FUTURE

4.1 Japan's electricity grid

Japan's electricity grid is characterized by 10 weakly linked grids, one grid for each of the 10 regional electricity operators.

There is no national grid covering all of Japan, and Japan has no links at all to other countries, unlike Europe, where all countries are strongly linked to their neighbors, including an increasing number of underwater cables, e.g. between the Netherlands and Norway.

We expect many business opportunities in expanding and transforming Japan's electricity grid as a consequence of the electricity market liberalization, the transformation for the current system of 10 separate regional operators to a more liberalized market structure with a much larger number of participants.

A further factor driving change in Japan's grid is that investments and new grid infrastructure will be necessary to accommodate renewable energy, such as off-shore and on-shore wind energy and solar energy and other forms of new renewable energy sources.

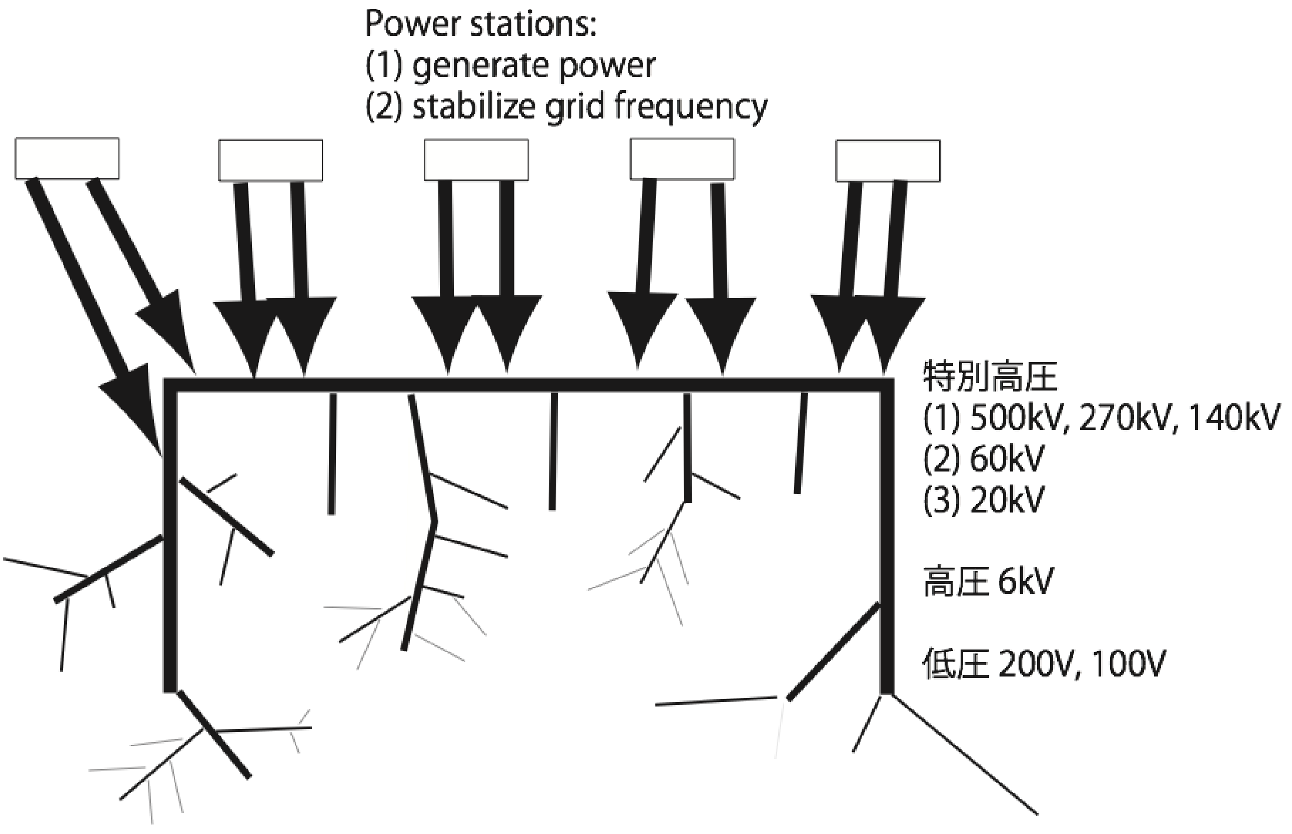

Figure 7: schematic view of Tokyo's power distribution network (grid): electricity is produced in large nuclear and fossil fuel power stations far from Tokyo, and a hierarchical grid distributes the electrical power to large industrial customers (at voltages between 20kV and 500kV), medium sized industrial consumers (at 6kV voltage), and to households and small offices and stores (at 100V or 200V).

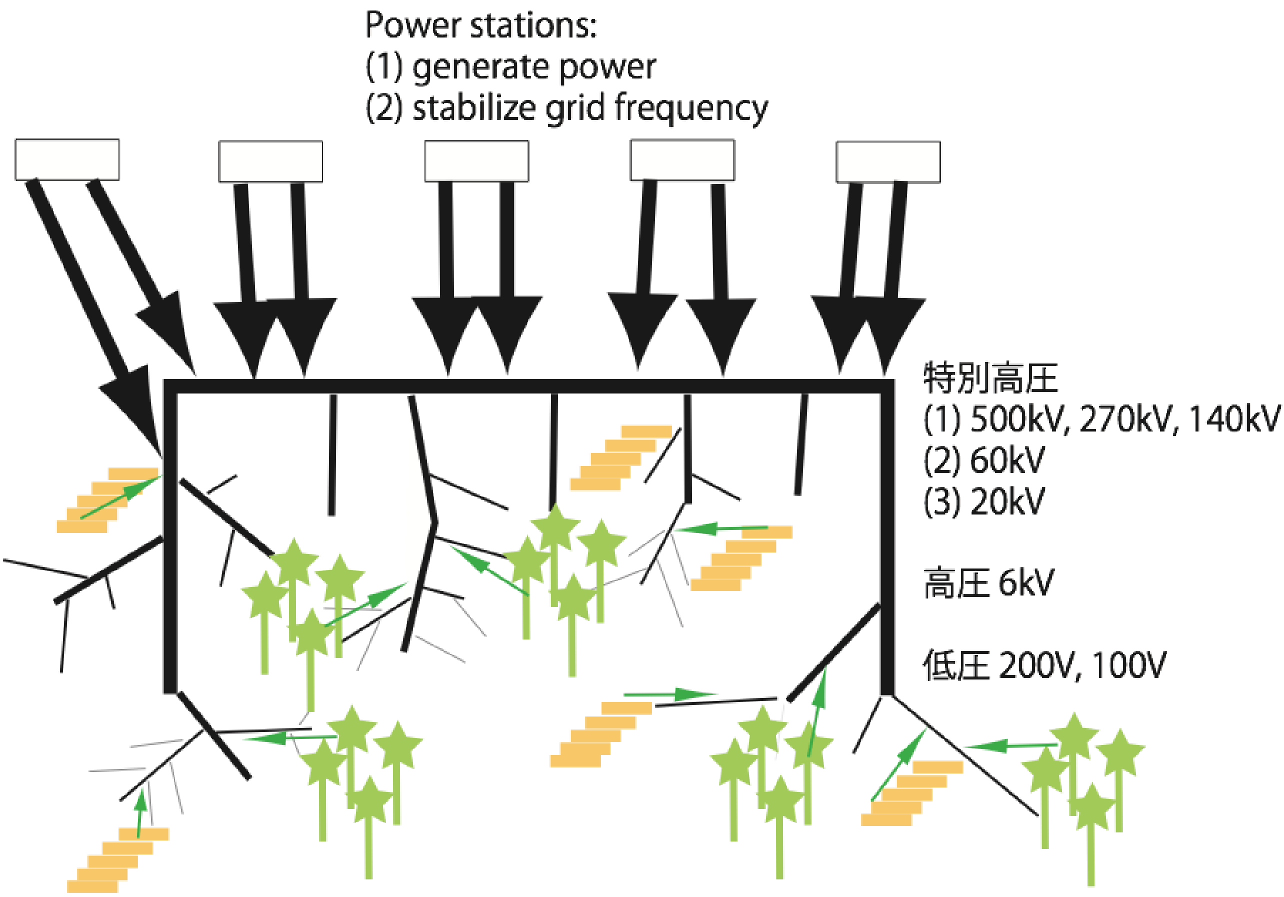

Figure 8: schematic view of Tokyo's power distribution network with local renewable energy input

4.2 Renewable energy in Japan: the unwritten 1% rule

Japanese electrical utilities until recently had an unwritten rule to keep "new" renewable energy (i.e. all renewable energy except for pump-storage hydro and large scale hydro) below 1% of total electricity production. Several of Japan's electricity utilities kept renewables far below this 1% ratio.

Because the installation of new hydro-power stations slowed down and stopped, the contribution of renewable energy to Japan's energy mix fell from about 25% around 1970 to around 10% around 2012.

The following sections will give an overview of renewable energy in Japan, but because of limited space it will not be a more complete market research report, which interested readers can find here[41].

[41] http://www.eurotechnology.com/store/j_renewable/

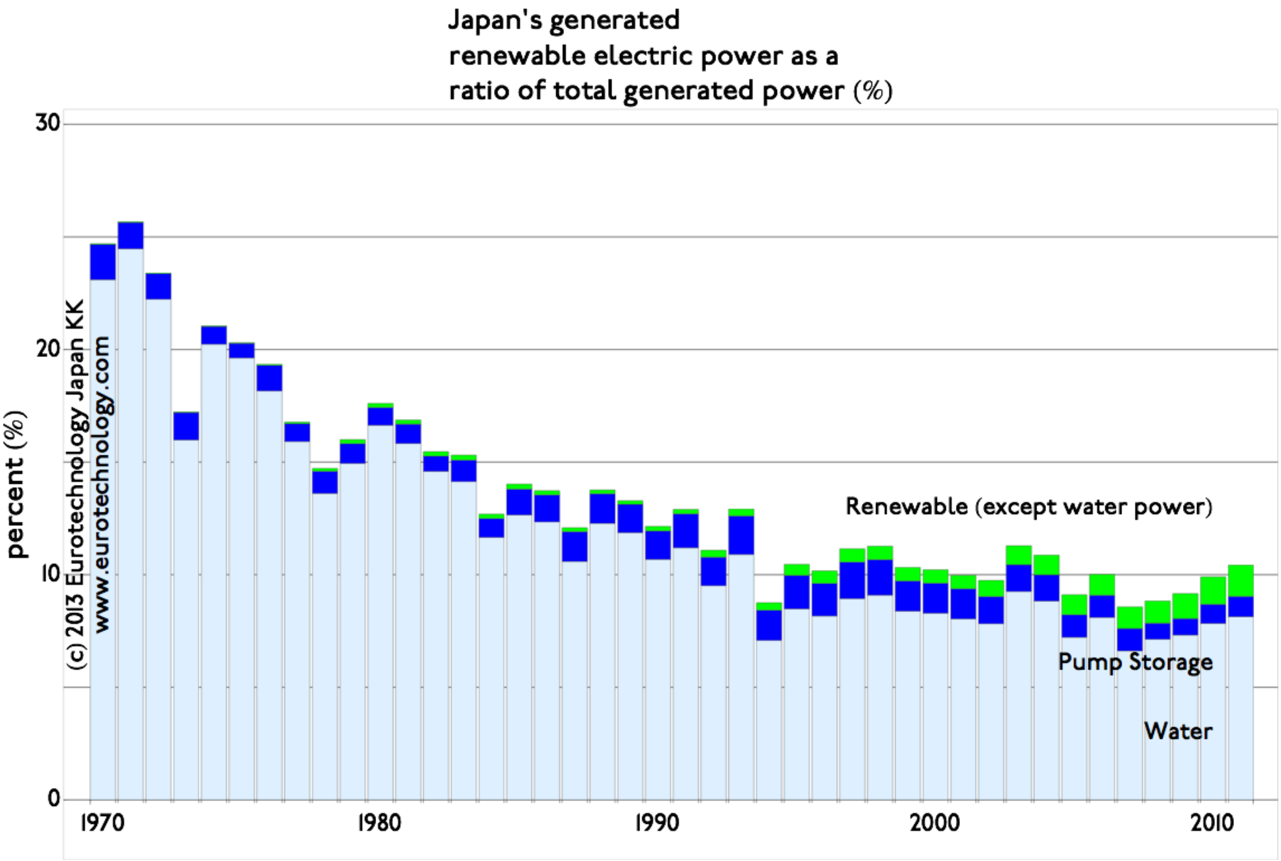

Figure 9: Japan's electrical utilities until recently had an unwritten rule to keep "new" renewable energy (= any renewable energy except for large scale hydro-power and pump-storage hydropower) below 1% of total generation capacity. Total renewable electricity (including hydropower) fell from about 25% in the 1970s to below 10% of total annual electricity production in the period between 2000-2010.

4.2 Renewable energy in Japan: feed-in-tariffs

Feed-in tariffs for the following types of renewable energy were introduced on July 1, 2012:

- solar energy
- wind farms
- hydroelectric
- biomass
- geothermal

Feed-in-tariffs for small scale solar installations for private homes were introduced earlier.

The following table shows, that the feed-in-tariffs are currently far higher than in Europe, and in particular Germany.

Energy type	size of plant	Feed-in-Tariff (FIT)	time period of assured purchase under the law	Germany for comparison
Solar	10 kilowatt or larger	37.8 yen/kWh (incl tax)	20 years	12.71-18.36 c/kWh 12.7-18.3 yen/kWh
	smaller than 10 kilowatt	38yen/kWh	10 years	
Wind farms	20 kilowatt or larger	23.1 yen/kWh	20 years	8.93-19 c/kWh 8.4-19 yen/kWh
	smaller than 20 kilowatt	57.75 yen/kWh		
Hydroelectric		25.2-35.7 yen/kWh depending on size	20 years	3.4-12.7 c/kWh 3.4-12.7 yen/kWh
Biomass		13.65-35.7 yen/kWh depending on source	20 years	6-25 c/kWh 6-25 yen/kWh
Geothermal	15 megawatt or larger	27.3 yen/kWh	15 years	24-40 c/kWh 15-40 yen/kWh
	smaller than 15 megawatt	42 yen/kWh		

Table 2: This table shows Japan's feed-in-tariffs for renewable energy, which was in force between April 1, 2013 and March 31, 2014. Feed-in-tariffs are far higher than in Germany, and are reduced in intervals of 12 months. These intervals are expected to be reduced in the future. For the period from April 1, 2014 - March 31, 2015, the feed-in-tariffs for solar power were reduced, while those for off-shore wind were increased.

4.3 Wind power

Scenario	onshore	offshore, fixed	offshore, floating
No limit scenario	1550 gigawatt (METI) 1320 gigawatt (MofEnv)	370 gigawatt (METI)	1380 gigawatt (METI)
Restricted scenario	290 gigawatt (METI) 280 gigawatt (MofEnv)	330 gigawatt (METI) 1570 gigawatt (MofEnv)	1170 gigawatt (METI) 1570 gigawatt (MofEnv)
FIT + 33% subsidies	200 gigawatt (MofEnv)	120 gigawatt (MofEnv)	120 gigawatt (MofEnv)

Table 3: this table shows different scenarios for the development of wind power. These scenarios have been prepared by Japan's Industry Ministry METI and by Japan's Ministry of the Environment. Similar scenarios have been developed by other agencies as well.

Japan's total installed electricity generation capacity today is approximately 250 gigawatt. Several proposed wind power scenarios show that Japan has the potential of producing substantially more than 250 gigawatt in nominal capacity. Therefore it can be assumed that wind power, if developed sufficiently, can cover all of Japan's electricity needs, provided that solutions can be developed to the issue of wind strength dependent fluctuations of wind power output.

This is an abbreviated form of the full table showing a wider range of scenarios, which can be found in our report on Japan's Renewable Energy Sector[42].

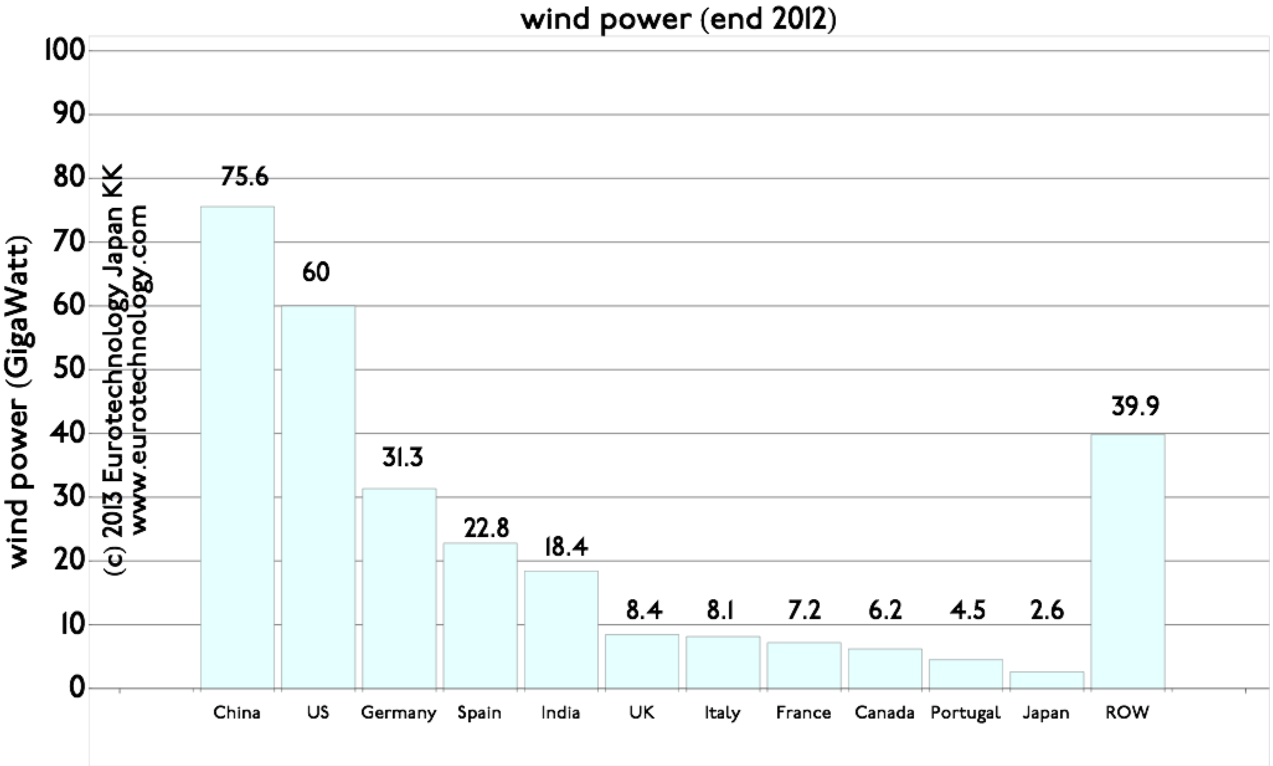

Figure 10: At the end of 2012, China, US and Germany are the countries with the highest amount of installed wind power, while Japan has about 1/2 as much wind power installed as Portugal. Japan's potential for wind power generation is very high, especially for off-shore wind power.

42 http://www.eurotechnology.com/store/j_renewable/

4.4 Geothermal energy

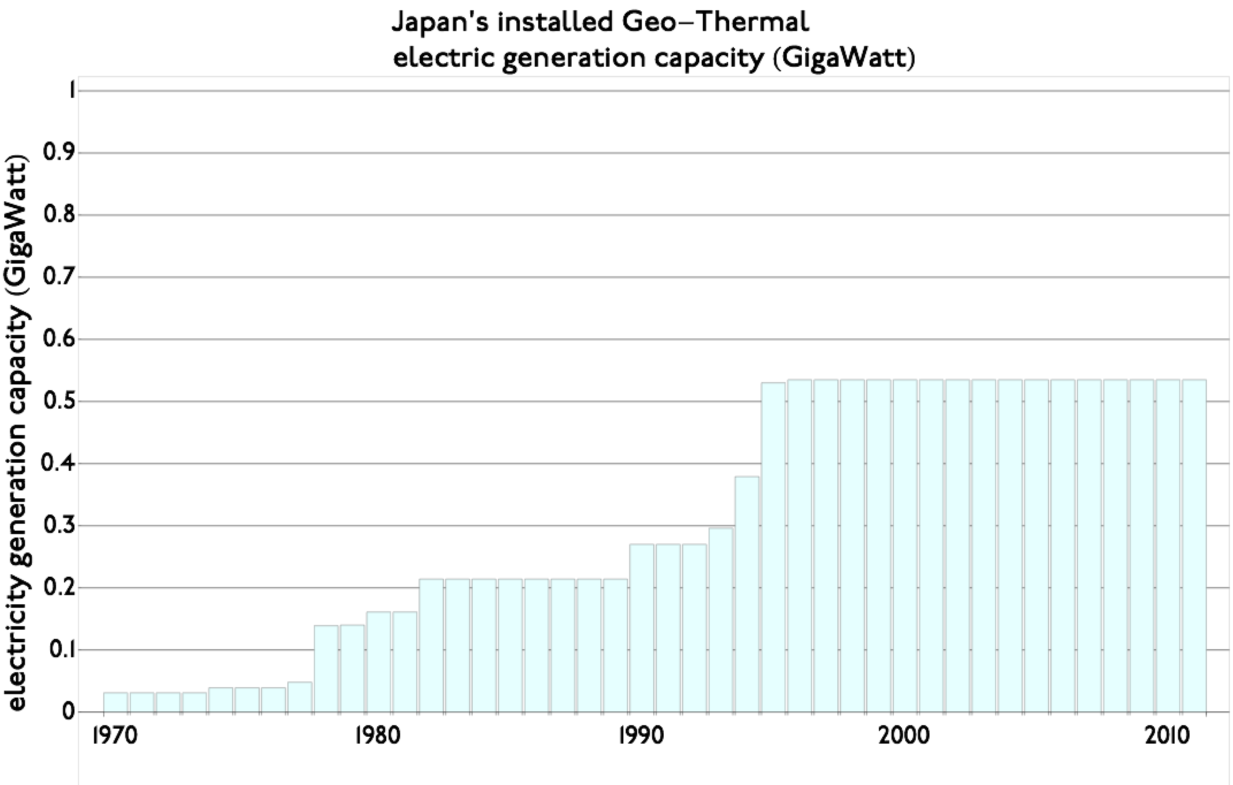

Figure 11: Geothermal energy in Japan was developed until 1995, and further construction of geothermal power plants was stopped in 1995. The author discussed this issue with Japan's geothermal industry association, and was explained that development of additional geothermal plants was stopped in 1995 because of the national priority on nuclear energy. Japan is among the countries with the highest potential for geothermal energy globally.

With the introduction of feed-in-tariffs, the development of new geothermal plants has now started again on a small scale. Geothermal plants are very slow to plan and build, since complex environmental impact assessment and often also the consent and cooperation of the local tourism industry is necessary. In some cases, locations for potential geothermal power plants are located inside Japan's National or Quasi-National Parks, which creates additional complications for obtaining the necessary approvals. It is often reported, that Onsen (hot-spring) resort owners are concerned that geothermal plants could interfere with the quality and temperature and views of Onsen hot-springs and drive tourists away.

Generally speaking, geothermal energy could potentially be very important for Japan, however development will take a long time, and even if fully developed is unlikely to cover all of Japan's energy needs.

Location of geo-thermal resource, type	developed	undeveloped geothermal generation capacity
geothermal generation capacity	0.533 gigawatt	22.9 gigawatt (estimated)
Japan's total installed electricity generation capacity	250 gigawatt	

Table 4 shows that if fully developed, geothermal energy is estimated to be able to potentially cover about 10% of Japan's total current electricity generation capacity. This table also shows that today only about 2% (= 1/50th) of Japan's geothermal generation potential has been developed.

4.5 Deregulation of Japan's electricity industry

The electrical power industry has essentially three components (not including equipment makers and service industries):

1. electricity generation
2. electricity transportation, grid
3. electricity sales and local distribution, including metering, invoicing and payment collection

and on the electricity usage side, the market is divided into three approximately equally sized sectors:

1. large industrial
2. medium size industrial
3. private home users, offices and small companies and stores, restaurants etc.

In many countries the electricity industry has been split into

- generation companies,
- one or more transportation or national grid companies
- and electricity distribution and retail.

In Japan, such a split-type liberalization has never taken place, and the electric power monopoly companies have always strongly and successfully resisted previous attempts of such liberalization.

Partial reforms a few years ago in Japan have not brought real change to this structure, mainly because of the resistance by the incumbent 10 regional monopoly electrical operators.

After the Fukushima nuclear disaster several influential leaders, including SoftBank Founder Masayoshi Son, are now demanding the liberalization and split of generation, grid and distribution. It will remain to be seen, whether such a liberalization will be carried out with full force. At the moment the author does see liberalization of the market in progress, but the liberalization is not carried out as quickly and as forcefully as it could be.

As long as electricity market liberalization is not fully carried out, independent solar energy producers, mega-solar power plants, wind farms, biomass or small scale hydropower and other new energy producers, need to sell their generated electricity via government mandated feed-in tariffs to the electricity operating monopolies which own the transportation grid and the distribution to end-customers. In this constellation, newcomers are always the junior partners to established utilities.

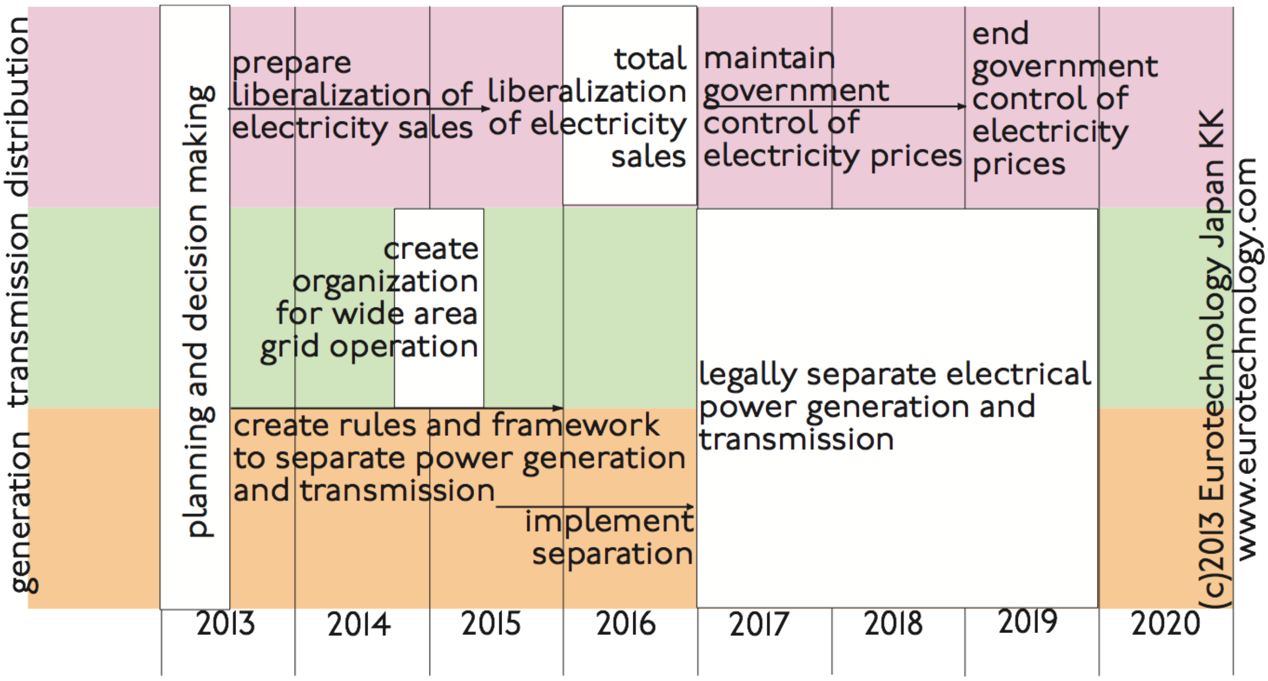

Figure 12: Electricity market liberalization is now under way in Japan, and is expected to lead to a more efficient energy market structure. The retail market will be liberalized during 2016. In the next phase, electrical power generation and transmission will be liberalized.

4.6 The EU Energy Efficiency Directive

The EU Energy Efficiency Directive is a complex framework which went into force as EU Law on 4 December 2012. Essentially every EU member state has to prepare a set of performance indicators and commit to achieve these performance indicators in a verifiable way.

The headline target is to save 20% of EU primary energy consumption by 2020, however the detailed regulations are far more complex than this headline target.

There is a large scope for cooperation between European and Japanese companies, institutions and individuals, and much cooperation is under way already. This section only gives several examples and indications about existing and possible future cooperation, joint ventures and investments.

5.1 Cross-border direct investments and M&A between EU and Japan

Cooperation between businesses can take many forms: direct investments and acquisitions are forms of cooperation, licensing and joint-ventures are others. Japanese companies have been particularly active in acquiring European companies in the energy field, here are some examples (for a listing of Japanese direct investments in European companies, see the EU-Japan direct investment register[43]):

- Toshiba acquires an additional 10% of NuGeneration Ltd from GDF Suez, making NuGeneration a joint-venture between Toshiba (60%) and GDF Suez (40%). NuGeneration is a nuclear power company planning a 3.4 gigawatt nuclear power plant in Cumbria (UK).

- Japan's JFE Engineering acquires boiler, biomass and waste-to-energy plant maker Standardkessel Power Systems Holding GmbH of Germany for approximately YEN 10 billion (US$ 87 million)[44].

- Hitachi Zosen Inova AG (HZI AG) acquires AXPO Kompogas Engineering AG (Komeng) of Switzerland. AXPO Kompogas Engineering AG (Komeng) is an EPC planning and constructing dry fermentation plants which produce biogas and compost from biological waste using the Kompogas process[45].

- Hitachi acquires UK based Horizon Nuclear Power from Germany's RWE and EON AG for UKL 696 million (US$ 1.2 billion). Horizon Nuclear Power is a nuclear power company planning to build nuclear power plants with up to 6 reactors delivering 5.4 gigawatt nuclear power at two locations: Wylfa Newydd (in Wales) and Oldbury in UK.

- Landis & Gyr AG Special Purpose Vehicle (Toshiba and others) acquires the smart-meter and smart-grid component maker Landis & Gyr AG (Switzerland) for US$ 2.3 Billion.

- Hitachi Zosen acquires Switzerland's AE&E Inova Holding AG, renamed to Hitachi Zosen Inova AG (abbreviated: HZI AG). AE&E Inova Holding AG developed from a department of the Gesellschaft der Ludwig von Roll'schen Eisenwerke for thermal waste treatment. Hitachi Zosen Inova AG is focused on: "Waste is our energy!"[46]

5.2 Renewable energy technologies

Both Japan and European countries have complementary technologies and there are many business opportunities. To select a few examples:

- Japanese companies have the largest global market share for geothermal equipment, and therefore Japanese geothermal equipment is installed for example in Iceland, and there is cooperation between Iceland and Japan in the development of geothermal power. Japanese geothermal equipment and know-how could be used in other European locations

---

[43] http://eu-japan.com/investment/japan-to-europe/

[44] http://eu-japan.com/2014/11/jfe-engineering-standardkessel/

[45] http://eu-japan.com/2014/11/hitachi-zosen-inova-axpo-kompogas-energy-from-waste/

[46] http://eu-japan.com/2010/12/hitachi-zosen-inova/

- European companies are very advanced in different forms of biomass. European biomass generation equipment is exported to Japan, and Japanese companies have acquired or invested in European biomass generation equipment companies.

- There is a large number of study tours by Japanese experts, and national and local government officials to learn from Europe's experience with deregulation and renewable energy, while European experts learn lessons from the Fukushima Dai-Ichi disaster.

- European companies and European countries are very advanced in the development, installation and operation of wind power. European companies have delivered wind mills to Japan, Japanese companies have invested in European wind farms, and there are certainly many more business opportunities in the wind farm sector.

5.3 Regulation, deregulation and cooperating with energy ventures

Europe includes many different countries, and each country, or groups of countries such as the Scandinavian countries, all have different regulatory regimes for electricity, gas and other energy industries as well as environmental energy regulations. Thus the variety of cases found in Europe is an excellent laboratory to see the advantages and disadvantages of different regulatory regimes. Indeed, many study groups have travelled from Japan to Europe to study European countries regulatory issues.

Japanese and European new market entrants into the electricity field, e.g. electricity venture companies cooperate.

5.4 Transnational grids and underwater cables

Globally the electricity grid is evolving. Several of the grid equipment and underwater cable companies are European, and they deliver equipment to Japan.

Japan has no electricity link to any other country, while there are many links between European countries including many transnational underwater cables, e.g. between the Netherlands and Norway.

It can be expected that Japan will in the future also be linked to at least some neighboring countries by underwater electricity cables. Europe and European companies have much experience in planning, constructing, building and operating international long distance underwater cables. In addition, European companies also have much experience in the commercial operation of such underwater cables to offer via commercial cooperation, investments, or joint-ventures.

5.5 Lighting industry revolution - kill the light bulbs and pseudo-green lighting

The global lighting revolution has the potential to save around 10% of global electricity consumption. Gallium-Nitride based LED lighting is far more efficient than traditional fluorescent tubes and incandescent light bulbs, which convert electricity mainly into heat, and which are very inefficient and short-lived light generators. Once these traditional light bulbs and tubes have reached the end of their relatively short lifespan, they become harmful waste, much more harmful than GaN LEDs, which also typically last 10 times longer and therefore produce far less waste.

GaN LEDs were invented by Shuji Nakamura, Isamu Akasaki and Hiroshi Amano who have been awarded the 2014 Nobel Prize in Physics[47] [48] for this invention[49], which is the basis for the global lighting industry revolution, making lighting far more sustainable and environment-friendly.

There is much business cooperation, cross licensing and other relationships between European and Japanese companies in the lighting business. Both Europe and Japan have very successful and important lighting companies, and all are active in GaN based LED lighting and other forms of modern lamps, including organic light emitters (OLEDs).

5.6 Green transportation

---

47 http://www.nobelprize.org/nobel_prizes/physics/laureates/2014/

48 http://www.eurotechnology.com/2014/10/09/shuji-nakamura-nobel-prize/

49 Shuji Nakamura, Stephen Pearton, Gerhard Fasol, "The Blue Laser Diode: The Complete Story", Springer Verlag, 2nd Edition, ISBN-13: 978-3540665052

Both Europe and Japan have great technology, R&D and operations for green transportation, ranging from Hydrogen-Vehicles, Zero-Emission Vehicles including electrical vehicles, battery technology, to rental bicycles, car sharing systems, and efficient train systems and street cars.

In many cases, European and Japanese strengths and weaknesses match up resulting in good opportunities. As an example, European countries have far more tram lines and light rail systems installed than Japan.

Japan on the other hand, has far more expertise in operating commercially efficient and high quality rail systems fully in the private sector at profit and without the need for government subsidies. Japan has a very thriving and successful and profitable private sector railway industry, while Europe has not such an industry (with a few exceptions). Again we see excellent opportunities for cooperation, investment and acquisitions in both directions for mutual benefit - both commercially and also for energy efficiency and our environment.

5.7 Nuclear technology

In the field of nuclear technology, both Japan and also European companies and countries have great technology and expertise, and many types of cooperation are underway, including Toshiba and Hitachi's investments in UK Nuclear Power Station developer companies, and many types of cooperation connected to the Fukushima-Dai-Ichi decommissioning work.

6. CONCLUSIONS

The Fukushima-Dai-Ichi nuclear disaster has shaken up Japan's energy and electricity sector and has triggered much overdue change, such as improvements in the nuclear industry regulatory environment, vastly accelerated development of renewable energy, and electricity market reform and liberalization. Many changes are underway in Japan's energy and electricity markets which present many new opportunities for cooperation and investments between Europe and Japan.

Japan has many technologies and fields of expertise, products, services and capital which are needed in Europe and vice versa. Many types of joint-ventures, market entrance, investments and acquisitions are underway, and we can expect many more to happen.

European investors operate power generation companies in Japan, and Japanese companies have invested in European energy and electricity generation companies.

We believe that the opportunities realized so far are just the tip of the iceberg, and we can expect much more cooperation, acquisitions, and investments between Europe and Japan in the energy field in the future.

7. ABOUT THE AUTHOR

Dr. Gerhard Fasol

http://fasol.com/

https://twitter.com/gfasol

In 1984, Gerhard Fasol recognized Japan's importance in technology and Japan's relatively weak links with the outside[50]. Fasol's company helps Japanese technology companies globalize, and builds foreign business in Japan. He is advisor to the CEO of a major Japanese electrical engineering company, helping to double their business within five years and Board Director of GMO Cloud KK[51]. He is curator of the Ludwig Boltzmann Forum[52] as a leadership platform.

---

50 http://www.eurotechnology.com/2013/10/07/galapagos/

51 http://ir.gmocloud.com/company/profile/

52 http://www.eurotechnology.com/events/ludwig-boltzmann-symposia/

Professional

CEO, Eurotechnology Japan KK — 1997–Present
Focusses on energy, IT and telecommunications, and builds foreign business in Japan. Prepared SIEMENS' entry into Japan's environmental technology markets, worked on NTT-Communications entry into Europe, helped a French pharmaceutical company acquire a Japanese factory.

Board Director, GMO Cloud KK — March 2014–Present
Duties of a Board Director, responsibility to take part in all major decision making of the company, in addition support further growth and development of GMO Cloud KK, a cloud services and internet security company.

Assoc. Professor, University of Tokyo, Electrical Engineering — 1991–1996
Project leader, "Sakigake" (=pioneer) R&D project on Spin-Electronics — 1993–1996 of Japan's Science and Technology Agency. Research in opto-electronics and spin-electronics[53].

Manager, Hitachi Cambridge Laboratory — 1990–1991
Tenured Lecturer in Physics, University of Cambridge — 1986–1990
Director of Studies, Teaching Fellow of Trinity College, Cambridge — 1986–1990
Staff Scientist, Max-Planck-Institute, Stuttgart — 1982–1986
Research Fellow, Trinity College Cambridge, UK — 1981–1985
Research in opto-electronics and semiconductors.

Education, books and research publications[54]

PhD in Physics, Cambridge University, Trinity College, UK.

Diplom-Physiker, Ruhr-University, Bochum, Germany. Scholar of the Konrad-Adenauer-Foundation for the promotion of students and graduates of exceptional academic achievement and outstanding political or social commitment.

Personal

Two boys. Born in Vienna Austria. Nationality: Austria (EU), permanent residence in Japan. Languages: German, English, French, Japanese, a little Swedish

---

Konrad-Adenauer-Stiftung
Japan Office

Tel +81 3 6426 5045
Fax +81 3 6426 5047

KAS-Tokyo@kas.de

www.kas.de/japan/en/
www.facebook.com/KAS.Japan

---

[53] http://www.fasol.com/gerhard-fasol/tokyo-university-fasol-lab/

[54] http://www.fasol.com/gerhard-fasol/publications/