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Japan's Quest for Renewable Energy

Japan, for many years the symbol of safe use of nuclear energy, started to revise its focus on atomic power following the 2011 tsunami and Fukushima plant meltdowns. After the accident, atomic plants were shut down, and in 2012, the government declared its commitment to the diversification of energy sources, working towards making the country renewable energy-powered.

Yet this wishful thinking was soon confronted with the reality of slow growth of renewable energy generation. In April 2014, a new energy plan re-designated coal as an important long-term electricity source, with similar importance given back to nuclear power. While Japan is unlikely to abandon fossil fuels and nuclear power in any foreseeable future, the shifting focus and public reluctance to atomic power gave start to a more dynamic development of renewable power generation technologies.

Several projects across solar, hydro, biomass, and to a lesser extent geothermal, had already been developed prior to Fukushima accident, but it is now the time for Japan to embrace its renewable energy potential at a larger scale.

June 2014

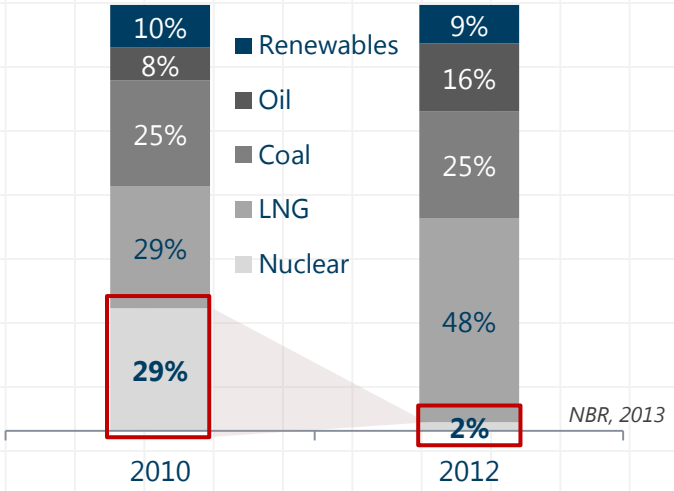
Since 2011, Japan Has Embarked On A Road To Reduce Its Reliance On Nuclear Energy

- Following the March 2011 earthquake and the aftermath of Fukushima nuclear plant crisis in Japan, there has been a considerable decrease in trust in nuclear energy; this change in sentiment, or even growing resistance towards nuclear energy, has been a direct result of the realization of the actual costs and dangers associated with this type of power generation
- Before the Fukushima accident, Japan was the world's third largest producer of nuclear power after the USA and France, however, post the meltdowns, majority of nuclear power has remained switched off
  - This has brought a considerable change in Japan's energy mix, with nuclear providing some 2% of energy in 2012, compared with 29% in 2010; as of February 2014, all of the country's 54 nuclear reactors were offline, with plans for some of them to reopen only if they meet new, stricter safety guidelines to be developed by Japan's Nuclear Regulation Authority by July 2014
- While decision makers, led by Prime Minister Abe, would obviously want to see several of the nuclear plants go back online, the social acceptance has decreased to a level where it cannot be ignored; moreover, while it is very much likely that some of the nuclear plants will come back online, the plans for new nuclear energy projects development are more than likely to be shelved for quite some time

- Despite the change of sentiment, nuclear power is not taking a backseat yet, and the government reiterated in 2014 that nuclear remains an important energy source in Japan
- Government's resistance to discard nuclear energy is unsurprising, as following the Fukushima accident, Japan has tried to make up for the lack of nuclear power with other energy sources, leading to an increase in its annual imports of fossil fuels by JP¥3.6 trillion (US$34.9 billion) over the levels prior to March 2011
  - This resulted in a continuous trade deficit, increased electricity rates, which started to affect household and business budgets
  - These economic burdens were not to be eased quickly as it has become part of Japan's revised energy policy that the dependence on nuclear energy will be gradually reduced, which would further increase the social and economic costs of importing energy

"Costly fossil fuel imports have helped push Japan into a trade deficit for a third consecutive year as the country's nuclear plants remain off line. Preliminary 2013 figures released by Japan's Ministry of Finance reveal a deficit of JP¥ 11.5 trillion (US$112 billion), up 65% on 2012's deficit of JP¥6.9 trillion (US$67.5 billion). A major contributing factor has been the cost of the fossil fuels - especially liquefied natural gas (LNG) - that the country has been forced to continue to buy as the nuclear reactors that used to provide some 30% of Japan's electricity prior to the Fukushima accident of 2011 remain offline." – ***World Nuclear News, 2014***

Energy Mix in Japan
(% share, 2010 and 2012)



Between 2011 and 2012, majority of energy gap caused by nuclear plants remaining offline in Japan was compensated by LNG and oil

Source: Japan Times; Emerging Energy; EcoWatch; The Asahi Shimbun; Nikkei Asian Review; Arcticgas.gov; The National Bureau of Asian Research (NBR)

Japan Has Increasingly Introduced Robust Policies To Spur Renewable Energy Alternatives Growth

- Rising energy costs post Fukushima, made it evident that Japan needs to develop new energy policy and gave start to several projects in power plants using different – safer and renewable – sources of energy
- Japan started deployment of nation-wide program for clean, renewable energy, with feed-in tariff (FIT) introduction in mid-2012, a long-term subsidy program for electricity producers
  - Expanded from solar to include wind, biomass, small hydro, and geothermal generation, the new mechanism brought generous FITs to encourage electric utilities to purchase electricity made with renewable fuel sources, except nuclear
  - The program allowed for the development of some 1.4 GW of renewable energy capacity only between July 2012 and February 2013 alone

Renewable Energy Feed-In Tariff Mechanism

- *Producers of electricity from renewable energy sources (…) can sell all of their output to electric power companies for a certain period of time at prices determined by the government*
- *The current mechanism, put into effect in 2012, promotes the generation of electricity from what are sustainable but higher-cost sources*
- *The cost is borne by all users (both businesses and individuals) in the form of higher rates for the electricity they consume*

Nikkei Asian Review, 2013

Residential solar PV

Large scale solar PV

Wind

Geothermal

Biomass

Small/medium hydraulic

Electricity generated from these renewable sources is connected to and transmitted via transmission line of the electric utility company

Electric utility company pays a fixed price, set by the government, corresponding to the amount sent

Utility Company

Surcharge

Electricity Customers

The cost of power purchase at fixed price is shared by all electricity customers in the form of a surcharge

Source: The US Energy Information Administration; Japan Times; Emerging Energy; EcoWatch; The Asahi Shimbun; Nikkei Asian Review; Ministry of Economy, Trade and Industry of Japan (METI)

Generous Feed-in Tariffs Incentivise Development Of Renewable Energy Projects In Japan

Evolution of Japan's Feed-In Tariffs for Renewable Energy[1,2]

Energy Source	Plant size/type	2012 Tariff (JP¥ per kWh) Tax inclusive	2012 Tariff (JP¥ per kWh) Tax exclusive	2013 Tariff (JP¥ per kWh) Tax inclusive	2013 Tariff (JP¥ per kWh) Tax exclusive	Purchase period (years from start of purchase)
Solar	10 kW or more	42	40	37.8	36	20
	Less than 10 kW (purchase of excess electricity)	42	42	38	38	10
Wind	20 kW or more	23.1	22	23.1	22	20
	Less than 20 kW	57.75	55	57.75	55	20
Geothermal	15MW or more	27.3	26	27.3	26	15
	Less than 15MW	42	40	42	40	15
Hydro	1MW – 3MW	25.2	24	25.2	24	20
	200 kW –1MW	30.45	29	30.45	29	
	Less than 200 kW	35.7	34	35.7	34	
Biomass	Biogas	40.95	39	40.95	39	20
	Wood-fired - Timber	33.6	32	33.6	32	
	Wood-fired - Other	25.2	24	25.2	24	
	Wastes	17.85	17	17.85	17	
	Wood-fired – recycled wood	13.65	13	13.65	13	

Solar-generated electricity is the only energy type to have witnessed continuous year-on-year reduction in fixed prices to be paid by utility companies; this has been linked to a successful take off of solar generation, with the authorities now trying to encourage installations in other renewable energy types to diversify deployment of renewable energy sources

Power generated with other renewables has enjoyed unchanged rates since the feed-in tariff scheme introduction in 2012

In some renewables, the 2014 update issued by METI added new, previously not recognized power generation categories; this was to attempt to encourage diversified energy generation, e.g. offshore wind projects or upgrading existing electricity facilities and hydroelectric water pipes with already installed headrace tunnels; tariff for large scale offshore wind was set higher than for large scale onshore turbines, to encourage these more costly offshore installations in the face of lack of suitable onshore sites

Energy Source	Plant size/type		2014 Tariff (JP¥ per kWh) Tax exclusive	Purchase period (years from start of purchase)
Solar	10 kW or more		32	20
	Less than 10 kW (purchase of excess electricity)		37	10
Wind	20 kW or more		22	20
	Less than 20 kW		55	20
	Offshore		36	20
Geothermal	15MW or more		26	15
	Less than 15MW		40	15
Hydro	New facility	1MW – 3MW	24	20
		200 kW –1MW	29	
		Less than 200 kW	34	
	Utilizing existing headrace channels	1MW – 3MW	14	20
		200 kW –1MW	21	
		Less than 200 kW	25	
Biomass	Biogas		39	20
	Wood-fired - Timber		32	
	Wood-fired - Other		24	
	Wastes		17	
	Wood-fired – recycled wood		13	

METI

Note: 1 Every year, METI announces purchase prices for newcomers in the coming year under the FIT scheme for renewable energy
2 Tax-inclusive price and the tax-exclusive price are indicated, assuming that the tax rate may change in the future; prices are the same for the purchase of excess electricity produced from solar PV (less than 10kW), which is mostly intended for general consumers; the 2014 announcement by METI listed only 'Tax exclusive' prices

Source: The US Energy Information Administration; Japan Times; Emerging Energy; EcoWatch; The Asahi Shimbun; Nikkei Asian Review; Ministry of Economy, Trade and Industry of Japan (METI)

Solar Power – Full Steam Ahead

Omuta Mega-Solar Power Plant

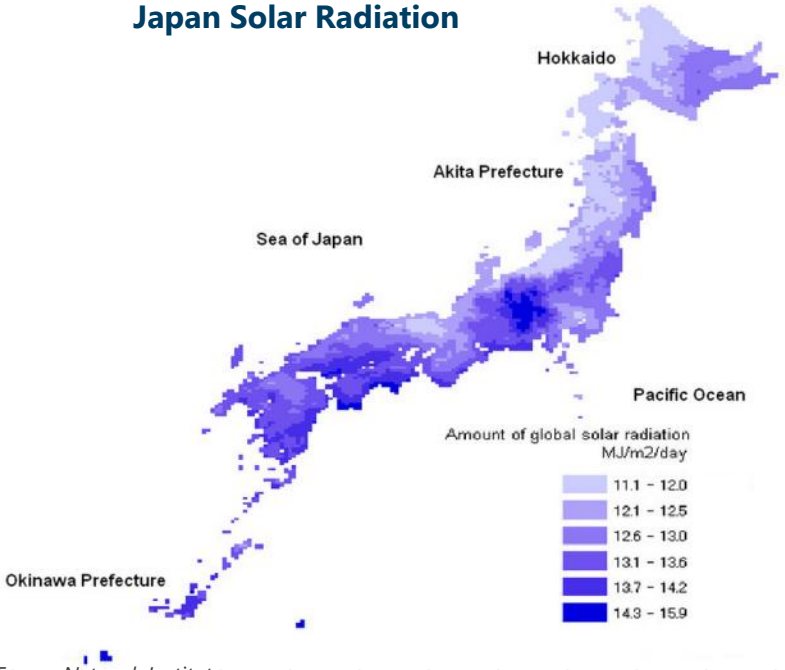
Solar Novus Today

Shinto Solar Power Plant

World Review

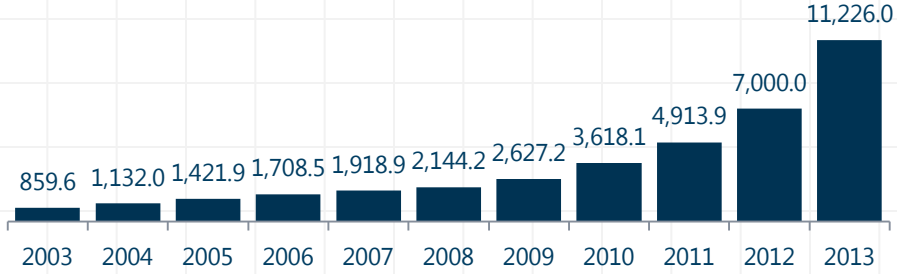
Solar Power Has Witnessed The Most Growth, Boosted By Pro-renewable Policies Post 2011

Japan Solar Radiation



Global Energy Network Institute

Japan Cumulative Installed Solar Power (MW, 2003 – 2013[1])



International Energy Agency , PV Magazine

- For the past two decades, solar energy in Japan has been growing, and Japan was the first country to cross 1 GW of cumulative PV capacity in 2004
  - Following Japanese Ministry of Economy, Trade and Industry (METI) subsidy program initiated in 1994, that covered 50% of the cost of PV systems, till 2005, Japan continued to have the largest installed PV capacity globally
  - Similarly to other renewables, solar energy growth slowed down in mid-2000s, giving space to nuclear energy development plans
- While the 2012-introduced FIT incentive program with payments above-market rates for all types of renewable energies, it was solar energy that witnessed the most growth, associated with investment in large-scale PV
  - Solar received the biggest boost from the incentive program as the FITs for solar projects were amongst the highest compared with other renewables (apart from small-scale wind)
  - The FIT rates for solar PV energy have been gradually reduced, however, this type of power generation continues to be attractive, as solar projects development and construction require shorter time than other renewable projects, therefore offer quicker returns
  - However, some forecasts indicate that the solar boom for large-scale solar power plants in Japan is likely to slow down in the next few years, driven by decreasing space availability and declining incentives
- This support program has led to Japan making up for the solar development slowdown since mid-2000s, advancing to a group of countries with over 10 GW of installed cumulative solar PV power, and becoming one of the world's fastest-growing solar markets, with over 5GW of new solar PV installations in 2013
- As of October 2013, Japan's total installed solar PV capacity was around 11.226 GW, having grown considerably over 2012 level (7 GW)

Notes 1 2013 data covers capacity as of October, and not the full year
Source: Japan Daily Press; Global Energy Network Institute; Clean Technica; PV Magazine; International Energy Agency

Japanese Solar Power Generation Has Seen Several New Large-scale Plants Being Opened

- With its current capacity exceeding 11.2 GW, Japan has been dynamically developing solar projects for the past couple of years; the government set a target to reach 28 GW of solar generating capacity by 2020, and 53 GW by 2030
- There have been several solar PV projects developed and opened since 2012, with Kagoshima Nanatsujima mega solar power plant being one of the flagship, major projects completed in 2013; several other projects have been opened, including a 30 MW mega-solar completed in February 2014 by Eurus Energy on Hokkaido island
- The number of solar PV projects that came online since 2012 has been so high that the cumulative power generated by solar plants outpaced the capacity of the energy grid, which led to limits on newly added solar output joining the grid
- Many currently developed projects are located in northern region of the country, Hokkaido, however power is needed in large cities in the south-eastern regions of the country, including Tokyo and Osaka; this leads to the requirement for investment in projects focused on energy storage, long distance transmission, and technologies compatibility improvements
- Additionally, further solar PV projects are likely to be encouraged outside of Hokkaido and northern parts of the country

Kagoshima Nanatsujima Mega Solar Power Plant

- Japan's largest solar plant – the Kagoshima Nanatsujima mega solar power plant was launched in October 2013 by Kyocera Corporation in Kagoshima Prefecture on Kyushu island
- The plant, with capacity of 70 MW and 1.27 million sq meters of solar panels, was built offshore, at investment cost of JP¥ 27 billion (about US$ 278 million)
- Through guided tours facility, the plant is also used to foster deeper understanding of solar energy to build social acceptance in anticipation of further renewable energy growth in Japan

Source: Japan Daily Press; Renewable Energy Focus; Business Wire, iTersNews; Berkley Energy & Resources Collaborative

While Most Solar Projects Install Local Equipment, Opportunities Exist Also For Foreign Suppliers

Current Developments

- There is a plethora of currently running projects, at varied stages of advancement, with new plants being opened virtually every few months; while no source tracks a comprehensive list of presently developed plants, some of the upcoming projects include:
  - A major combined solar and wind 56 MW plant in Aichi Prefecture to open in October 2014, developed by a consortium of 7 companies (including Toshiba, Mitsui, and Toagosei), at a total cost of JP¥ 8 billion (US$ 225 million)
  - A mega 400 MW solar power park on a remote island in southern Japan, off of the city of Sasebo, with output to be brought mainland via an undersea transmission line; developed by consortium including Photovolt Development Partners and Kyushu Electric Power, the project will cost about JP¥ 100 billion (US$1,036 million)
  - Multiple projects developed on Japan's northern island of Hokkaido, including a 111 MW plant developed by SB Energy and Mitsui to be opened in winter 2015, or Eurus Energy's JP¥8.6 billion large-scale solar project planned for Hokkaido's Shiranuka District; this led to METI planning to install a 60 MWh energy storage system by March 2015, to absorb and stabilize the grid on the island, at a cost of JP¥ 20.9 billion (US$ 204 million)
  - SB Energy and Mitsui are also partnering on a 42 MW project to be completed in 2015, comprising two plants on southern island Kyushu, where the largest Kagoshima plant is already located
  - Eurus Energy alone is currently building 5 solar power plants in Japan, with total target generation capacity of 192.5 MW
  - Amongst the currently developed projects there is also a set of 10 PV plant projects of 420 MW modules (supplied by Chinese ReneSola) for residential areas in mountainous parts of Japan; the project is to be completed in December 2015

Equipment and Know-how

- Much of technologies and equipment for solar projects can be sourced domestically in Japan, providing good level of independence and cost savings; most large scale projects are developed by consortia consisting of only Japanese companies
  - In Japanese solar PV market, domestic manufacturers dominate in installations projects, a trend expected to continue; leading domestic suppliers include Sharp, Kyocera, Panasonic, Solar Frontier, or Toshiba Corporation
  - Overall know-how, expertise, and technologies are also offered by local companies, such as Japan Asia Group, Nippon Paper, Toyota, Mitsubishi, Mitsui, and Tokuyama, which are only some of the active players in the country's booming solar market
- However, there is also scope for foreign equipment and technologies solutions providers, to supply certain components required in such projects, as despite good domestic supply, the demand is very high (e.g. PV inverters in Kagoshima Nanatsujima mega plant were supplied by German SMA Solar Technology)
  - Several foreign producers, such as US-based importers (e.g. SunPower, First Solar) as well as Chinese companies (ReneSola, JA Solar, Yingli Green Energy Holding, Trina, Suntech, or Chaori Solar), already exported considerable supplies of PV panels and other components in 2013 to Japan, expected to increase in 2014
  - Foreign suppliers face challenges, such as strict certification requirements and strong preference for Japanese brands – especially in residential segment (40% of demand in 2013); in large-scale projects foreign suppliers have been successfully partnering with local suppliers, therefore getting good access to the market

Source: Japan Daily Press; Clean Technica; SeeNews Renewables; PV-Tech; Nikkei Business Publications; PV Magazine; Solar Industry Magazine; IHS Technology

Geothermal Power – Slow Beginnings with Great Potential

Oita Prefecture Geothermal Plant

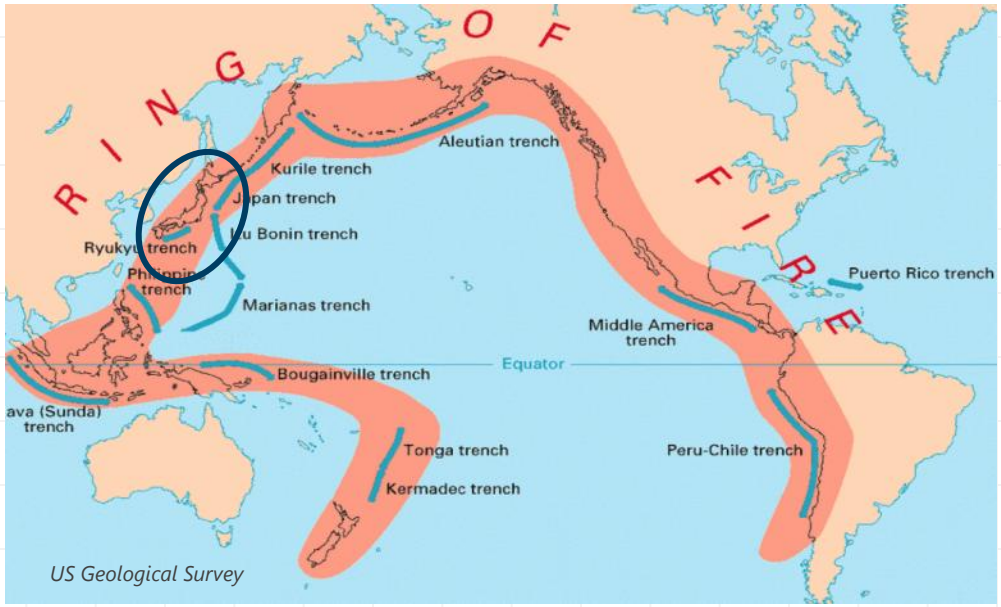
Japan Times

Yanaizu-Nishiyama Geothermal Plant

Panoramio

Geothermal Energy Offers Opportunities, With Japan Housing World's 3rd Largest Resource Pool

Japan Location on Ring of Fire



US Geological Survey

Geothermal Resources Worldwide			
Potential – Store of Resources (in MW)		**Capacity – Installed Production (in MW)**	
USA	39,000	USA	3,112
Indonesia	27,000	Philippines	1,967
Japan	**23,000**	Indonesia	1,189
Philippines	6,000	Mexico	887
Mexico	6,000	Italy	863
Iceland	5,800	New Zealand	769
New Zealand	3,700	Iceland	665
Italy	1,500	**Japan**	**502**

Nikkei Asian Review, 2013

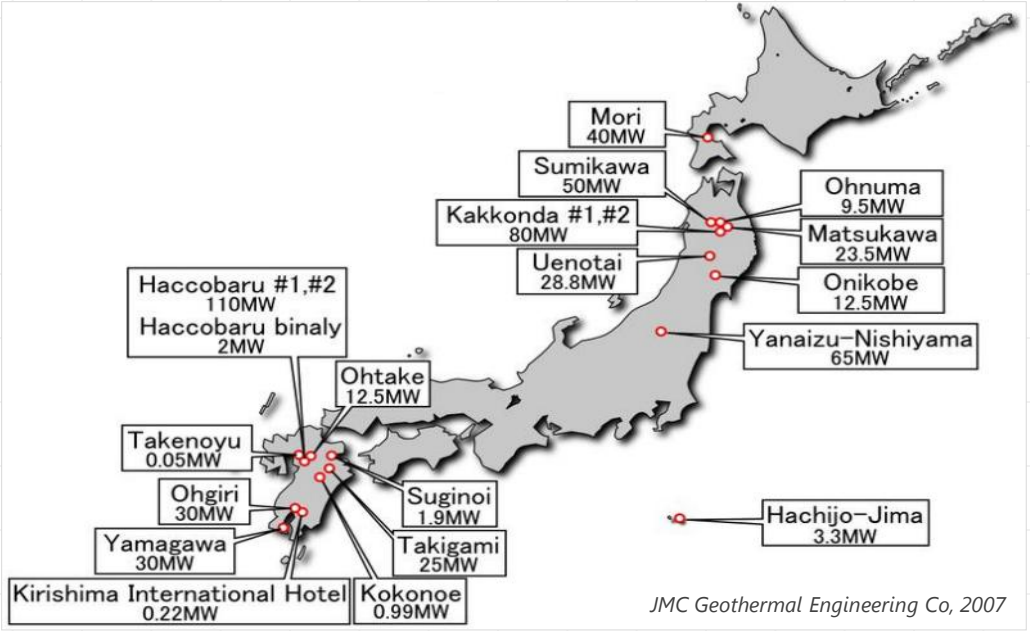
- Japan's geothermal energy potential appears enormous, as the country is located on the geologically active Ring of Fire, a string of volcanoes making the area seismically active around the edges of the Pacific Ocean
- The country is home to nearly 200 volcanoes, around 120 of them active, and large reserves of volcanic heat are available close to the ground surface
  - It is an attractive source of energy, as it is stable and reliable, available in great abundance throughout the day regardless of weather, and is not associated with risks and dangerous waste as is the case with nuclear power or traditional fossil fuels
  - It also offers the advantage of not polluting air, as it generates minimal amounts of CO_2, a factor of great importance in the face of an increasing pressure to reduce CO_2 emissions to control global warming
- As Japan is attempting to build a more diversified energy mix, it wants to avoid overdependence on a single source (even a renewable one), which has spurred an increased interest in geothermal energy in post-Fukushima Japan
- Being a land of volcanoes, the country has a considerable potential in geothermal energy estimated at 23,000 MW of power from underground heat (placing it third after the USA and Indonesia)
- Yet, the actual installed capacity lags behind, and currently, Japan has some 17 geothermal plants online (18 in 2007), with just above 500 MW of capacity (about 533 MW in 2007) accounting for about 0.2% of Japan's electricity

Source: US Geological Survey; National Geographic; The Asahi Shimbun; AsianPower.com; Nikkei Asian Review; Bloomberg; Japan Times; Deutsche Welle; Oilprice.com

In Its Quest For Clean Energy, Japan Eased Restrictions On Geothermal Plants In National Parks

- Japanese Ministry of Economy, Trade and Industry (METI) is considering 21 geothermal projects in addition to the existing 17 plants, in recognition of the significant potential of geothermal power
  - If capacity corresponding to the country's potential of 23,000 MW was installed, it would be equivalent to the output comparable to 20 nuclear plants
- Geothermal energy generation received a kick-start in 2012, when, in the attempts to drive renewable energy growth, the government altered the rules, which previously limited projects in national parks; these parks, coincidently, house over 60% of geothermal resources available in Japan
  - In 2013, METI declared its support for the development of geothermal energy in Japan's 16 regions, while the government proposed to shorten the lead times for environmental assessments required for geothermal power stations development in national parks
- The loosening of these regulations was an important step for geothermal projects, as since 1970 no new construction of geothermal plants was allowed in national parks, apart from those already existing (6 plants at that time)
  - This meant that the development of power generation with geothermal energy received very limited attention for several decades, except for a couple of geothermal plants opened in the 1990s

Japan Geothermal Power Plants (2007)



JMC Geothermal Engineering Co, 2007

Haccobaru Geothermal Power Plant

The Asahi Shimbun

Matsukawa Geothermal Power Plant

AsianPower.com

Source: JMC Geothermal Engineering Co; Nikkei Asian Review; Bloomberg; Japan Times; Deutsche Welle; Oilprice.com;

Regulatory Changes Have Opened Up Opportunities For Geothermal Projects To Push Forward

Current Developments

- Since early 2013, several geothermal surveys have been conducted, including five projects in the country's four national parks
  - These studies are still under way, and it will be several years before such plants can become operational, as following the studies, test drilling has to be approved and conducted, as well as location suitability must be assessed, a process that typically takes up to a few years
  - Some of these projects include survey in Daisetsuzan National Park in Hokkaido by Marubeni, or a survey in Akita Prefecture National Park by Idemitsu Kosan
- While a considerable expansion and commercial deployment of geothermal capacity is likely to occur only in the next several years, as soon as in April 2014, a new geothermal plant is be opened in Kumamoto Prefecture by Chuo Electric Power, the project being Japan's first geothermal power plant going online since 1999
  - The new plant is a small scale project, with output capacity of about 2MW, and Chuo Electric Power announced further plans to build five more geothermal plants of a similar scale in the next five years
- Additionally, Orix and Toshiba are expected to complete works on a 2MW geothermal plant in Takayama, Gifu Prefecture, in the first half of 2015, a project to be followed by the construction of similar facilities in the Hokkaido, Tohoku, and Kyushu regions

Equipment and Know-how

- Japan holds a considerable advantage in the potential development of geothermal plants as it houses leading providers of geothermal equipment (Japanese companies boasting about a 70% share of the global market for geothermal power station equipment)
- Japan is an engineering powerhouse with the necessary solutions, technologies, and experience in this field
  - The development of geothermal energy projects is welcomed by turbine manufacturers, including Toshiba Corporation, Fuji Electric, or Mitsubishi Heavy Industries (which together hold more than 50% of global market for geothermal turbines)
  - These producers have already developed equipment and solutions used in this type of energy generation, but currently supply them mostly to foreign projects (where their turbines worked for several years, without malfunction or downtime)
  - Several technological challenges associated with geothermal power generation are increasingly tackled by the leading Japanese players, including development of systems and solutions to isolate impurities from hot underground water that damage the turbines, improvements in corrosion resistance coatings, or alterations to turbines designs to reduce scaling
- This readily available in-house know-how helps Japan develop geothermal infrastructure at lower cost, without the need to invest in R&D, import technologies, or being forced to engage with foreign suppliers, which often increases the costs and is associated with delays from procedural factors

Source: Mainichi.jp; Oilprice.com; Nikkei Asian Review; Bloomberg; Japan Times; Geothermal Energy Association Weekly Newswire; METI

Wind Power –
Still at the Verge of Taking Off

An Offshore Wind Turbine Off The Coast of Fukushima

Yoshikazu Tsuno/Agence France-Presse

Hokujo Dune Wind Farm

Nashino Hana Onsenkyo Area Tourism Association

Japan's Wind Power Resources Are Huge At 3,300 GW, With Usable Potential Of Some 1,800 GW

Estimations of Japan's Wind Energy Resources

Source:	Ministry of Economy, Trade and Industry of Japan (METI)			Ministry of Environment (MOE)		
Turbine type:	Inland	Offshore	Floating	Inland	Offshore	Floating
Abundance (with no restrictions)	1,550 GW 5.5 m/s	370GW 6.5 m/s	1,380 GW 6.5 m/s	1,320 GW 5.5 m/s	-	-
Potential (under some restrictions)	290 GW 5.5 m/s	330 GW 6.5 m/s	1,170 GW 6.5 m/s	280 GW 5.5 m/s	1,570 GW 6.5 m/s	
Grid capacity	About 10 GW			-	-	-

European Wind Energy Association

Japan Cumulative Installed Wind Power (MW, 2008 – 2013)

Japan Wind Power Association

- Wind power in Japan has also received a push to the forefront as a safe energy to increase its share in clean energy mix
- Wind power has great potential in Japan, given the country's location and vast coast line, which offers strong wind currents
  - The location also causes several technological challenges for the installation of wind farms, mostly due to severe weather conditions for wind turbines such as frequent typhoons or strong turbulence due to complex terrain
  - In offshore generation, 80% of Japan's resources are in depths greater than 100 meters, which is beyond the reach of the traditional bottom-founded turbines, and requires development of more complex and expensive floating turbines
  - Additionally, limitations on transmission grid capacity and its ability to absorb new wind-generated power remains limited, and works towards strengthening the grid interconnection between electric power companies is necessary to develop wind power potential
- The estimated cumulative wind power capacity in Japan stood at around 2.7 GW at the end of 2013, with 1,922 units operating on 414 wind farms
  - The y-o-y increase in cumulative installed capacity in 2013 over 2012 was about 2.8%, the lowest annual increase since 2003
  - While wind power generation is encouraged by FITs, its development continues to be hindered by strict environmental impact assessments (EIAs) that must be performed for all wind farms projects of over 10 MW capacity since October 2012
  - As of February 2014, some 3.8 GW of projects were under EIA procedures, with EIA requiring about 4 years to pass through, therefore a more considerable increase in installed capacity is expected upon the completion of the EIA procedures

Source: Japan Wind Power Association; European Wind Energy Association; Wind Power Monthly; Japan Renewable Energy Foundation

Development Roadmap Set A Goal For Wind Power To Supply 10% Of Electricity Demand By 2050

Japan Wind Power Goals		
Mid-Term Installation Goal (2020)	• More than 11 GW • About 22,000 GWh/year • About 2% of total demand	• Reduction of 10 M CO2t/year
Mid-Term Installation Goal (2030)	• More than 28 GW • About 54,000 GWh/year • About 5% of total demand	• Reduction of 25 M CO2t/year
Long-Term Installation Goal (2050)	• More than 50 GW • About 100,000 GWh/year • About 10% of total demand	• Reduction of 45 M CO2t/year

Japan Wind Power Association

Shin Izumo Wind Farm

Eurus Energy

- Japanese Wind Power Association listed a set of goals for wind power generation development, with long term objective of achieving over 50 GW of installed wind power production by 2050
  - The total target 50 GW capacity is to come predominantly from onshore turbines (i.e. 25 GW from onshore, 7.5 GW from offshore bottom-founded, and 17.5 GW from offshore floating turbines)
- It is uncertain whether the country will be able to achieve such goals, given that it already had not been able to meet its past target of 3 GW by 2010
  - Japan Wind Power Association indicated that the newly announced FIT for offshore energy (JP¥ 36 per kWh) is unreasonable, and only JP¥ 50 per kWh allows to raise the required funds to develop costly offshore wind power infrastructure
  - Therefore, these long term goals appear extremely ambitious, considering that as of 2013 wind power contributed only 1% of Japan's total power capacity (only some 45 MW of it being offshore generation); also as of 2013, Japan still has not crossed the 2010 goal of 3 GW capacity mark
- In attempts to push wind energy growth, the government launched a decade-long project in early 2013 to triple Japan's supply capacity for wind-generated electricity
  - The program assumes that public and private sectors will spend US$3.35 billion in developing wind power in Hokkaido and Tohoku regions, which are believed to offer the highest wind speeds; however, being predominantly rural areas, the electricity demand in these region is low, grid capacity is limited, and development of farms in these locations require investment in power transmission to regions with higher electricity demand
- Some of the recently commissioned wind farms and expansion projects include:
  - Launched in 2009, Shin Izumo 78 MW-capacity farm developed by Eurus Energy; the company also launched a 46 MW Takine Ojiroi farm in 2010 in Tohoku region, and expanded its existing Kunimiyama farm in Kyushu to reach a total of 35 MW in 2011, to name a few
  - Other additions include new 66 MW Nunobiki farm launched in 2007 by J-Power in Fukushima region, and 2010 expansion to an existing onshore/offshore Kamisu farm, which added 14 MW of offshore capacity to reach a total of 50 MW capacity, operated by Wind Power Ibaraki

Source: Japan Wind Power Association; European Wind Energy Association; Japan Daily Press; Marubeni; Wind Power Monthly; Japan Renewable Energy Foundation; The Wind Power Database

A Range Of Large Scale Offshore Wind Power Generation Projects Are At Early Development Stages

Current Developments

- While wind power projects are being developed less dynamically than e.g. solar projects, there are several wind installations under way
- In late 2013, at a cost of about JP¥ 22 billion (US$226 million), Japan launched experimental floating wind turbines set around 20 km off the Fukushima coast, considered as step toward development of the world's largest offshore wind farm
  - Conducted by the Japanese government (MOE and METI), these demonstration projects with two 2 MW floating wind turbines became world third and fourth MW class floating wind turbines
  - The Fukushima farm, operated now by Marubeni, is still in its infant stage, with plans to expand its capacity to over 1 GW by 2020, and upon the successful completion of tests, a group of private investors, including Marubeni, Mitsubishi, Nippon Steel, Mizuho Information & Research, Furukawa Electric, Shimzu, and Hitachi, committed they would finance full installation of all 143 floating wind turbines
- As majority of currently operating farms are onshore, with shortage of new suitable land sites, several offshore wind generation projects are planned or currently remain at a very early stages of development, with no details on cost, dates of completion, and/or investors
  - These include a 125 MW Ibaraki Kashima Port wind farm to be developed by Wind Power Ibaraki, 100 MW Ishikari Bay farm by Green Power Investment Corporation, 125 MW Kamisu Megasite farm by Marubeni, as well as a dramatic expansion of currently operating 600 kW Akita farm to increase its capacity to 1,001 MW

Equipment and Know-how

- As of 2013, Danish turbine maker Vestas Wind Systems, followed by GE, led the Japanese market in cumulative wind systems; Japanese players, which in 2011 held 66% share in the local turbine market, include Japan Steel Works, Fuji Heavy Industries, and Mitsubishi Heavy Industries
  - While Japan has several domestic providers of wind power generation equipment and solutions, the country is unlikely to be able to carry its wind farms development based exclusively on only local resources
- In offshore wind generation in particular, domestic resources seem to fall short to allow to tap the country's wind power potential
  - Japan appears to lack much infrastructure for offshore wind development, and there are only few domestic developers willing to engage in offshore wind power investment; the country also faces shortage of skilled human resources who own the experience of offshore construction at the site
- Public bodies are working to develop domestic know-how to allow to tackle problems caused by terrain and severe weather conditions
  - This has been attempted with new guidelines, which are proposed through the cooperative researches between industries and academia supported with NEDO (New Energy Development Organization) and METI
  - Additionally, local equipment producers are working on advanced turbines to allow operation in Japan's severe conditions of weather

Source: The Wind Power Database; Japan Wind Power Association; Japan Daily Press; Bloomberg; European Wind Energy Association

Clean Energy Became The Focus Post 2011; Whether It Will Remain A Priority Remains Uncertain

A FINAL WORD

- The Fukushima earthquake, to some extent, triggered the Japanese government's renewed focus on clean sources of power generation and in doing so, has become important in Japan's quest for reducing its reliance on nuclear energy
- The last few years have seen the introduction of several policy measures to boost the development and growth of renewable energy projects in the country, the most notable being the deployment of nation-wide program for clean, renewable energy, with feed-in tariff (FIT) introduction in mid-2012, a long-term subsidy program for electricity producers
  - The new mechanism brought generous FITs to encourage electric utilities to purchase electricity made with renewable fuel sources, except nuclear
  - The 2014 update issued by METI added new, previously not recognized power generation categories to encourage diversified energy generation, e.g. offshore wind projects or upgrading existing electricity facilities and hydroelectric water pipes with already installed headrace tunnels
- Interestingly, while solar is currently the dominant source of renewable energy, with about 11 GW of total installed capacity, Japan boasts of the third largest resource pool of geothermal energy globally and a massive wind power resource of about 3,300 GW
  - The potential for power generation from these three sources is significant, and if adequate investment and manufacturing incentives are provided to private enterprises, Japan could potentially have one of the largest renewable source of power generation in the world
- Over the years, Japanese companies have also developed strong technical and operational know-how, with several Japanese companies undertaking development of solar, geothermal and wind projects; an estimated 65-70% of all geothermal and wind project equipment are domestically produced

- There is no questioning the immense underlying potential that renewable energy sources have in Japan, and the earthquake did bring into fore the need to harness these energy sources to ensure long-term sustainability of power generation
- The bigger question is if Japan is ready and willing to discard its nuclear power generating plans of the future to materially impact how renewable energy sources are developed and how the government incentivizes private enterprises to help it develop the required infrastructure to harness the full potential of solar, geothermal, wind, and other renewable sources
- In which direction Japan is headed might seem unclear at the moment, but what is certain is that continued import of fossil fuels at the current rate will severely impact the economy of the country

Perspective

- **What is your perspective on Japan's quest for renewable energy? Is Japan likely to overcome its currently fossil-fuel driven energy generation to adopt greater energy generation from renewable sources?**
- **Which of the renewable energy forms is Japan likely to benefit most from? In which form of energy are the greatest business and investment opportunities available to both local and international companies?**

- **We would like to hear from you. Write to us with your perspective at rediscover.research@eos-intelligence.com.**

Notes

About EOS Intelligence

EOS Intelligence is a professional services firm that delivers bespoke research solutions targeted at corporate planners and decision makers, and institutional investors.

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