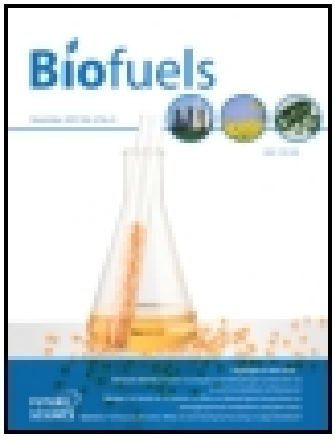


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# Rethinking renewable energy in Japan

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> "The success or failure of biofuels to become a major player in Japan lies squarely with the development of a coherent national energy policy, competitive production technologies and the appropriate socioeconomic infrastructure to bolster deployment."

**Blake Simmons**[†]

On Friday 11 March 2011, 14:46 JST, a magnitude 9.0 earthquake with an epicenter approximately 70 km east of the Oshika Peninsula of Tōhoku with the hypocenter at an underwater depth of approximately 32 km struck off the coast of Sendai, Japan [1]. The earthquake triggered tsunami waves that reached heights up to 38.9 m, which struck Japan. Some of the waves generated by the tsunami traveled up to 10 km inland. The earthquake and tsunami had a devastating impact: the Japanese National Police Agency has confirmed that over the 18 prefectures impacted by this catastrophic event, there have been 15,188 deaths, 5337 injured and 8742 people reported as missing [101].

The damage generated by the earthquake and tsunami resulted in a loss of 6800 MW of electric generating capacity at four nuclear power stations. This loss of nuclear power arose from a string of plant closures and nuclear accidents, with the most serious an ongoing level 7 event that has resulted in a 20-km (12-mile) evacuation zone established around the Daiichi Fukushima 1 Nuclear Power Plant, owned and operated by Tokyo Electric Power Company (TEPCO). The reactors were designed to handle tsunami waves with heights up to 6 m, but the nuclear power plant facility was hit by waves up to 14 m in height. The waves disabled the facility's emergency power generators that were required to maintain active cooling to the reactors to remove waste heat generated by the shut down reactors, and as a result a series of serious negative events occurred. The most serious of these are found in the explosions caused by hydrogen gas buildup in reactors 1 and 3, an explosion in reactor 2 that is believed to have damaged the primary containment vessel, and in the evidence of partial nuclear meltdowns in reactors 1, 2 and 3. Reactors 1, 2 and 3 at the Daiichi Fukushima plant all have substantial contaminated water in the basements of each reactor building, and there are indications that substantial damage has occurred in all three containment vessels. Reactor 4 is showing evidence of structural weakening due to damage generated by the explosions in the neighboring reactors.

As a result of these incidents and loss of containment, radiation has been leaked into the environment, generating concerns around public health and food safety. Two months after the initial string of events the situation is still far from under control, and it is expected that the efforts to re-establish active control to all of the reactors will continue through to January 2012, according to TEPCO. The fiscal damages associated with this nuclear incident are staggering – Merrill Lynch estimates TEPCO may face claims of up to US$136 billion in damages from this accident [102]. In short, from

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several perspectives, the Fukushima Daiichi nuclear accident could be considered the worst nuclear disaster in world history.

In light of these events and the growing realization of the impacts of the Daiichi event on the role of nuclear power in Japan, on 10 May the Prime Minister of Japan, Naoto Kan, made a very strong announcement to the world that Japan is dropping plans to double its nuclear power capacity and the construction of 14 new nuclear plants. He added that Japan will re-evaluate its national energy policy and will "start from scratch" by developing solar, wind and biomass energy supplies to build a robust supply of domestic renewable energy and decrease the nation's reliance on nuclear power [103].

Before discussing the options Japan has available in terms of potential renewable energy sources, it is important to first understand the complex energy production and consumption profile that exists in Japan today. Japan has limited domestic energy resources and currently produces only 16% of the energy consumed by the nation. In 2008, the total primary energy consumption in Japan was calculated to be approximately 22.3 quadrillion British thermal units [104]. Of all the primary sources of energy, oil is the largest energy resource in Japan, although its share of total energy consumption has declined from historically high values of approximately 80% in the 1970s to approximately 46% in 2008 [104]. In comparison, Japan is the third largest oil consumer in the world behind the USA and China, and Japan is the third largest net importer of crude oil. Furthermore, Japan is the world's largest importer of both liquefied natural gas and coal for energy and heat production. Japan is the third largest user of nuclear power in the world, after the USA and France. Unfortunately, hydroelectric (22 GW installed capacity in 2008), solar and wind power (combined 3.9 GW installed capacity in 2008) account for a relatively small percentage of the total energy consumed in Japan [104].

Biofuel production and consumption in Japan lags behind comparable efforts among several of the OECD nations. Increased resources and emphasis on this potential source of domestic energy supplies could make a positive impact relatively quickly over the next five to ten years if carried out strategically. Japan does not currently have a united strategy or set of national policies to encourage and promote biofuels, but rather has a range of documents and agreements in place that frame the topic and loosely define the overall national policy. One of these initiatives, The Biomass Nippon Strategy, is led by the Japanese Ministry of Agriculture, Forestry and Fisheries, and was the first roadmap strategy put forward in 2002 that addressed the utilization and conversion of lignocellulosic biomass resources in Japan. The Biomass Nippon Strategy has several familiar objectives: mitigation of global warming, development of a society that has low carbon intensity, development and maturation of new 'green' industries, and development of rural agricultural economies.

In addition, the New National Energy Strategy, issued by the Japanese Ministry of Economy, Trade and Industry in May 2006, established specific levels of production with the primary goal of improving Japan's energy security. Two out of the five stated goals are focused on the transportation sector: achieve 30% improvement in energy efficiency by 2030, and reduce the dependency of the transportation sector on oil from approximately 100 to 80% by 2030. The strategy aims to achieve the latter goal through a combination of improved engine efficiency, introduction of electric vehicles, introduction of fuel-cell vehicles, and introduction of new fuels, including biofuels. If the Japanese government is committed to increasing supplies of renewable, low-carbon domestic energy production, the establishment and implementation of a national energy policy with clear guidelines, goals and metrics for biofuels would provide added incentive to increase domestic efforts to boost production.

It is estimated that over the short term the biofuel production targets (50,000 kl by FY2011) established in the Biomass Nippon Strategy document can be met using available polysaccharides and starch-based feedstocks along with waste materials. It is important to note that Japan did plan on importing a large amount of ethanol from Brazil, but in terms of energy security it would be preferable for Japan to generate these biofuels domestically. One path to this outcome is found in the current biofuels program portfolio in Japan, where there are several pilot projects on lignocellulosic biofuels in Japan. Those that are found to be commercially viable could be rapidly scaled up by the government (using either direct funds or loan guarantees) to the commercial demonstration level in much the same fashion as the United States Departments of Energy and Agriculture has put in place. The Japanese government is currently funding approximately 11 projects, primarily through the Ministry of Economy, Trade and Industry and the Ministry of Agriculture, Forestry and Fisheries, focused on biofuel production – this number is relatively small with respect for the biomass resources currently available for conversion [2].

Over the middle- and long-term, Japan needs to fully resolve the technical, policy, and institutional challenges to produce biofuels from other sources such as lignocellulosic materials (e.g., rice straw, forestry residues and potential dedicated energy feedstocks). It is estimated that Japan has enough biomass resources of

this type to sustainably produce 6 million kl of biofuel if successful [2]. Another potential source of biofuels for Japan could potentially be found in microalgae and macroalgae that could be sited at locations that do not compete with traditional agriculture. Another option is to use the available biomass to generate biopower and directly replace the electrons currently generated from nuclear power. Another tool available to Japanese policy makers to boost domestic biofuel production is to increase the biofuel blending limits, which is currently set at 3% for ethanol and 5% for biodiesel. These rates are very low compared with other countries, and there is a substantial amount of codes and standards work in the USA and other nations that could be used to address any concerns with engine compatibility and engine performance. The increase in these blending limits and the establishment of aggressive production targets would spur the growth of the domestic biofuels industry in Japan.

In summary, the recent nuclear accidents in Japan have served as a wake-up call for the nation (and the world) to re-examine its energy portfolio and establish new directions and goals for realizing a sustainable low-carbon economy. One source of renewable energy that could be substantially increased over the next 5–10 years in Japan is found in biofuels and biopower. While the ability of biofuels and biopower to significantly contribute to Japan's energy security is constrained by the potential scale of domestic production, there is a significant amount of renewable biomass available for conversion into low-carbon biofuels and/or biopower. This activity would boost rural economies throughout Japan. The success or failure of biofuels to become a major player in Japan lies squarely with the development of a coherent national energy policy, competitive production technologies and the appropriate socio-economic infrastructure to bolster deployment. As with all biofuels and biopower efforts, it is vital that correct decisions on the location of cultivation and the choices of feedstock are made. If done correctly, biofuels and biopower can be a robust and vibrant domestic energy industry for Japan.

## Financial & competing interests disclosure

*The author has no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.*

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