Spring 2012

# Japan as a Clean Energy Leader

Stefan N. Norbom
*Gettysburg College*



Norbom, Stefan N. "Japan as a Clean Energy Leader." Gettysburg Economic Review 6 (Spring 2012): 58-73.

# Japan as a Clean Energy Leader

**Abstract**
Over the past several decades, Japan's energy strategy had positioned it as the world's leader in clean and efficient electricity production and usage. This strategy, heavily dependent on nuclear energy, was essentially destroyed by one of history's largest earthquakes, followed by a tsunami which overwhelmed five nuclear reactors on March 11, 2011. As of April 2012, all of Japan's 54 nuclear reactors have been shut down and it is uncertain when and how many may be restarted. This paper examines Japan's options for crafting a new way forward with an energy policy to power the world's third largest economy while taking into account the lack of domestic sources of fuel, high government debt, antinuclear sentiments and looming power shortages.

**Disciplines**
Economics | International Economics

# Japan as a Clean Energy Leader

*Stefan N. Norbom*

**Abstract**

Over the past several decades, Japan's energy strategy had positioned it as the world's leader in clean and efficient electricity production and usage. This strategy, heavily dependent on nuclear energy, was essentially destroyed by one of history's largest earthquakes, followed by a tsunami which overwhelmed five nuclear reactors on March 11, 2011. As of April 2012, all of Japan's 54 nuclear reactors have been shut down and it is uncertain when and how many may be restarted. This paper examines Japan's options for crafting a new way forward with an energy policy to power the world's third largest economy while taking into account the lack of domestic sources of fuel, high government debt, anti-nuclear sentiments and looming power shortages.

## Introduction

Japan's position as the clear leader in the area of clean energy has been threatened by the earthquake, tsunami and resulting nuclear disaster at the Fukushima Daiichi power plant. Japan needs to completely reevaluate its national energy strategy but this does not mean that Japan has to abandon its position a clean energy leader.

Over the past several decades, Japan has been a distinct leader in the area of clean and efficient energy. A Forbes special report published in 2008 listed countries leading in energy efficiency and the reasons why. Japan was #1 with energy (measured in BTUs per dollar of GDP) two-times more efficient than the US, more than 7 times efficient than China and 30 times more efficient than the Ukraine[1]

In general, much of this efficiency is driven by a country's stage of development and its access to fuel. Countries that are highly developed generally have higher technology and place more emphasis on productivity and quality of life than countries that are still pursuing quantum growth at any cost. Japan is highly

1 Zumbrun, Joshua. "The Most Energy-Efficient Countries." *Information for the World's Business Leaders - Forbes.com*. 07 July 2008. Web. 09 Dec. 2011. <http://www.forbes.com/2008/07/03/energy-efficiency-japan-biz-energy_cx_jz_0707efficiency_countries_slide_2.html>.

developed but has almost no domestic sources of fossil fuel, so it uses these precious imported resources as efficiently as possible. This is not only because of the cost of importing fuel, but also in the interests of economic security, in that more dependency on importing fuel, the greater the risk of external factors and other countries controlling the direction of the economy.

Another indication of Japan's leadership position in clean energy is their leading role in the development and adoption of the Kyoto Protocol, the United Nations Framework Convention on Climate Change (UNFCCC) on global warming, adopted December 1997 in Kyoto, Japan. The UNFCCC is an international environmental treaty targeting the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." As of September 2011, 191 states had signed and ratified the protocol, with the US being the only country to have signed but not yet ratified.[2]

With its focus on energy security, Japan's energy policy was highly dependent on nuclear as a source. Figure 1 shows how nuclear has become increasingly important to Japan's energy strategy. Starting in the 1960's, Japan installed nuclear reactors that supplied close to one-quarter of its electricity supply by 2004, and nearly 30% by early 2011 from 54 reactors in operation.[3]

2 Kyoto Protocol. (2010). In The Hutchinson Unabridged Encyclopedia with Atlas and Weather guide. Retrieved from http://www.credoreference.com/entry/heliconhe/kyoto_protocol

3 Cleveland, Cutler. "Energy Profile of Japan." *Encyclopedia of Earth*. 23 Apr. 2010. Web. 09 Dec. 2011. <http://www.eoearth.org/article/Energy_profile_of_Japan>.

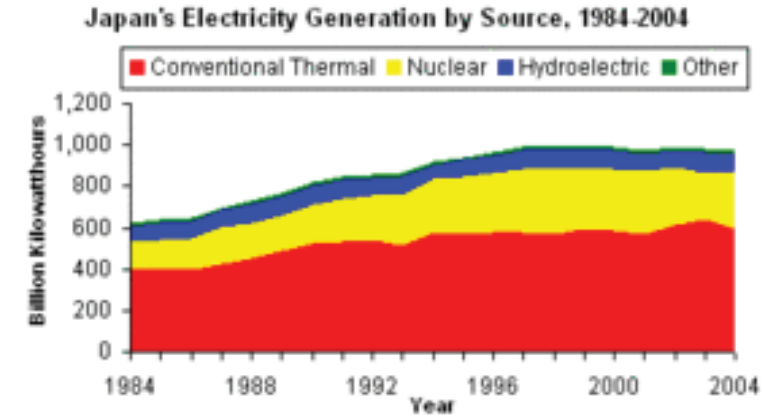


**Figure 1: Japan's electricity sources 1984-2004**

Furthermore, Japan's energy policy was set to grow its dependence on nuclear energy to more than 50% of its supply by 2030[4]. What could be better than clean energy with a virtually unlimited supply of fuel?

**A drastic change of plan**

At 2:46PM on Friday, March 11, 2011, the most powerful known earthquake to have ever hit Japan struck off its East coast. The earthquake had a magnitude of 9.0[5], and triggered a disastrous tsunami, with waves reaching heights of more than 40 meters (~130 feet) in the city of Miyako, in Tohoku's Iwate Prefecture. The earthquake knocked out the direct electricity supply to the cooling system of the Fukushima reactor, however backup power supplies were in place in the form of diesel generators and batteries. Then the tsunami struck the Fukushima plant with a wave more than twice the height of what the plant had been designed to handle. The two alternate sources of power were knocked out

4 Drysdale, Peter. "Japan's Energy Options after Fukushima." *East Asia Forum*. 5 Sept. 2011. Web. 09 Dec. 2011. <http://www.eastasiaforum.org/2011/09/05/japans-energy-options-after-fukushima/>.

5 Fackler, Martin. "Powerful Quake and Tsunami Devastate Northern Japan." *The New York TImes*. 11 Mar. 2011. Web. 9 Dec. 2011. <http://www.nytimes.com/2011/03/12/world/asia/12japan.html?pagewanted=all>.

and the cooling systems failed. No one could have anticipated or even imagined the triple disaster of March 2011 -- an earthquake, tsunami and a nuclear accident.

Without cooling, the most daunting of the problems facing Japan became containment after partial meltdowns in three reactors[6]. Radiation levels skyrocketed to 400 times the normal level. More than 200,000 people were evacuated from the surrounding areas. While still recovering from the severe loss of life and infrastructure, the events of March 11 forced Japan to begin evaluating options for a new energy strategy. Whereas Japan had considered atomic nuclear energy as the most promising path to a future with clean energy, a September 2011 poll by Japan's Mainichi Shimbun shockingly concluded that 74% of Japanese wanted to gradually phase out nuclear power completely. Following the crisis, former Prime Minister Kan announced future plans for a bottom-up review of the country's nuclear-focused Basic Energy Plan. Authored by the Ministry of Economy, Trade and Industry (METI) in collaboration with private power utilities, the plan announced the construction of fourteen additional nuclear power plants by 2030. Now Japan is forming a new national energy policy plan and is currently at a crossroads: should the country continue with their nuclear-centered plans based on economic security, or should Japan pursue another energy plan that may present a more acceptable path for its people?

**Considerations of the new strategy**

As the Japan government considers its strategy, there are several elements that need to be kept in mind and balanced:

*Cost* – What is the upfront investment and on-going costs give Japan's government debt already reached 220% of GDP?[7]

6 CNN Wire Staff. "3 Nuclear Reactors Melted down after Quake, Japan Confirms - CNN." *Featured Articles from CNN*. 06 June 2011. Web. 09 Dec. 2011. <http://articles.cnn.com/2011-06-06/world/japan.nuclear.meltdown_1_nuclear-reactors-fuel-rods-tokyo-electric-power?_s=PM:WORLD>.

7 "List of Sovereign States by Public Debt." *Wikipedia, the Free Encyclopedia*. 6 Dec. 2011. Web. 09 Dec. 2011. <http://en.wikipedia.org/wiki/List_of_sovereign_states_by_public_debt>.

*Speed of implementation* – How soon can this be implemented in a significant way?

*Long-term potential* – How soon can alternatives be implemented and what is the ultimate potential that an electricity source can provide.

*Energy security* – Does this fit Japan's goal of being economically secure with its energy sources?

*Cleanliness* – Does it meet Japan's goal of clean energy?

*Acceptance* – Will the public accept the solution?

The strategic investment options can be viewed as follows with a high level assessment (R being bad, Y being challenging, G being good) of each alternative based on the above factors. Also noted is the supply situation as of 2009, which shows the heavy reliance on nuclear and fossil (oil, LNG and coal):[8]

**Strategic Assessment (2009)**

| Generation | Supply | Cost | Speed | LT Pot | Secure | Clean | Accept |
|---|---|---|---|---|---|---|---|
| Nuclear | 27% | G | G | G | G | G | R |
| Fossil | 63% | G | Y | G | R | R | Y |
| Hydro | 8% | G | R | R | G | G | G |
| Renewables | <2% | R | R | G | G | G | G |
| Distribution & usage Smart grid | - | R | Y | G | G | G | G |
| Control consumption | - | G | G | G | G | G | Y |
| Green use | - | R | Y | G | G | G | Y |

**Table 1: Strategic assessment of energy investment options**

It is worthwhile to look at each of these areas to assess the relative benefits and negatives to being part of the new Japan energy strategy.

**Re-introduction of nuclear energy**

Today, only eleven of the fifty-four nuclear reactors in Japan are operating. Most of these were not affected by the March events, but have stopped operating due to the regulatory requirement for maintenance shut down every 13 months. To restart after maintenance, not only does the nuclear regulatory agency

8 "Japan." *Country Analysis Briefs*. Mar. 2011. Web. 9 Dec. 2011. <http://www.eia.gov/emeu/cabs/Japan/pdf.pdf>.

need to give its approval but also the local government. It is the second half of that process that is proving difficult – local government is voted in by the people and the majority of people are against nuclear. If no reactors are restarted, all 54 will be shut down by April 2012 – 13 months after the events at Fukushima.

This could put a tremendous strain on Japan's economy, as it is difficult to cope with eliminating 30% of the power supply within such a short period. As we saw in the strategic assessment, there is no way to instantly replace this supply shortfall. The only solution would be a reduction in consumption and then, over time, fossil fuel sources can be built-up, and renewables in the long run.

The following is the view of 50 major companies, both Japanese and US, that comprise the US-Japan Business Council (USJBC), which met in New York on December 1-2, 2011: "Japan has a world-leading nuclear energy industry. As with renewables, nuclear energy offers virtually emissions-free power generation and requires no fossil fuel imports. It accounted for about 30 percent of Japan's power generation capacity prior to the events of March. The Council recommends that Japan promptly re-start nuclear power stations after assuring their safety. It would be unrealistic to expect that other sources of power generation could be built rapidly enough to offset a complete elimination of nuclear energy, and the costs would be high. Jobs and economic development should also be considered. For Japan's industry to succeed internationally, it is imperative for the country to maintain a strong domestic nuclear energy capability."[9]

The USJBC view represents a less-emotional, more practical perspective given the alternatives available. Yet the political situation will make this difficult to accomplish without a great deal of analysis and debate.

**Conventional fossil fuels**

Although Japan's goal is move towards green technology that utilizes

9 Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011

renewable resources, conventional fossil fuels cannot be overlooked since it would take decades until renewable energy is a viable major source of energy. Currently Japan imports a high amount of liquefied natural gas (LNG), and with the recent discovery of unconventional gas reserves through shale, it seems more economically efficient and feasible to exploit this opportunity. One issue that Japan is currently facing as an importer of gas has to do with the scarcity of gas, which allows other countries with reserves to control and drive up the price. With the increase in supply of gas by 33%[10] (2015), which is due to the discovery of unconventional gas reserves, the overall prices of gas should begin declining (Refer to Figure 2). Recently the IEA has predicted that by 2035, unconventional gas will account for a staggering 35% of new global energy by 2035[11].As it becomes a more dominant source of energy, incentives will arise to innovate and create technology based solution that would mitigate the environmental impacts of gas thus making it even more clean.

Although coal has drawbacks of environmental pollution through the emission of green house gasses, coal currently is a reasonably priced fuel source[12]. Clean coal technology, while expensive, allows industries to capture the carbon that would be emitted prior or following the combustion process.

It is clear that fossil fuels need to be used to some degree, in the short-term in order to meet Japan's energy needs. Through innovation, firms will be able to minimize the environmental costs of fossil fuel use until renewable energy becomes a viable option in the long term. [13]

10 Presentation by Department of Energy Representative at USJBC Annual Meeting, New York City, December 1-2, 2011
11 Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011
12 Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011
13 Presentation by Department of Energy Representative at USJBC Annual Meeting, New York City, December 1-2, 2011

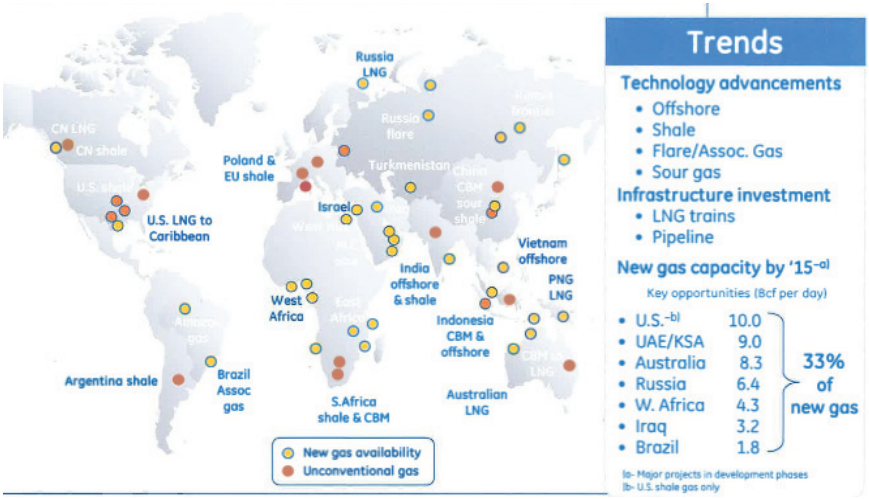


**Figure 2: Recent trends of gas energy**

**Hydroelectric power**

Hydroelectric power is clean and secure from an economic point of view, thus Japan has fully focused on exploiting this as a source of power and has grown capacity to 8% of total. Unfortunately, Japan has a limited geographic space and limited usable rivers and has already harnessed all major sources, so this does not represent a viable option for expansion in the future.

**Other renewable energy**

When considering renewable energy other than hydroelectric, the main alternatives are wind, solar and geothermal power. Prior to his resignation, Prime Minister Kan announced a bold objective to increase the supply of renewable energy from its current contribution of less than 10% to 20% by the 2020s. The planning agency of Japan's economy, METI (Ministry of Economy, Trade and Industry) outlined aggressive objectives for both solar and wind power as can be seen in the chart below:

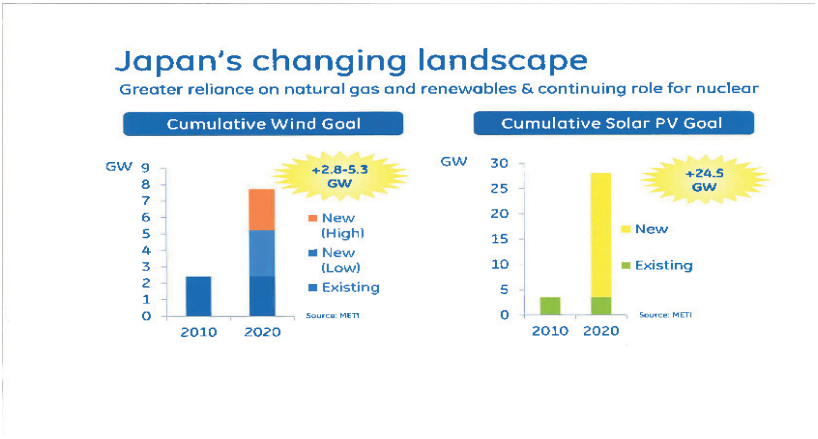


**Figure 3: Objectives for solar and wind power**

Geothermal was essentially considered as having little potential due to cost and, again, geographic limitations.

For any country, having a large supply of electricity from renewable resources provides numerous benefits. Specifically, renewable energy can be incorporated into Japan's electricity production strategies while not adding any greenhouse gas emissions to the environment. But incorporating renewable energy such as solar and wind power is no easy task. The following are obstacles that would need to be addressed: (1) The energy that would be produced from solar and wind are determined by the availability of sunlight and wind, therefore there is necessary research and development required in order to increase the efficiency and stability of these technologies; (2) Policies need to be developed to accelerate the onerous approval and review process currently in place in Japan; (3) at its current scale and technology, renewable energy is far more expensive than conventional fossil fuels, and (4) It takes a great deal of time and effort to build sufficient scale to be a significant contributor to the overall capacity. Because of these issues, Japan currently generates less than 1% of its power from solar and wind power but has committed, nonetheless, to move aggressively in

this direction. One recent positive sign -- the Action Plan to Stabilize Energy Demand-Supply was announced on November 1st, 2011, and this plan will address the regulations making renewable energy a more viable energy option.

In terms of the costs of wind and solar energy, technology has advanced at an incredible rate and the cost gap is closing on conventional fossil fuels. Some believe that, if the cost of CO2 and other emissions are considered, the cost equation is even closer. As an example, technology has advanced in the wind turbine area so that a single wind turbine can support the energy needs of 700 homes today versus only 420 homes in 2005.[14] Similar advances have been made in the solar energy area.

Technology advancements in storage and transmission and management can also address the stability of these power sources, but again this will take time. While solar and wind can be a major contributor to Japan's power supply, there will need to be other solutions to fill the short and medium term needs of the country.

**Distribution and usage control**

One major opportunity for Japan lies in the integration and distribution of technology that can control the usage of energy resources, which is further enforced by the estimate that only 70% of energy produced actually is productively used.[15] Through three major improvements, enormous benefits can be captured: Japan currently has one grid operating on a 60 Hz and one on a 50 Hz[16], one supplying the east and one supplying the west. This network connection issue is problematic because of the reduction in flexibility if one system experiences a power outage. Following the March 11th tsunami and earthquake, the two incompatible systems prevented eastern Japan from "borrowing" electricity from western Japan. A second issue is the grid reliability: through developing smarter

14 USJBC Annual Meeting, New York City, December 1-2, 2011
15 USJBC Annual Meeting, New York City, December 1-2, 2011
16 Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011

software systems the grid reliability and efficient usage of energy can be greatly improved. As recommended by the USJBC members, the United States and Japan should work together and develop a framework that will increase the efficiency of the distribution grids, through the integration of information and communication technologies into the already existing infrastructure[17]. The final improvement involves research and development in order to improve energy storage capability. Doing so would have three major benefits: (1) Secure supply to critical operations and facilities (examples: hospitals, communications, and nuclear power plants). (2) Facilitate energy stability management and peak demand. (3) And the successful integration of renewable energy into grid[18]. Therefore there is also a need for innovation in developing superior large size batteries to bring stability to the grid systems, particularly to renewables sources that have inherent variability.

The Japanese Government successfully established power-saving targets to avoid rolling blackouts in various areas of Japan during the peak summer season. Major users of electricity cut their consumption by up to 25%, while smaller industries reduced electricity consumption by 20%, and household 15-20%[19]. The potential energy efficiency increase could be enormous by incorporating a demand side program, which would increase the consumption and distributions of energy sources.

**Supply or demand-based solutions – the Nautilus proposal**

The Nautilus Institute for Security and Sustainability, located in San Francisco, Seoul, and Melbourne have analyzed and suggested that there are essentially two approaches to the problem – either central supply control or demand and usage control.

17 Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011

18 Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011

19 "BBC News - Japan Sets Power-saving Targets to Avoid Blackouts." *BBC*. 8 Apr. 2011. Web. 09 Dec. 2011. <http://www.bbc.co.uk/news/business-13008846>.

The Tokyo Electric Power Company (TEPCO) provides electricity to nearly 45 million people or 35% of Japan's population, while 12 million others are served by Tohoku Electric Power Company. Both TEPCO and Tohoku have announced power rationing programs, including rolling blackouts in many areas not affected by the earthquake and excluding central Tokyo[20]. Clearly TEPCO and Tohoku will struggle to fulfill Japan's electricity needs in the short term. The alternative "Best Case" scenario strategy, as outlined by Nautilus, focuses on the inevitable supply shortfall the two electric companies will experience, and which is likely to last five years. During this time, the condition of the existing nuclear and thermal reactors would be evaluated. The plan would also promote firms and individuals to employ "demand-side" alternatives, or energy-efficient and energy-saving techniques and regulate electrical distribution at the customer site, rather than using central power stations[21]. This demand-side approach would aim to generate excess energy, which could then be distributed through a smart grid that can accept power inputs, and re-distribute at a local level. For example, an office building could be equipped with a photovoltaic array on the rooftop that helps power the building[22]. The grid approach would allow intermittent renewable energy use to be scaled up, together with an aggressive program promoting extremely efficient end-use technologies, as well as energy conservation and peak power management[23]. This approach is believed to be cheaper, quicker, environmentally cleaner, and less risky in the short and long run, than relying on susceptible costal thermal or nuclear power plants to fulfill the demand for power.

20 "See, for example Tohoku Joins Tepco in Rationing Power", *Japan Times*, March 16, 2010, [retrieved 17 March 2011] <http://search.japantimes.co.jp/cgi-bin/nn20110316a5.htm>.

21 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

22 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

23 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

The Nautilus report compares two approaches to the issues faced by Japan: The first deals with energy efficiency, renewable energy and distributed generation (EE/RE/DG) estimated to cost US$11 billion per year.[24] The second includes central station gas and nuclear plants, estimated at US$10 billion/year.[25] Cost not withstanding, the long and short term benefits of each option provide very different results.

While the EE/RE/DG scenario is more costly in the short-run, over time as the program is deployed, it should prove to be a more cost-effective solution when taking into account the benefits of an early recovery that would otherwise result in unmet electricity demands. In addition, the demand-side management program, which would begin in the TEPCO/Tohoku service territories, ramps up so quickly that by the second year of the program, it saves 2% of sales annually. The program commands quick deployment over the next four years of energy-efficient and renewable sources, and consumer-site, gas-fired generation. Based on initial estimates, the program would be able to provide 81 TWh of delivered electricity supplies annually after the four-year implementation stage, in addition to 22 GW of delivered summer peak power[26]. This option would also bring emissions of 50% less carbon dioxide, which would aid in Japan's ambitious green house gas emission reduction goal, supporting the development of a "green economy." Another benefit is the ease of implementation. Although costly, it would begin producing and saving power immediately, in comparison to the central station option which would take three years or longer to implement, which would mean high costs from unmet electricity demand. While the EE/RE/DG program would

24 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

25 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

26 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

cost 14 cents/kWhe, the central station alternative would amount to 12 cent/kWhe, but considering the uncertainty of the central station alternative, the cost would be much higher than 14 cent/kWhe[27]. The destruction caused by the March disasters means Japan will rebuild a significant amount of infrastructure, at an estimated cost of US$310 billion. New infrastructure provides an opportunity to supply electricity grids, factories etc. with the most energy-efficient technology, incorporating "smart grid" technology[28]. The benefit of pursuing EE/RE/DG is difficult to calculate, but the marginal cost needed to bring improvements could create incentives for investment into larger market energy efficiency, demand-side technologies (such as solar hot water and solar photovoltaic systems) and distributed generation in Japan[29]. And the estimated total savings from this approach would be significant and possibly displace 50 million tons of carbon dioxide from thermal power plants.[30]

**A holistic approach with emphasis on demand side control**

At the USJBC Annual Meeting on December 1st and 2nd, it was extensively discussed to take a holistic approach by creating an intelligent and diverse energy system.[31] In doing so it will decrease the risks and costs associated with energy supply and production while at the same time making Japan's energy processes more cost-effective and efficient. The common opportunity presented in this approach, but more heavily stressed in the Nautilus approach, is the focus

27 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

28 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

29 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

30 Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

31 Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011

on demand side programs, which entail capturing a greater proportion that 30% of the electricity wasted through improving the efficiency of existing systems while also cutting demand with improved technology, monitoring and controls. The practicality, emissions and low costs in comparison to alternative approaches, associated with demand side, indicates that greater emphasis should be placed on increasing energy efficiency through developing smarter systems.

The priorities under this approach with an emphasis on demand-side efficiencies would be as follows:

- Close the short-term supply-demand gap through 1) policies and incentives to encourage overall and peak demand reduction; 2) restart the newer nuclear reactors located in areas considered safe from earthquakes and tsunami risk.
- Formulate policies to increase the research and development and manufacture of smart grid, energy storage and clean distributed energy solutions to reduce the need for energy supply.
- Encourage installation of the most efficient gas-generated thermal energy systems as these are the cleanest and lowest overall cost (inclusive of consideration of emissions) alternatives to nuclear power that can be installed within the short term and take advantage of the new supply of unconventional gas.
- Put in place policies and incentives to encourage the rapid installation of renewable energy systems as these will be clean, cost competitive solutions in the long term, but need to be started now to be a significant part of the solution.

With these priorities in place, Japan can quickly address its energy needs and move confidently into the future with a clear path to maintaining its secure energy position and role as clean energy leader.

## References


"BBC News - Japan Sets Power-saving Targets to Avoid Blackouts." *BBC*. 8 Apr. 2011. Web. 09 Dec. 2011. <http://www.bbc.co.uk/news/business-13008846>.

Cleveland, Cutler. "Energy Profile of Japan." *Encyclopedia of Earth*. 23 Apr. 2010. Web. 09 Dec. 2011. <http://www.eoearth.org/article/Energy_profile_of_Japan>. Drysdale, Peter. "Japan's Energy Options after Fukushima." *East Asia Forum*. 5 Sept. 2011. Web. 09 Dec. 2011. <http://www.eastasiaforum.org/2011/09/05/japans-energy-options-after-fukushima/>.

CNN Wire Staff. "3 Nuclear Reactors Melted down after Quake, Japan Confirms - CNN." *Featured Articles from CNN*. 06 June 2011. Web. 09 Dec. 2011. <http://articles.cnn.com/2011-06-06/world/japan.nuclear.meltdown_1_nuclear-reactors-fuel-rods-tokyo-electric-power?_s=PM:WORLD>.

Drysdale, Peter. "Japan's Energy Options after Fukushima." *East Asia Forum*. 5 Sept. 2011. Web. 09 Dec. 2011. <http://www.eastasiaforum.org/2011/09/05/japans-energy-options-after-fukushima/>.

Fackler, Martin. "Powerful Quake and Tsunami Devastate Northern Japan." *The New York TImes*. 11 Mar. 2011. Web. 9 Dec. 2011. <http://www.nytimes.com/2011/03/12/world/asia/12japan.html?pagewanted=all>.

"Japan." *Country Analysis Briefs*. Mar. 2011. Web. 9 Dec. 2011. <http://www.eia.gov/emeu/cabs/Japan/pdf.pdf>.

Kyoto Protocol. (2010). In The Hutchinson Unabridged Encyclopedia with Atlas and Weather guide. Retrieved from http://www.credoreference.com/entry/heliconhe/kyoto_protocol

"List of Sovereign States by Public Debt." *Wikipedia, the Free Encyclopedia*. 6 Dec. 2011. Web. 09 Dec. 2011. <http://en.wikipedia.org/wiki/List_of_sovereign_states_by_public_debt>.

Ministry of Energy, Trade and Industry of Japan objectives announced summer, 2011

Presentation by Department of Energy Representative at USJBC Annual Meeting, New York City, December 1-2, 2011

"See, for example Tohoku Joins Tepco in Rationing Power", *Japan Times*, March 16, 2010, [retrieved 17 March 2011] <http://search.japantimes.co.jp/cgi-bin/nn20110316a5.htm>.

Supplemental statement on Energy and Environment, USJBC Annual Meeting, New York City, December 1-2, 2011

Von Hippel, David, and Kae Takase. "The Path from Fukushima: Short and Medium-term Impact of the Reactor Damage Caused by the Japan Earthquake and Tsunami of Japan's Electricity Systems." Nautilus Institute for Security and Sustainability, 11 Apr. 2011. Web. 9 Dec. 2011.

Zumbrun, Joshua. "The Most Energy-Efficient Countries." *Information for the World's Business Leaders - Forbes.com*. 07 July 2008. Web. 09 Dec. 2011. <http://www.forbes.com/2008/07/03/energy-efficiency-japan-biz-energy_cx_jz_0707efficiency_countries_slide_2.html>.