

# Energy in Japan

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**Energy in Japan** refers to energy and electricity production, consumption, import and export in Japan. The country's primary energy consumption was 477.6 Mtoe in 2011, a decrease of 5% over the previous year.<sup>[1]</sup>

The country lacks significant domestic reserves of fossil fuel, except coal, and must import substantial amounts of crude oil, natural gas, and other energy resources, including uranium. Japan relied on oil imports to meet about 42 percent of its energy needs in 2010.<sup>[2]</sup> Japan was also the first coal importer in 2010, with 187 Mt (about 20% of total world coal import), and the first natural gas importer with 99 bcm (12.1% of world total gas import).<sup>[3]</sup>

While Japan had previously relied on nuclear power to meet about one fourth of its electricity needs, after the 2011 Fukushima Daiichi nuclear disaster all nuclear reactors have been progressively shut down for safety concerns.<sup>[4][5]</sup> Ōi Nuclear Power Plant's reactor No. 3 was eventually restarted on 2 July 2012.<sup>[6]</sup> As of January 2013 most cities hosting nuclear plants state that they do not mind restarts.<sup>[7]</sup>

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## Overview

Energy in Japan <sup>[8]</sup>						
	Capita	Prim. energy	Production	Import	Electricity	CO <sub>2</sub> -emission
	Million	TWh	TWh	TWh	TWh	Mt
2004	127.7	6,201	1,125	5,126	1,031	1,215
2007	127.8	5,972	1,052	5,055	1,083	1,236
2008	127.7	5,767	1,031	4,872	1,031	1,151
2009	127.3	5,489	1,091	4,471	997	1,093
2010	127.4	5,778	1,126	4,759	1,070	1,143
2012 (Japan)	126.7	6,034	1,013	5,532	851 <sup>[9]</sup>	1,207 <sup>[10]</sup>
2012 (IEA)	127.8	5,367	601	4,897	1,003	1,186
Change 2004-10	-0.2 %	-6.8 %	0.0 %	-7.2 %	3.7 %	-5.9 %
Mtoe = 11.63 TWh, Prim. energy includes energy losses that are approximately 2/3 for thermal power stations <sup>[11]</sup>						

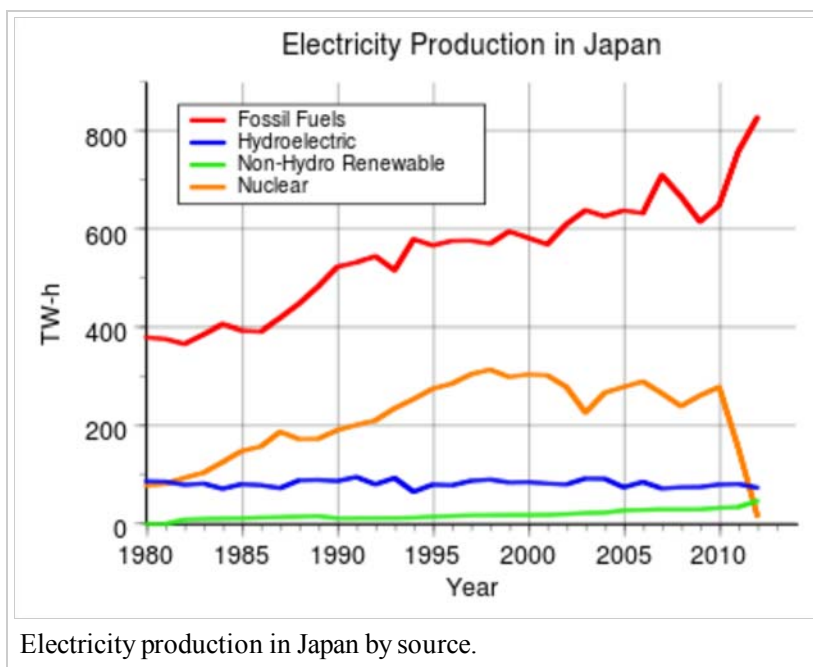


GDP versus energy consumption, 1978-2009

## History

Japan's rapid industrial growth since the end of World War II doubled the nation's energy consumption every five years into the 1990s. During the 1960–72 period of accelerated growth, energy consumption grew much faster than GNP, doubling Japan's consumption of world energy. By 1976, with only 3% of the world's population, Japan was consuming 6% of global energy supplies.

Compared with other nations, electricity in Japan is relatively expensive,<sup>[12]</sup> and, since the loss of nuclear power after the earthquake and tsunami disaster at Fukushima, the cost of electricity has risen significantly.<sup>[13]</sup>



Electricity production in Japan by source.

## Electricity

In 2008, Japan ranked third in the world by electricity production, after the United States and China, with 1,025 TWh produced during that year.<sup>[14]</sup>

In terms of per capita electricity consumption, the average person in Japan consumed 8,459 kWh in 2004

compared to 14,240 kWh for the average American. In that respect it ranked 18th among the countries of the world. Its per capita electricity consumption increased by 21.8% between 1990 and 2004.<sup>[15]</sup>

Japan had 282 GW of total installed electricity generating capacity in 2010, the third largest in the world behind the United States and China. However, after the damage by the 2011 earthquake, capacity is estimated to be around 243 GW in mid-2011.<sup>[2]</sup>

With 53 active nuclear power generating reactor units in 2009, that year Japan ranked third in the world in that respect, after the United States (104 reactors) and France (59).<sup>[16]</sup> Almost one quarter (24.93%) of its electricity production was from nuclear plants, compared to 76.18% for France and 19.66% for the United States.<sup>[17]</sup> However, after the 2011 Tōhoku earthquake and tsunami and the subsequent Fukushima Daiichi nuclear disaster, all plants eventually shut down in May 2012 and Ōi Nuclear Power Plant was restarted in June 2012.

## National grid

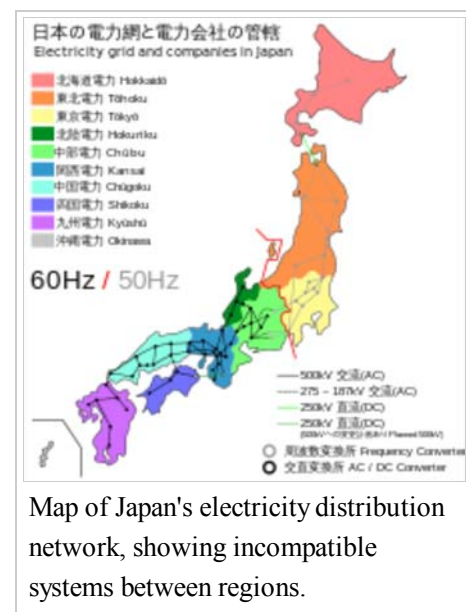
Unlike most other industrial countries, Japan doesn't have a single national grid but instead has separate eastern and western grids. The standard voltage at power outlets is 100 V, but the grids operate at different frequencies: 50 Hz in Eastern Japan and 60 Hz in Western Japan.<sup>[18]</sup> The grids are connected together by 3 frequency converter stations (Higashi-Shimizu, Shin Shinano and Sakuma), but these can only handle 1 GW.<sup>[19]</sup> A converter station also exists at Minami-Fukumitsu. The 2011 Tōhoku earthquake and tsunami resulted in 11 reactors being taken offline with a loss of 9.7GW.<sup>[19]</sup> The 3 converter stations did not have the capacity to transfer enough power from Japan's western power grid to significantly help the eastern grid.

The two grids were originally developed by separate companies. Tokyo Electric Light Co was established in 1883 which also established electric power in Japan. In 1885 demand had grown enough that TELCO bought generation equipment from AEG of Germany.<sup>[19]</sup> The same happened in the western parts of Japan with General Electric being the supplier to Osaka Electric Lamp.<sup>[19]</sup> GE's equipment used the US standard 60 Hz while AEG's equipment used the European standard of 50 Hz.<sup>[19]</sup>

## Utilities

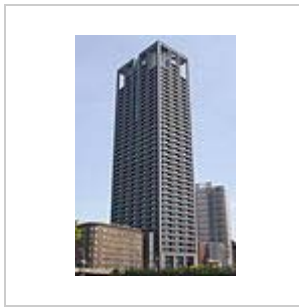
In Japan, the electricity market is divided up into 10 regulated companies:

- Chugoku Electric Power Company (CEPCO)
- Chubu Electric Power (Chuden)
- Hokuriku Electric Power Company (Hokuden)
- Hokkaido Electric Power Company (HEPCO)
- Kyushu Electric Power (Kyuden)
- Kansai Electric Power Company (KEPCO)
- Okinawa Electric Power Company (Okiden)
- Tokyo Electric Power Company (TEPCO)
- Tohoku Electric Power (Tohokuden)
- Shikoku Electric Power Company (Yonden)





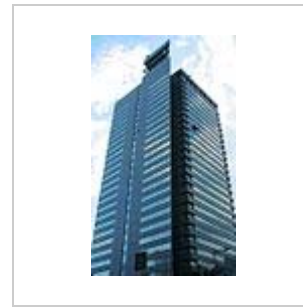
Tepco



Kepco



Chubu



Tohokuden



Kyuden

## Energy sources

In 1950 coal supplied half of Japan's energy needs, hydroelectricity one-third, and oil the rest. By 2001 the contribution of oil had increased to 50.2% of the total, with rises also in the use of nuclear power and natural gas. Japan now depends heavily on imported fossil fuels to meet its energy demand.<sup>[2]</sup>

In the wake of the two oil crises of the 1970s (1973 and 1979), Japan made efforts to diversify energy resources in order to increase security. Japan's domestic oil consumption dropped slightly, from around 5.1 million barrels (810,000 m<sup>3</sup>) of oil per day in the late 1970s to 4.9 million barrels (780,000 m<sup>3</sup>) per day in 1990. While the country's use of oil declined, its consumption of nuclear power and Natural gas rose substantially. Several Japanese industries, including electric power companies and steelmakers, switched from petroleum to coal, most of which is imported.

The state stockpile equals about 92 days of consumption and the privately held stockpiles equal another 77 days of consumption for a total of 169 days or 579 million barrels (92,100,000 m<sup>3</sup>).<sup>[21][22]</sup> The Japanese SPR is run by the Japan Oil, Gas and Metals National Corporation.<sup>[23]</sup>

## Nuclear power

Although Japan was a late starter in this field, it finally imported technology from the United States and obtained uranium from Canada, France, South Africa, and Australia. By 1991 the country had 42 nuclear reactors in

Japan—primary energy use <sup>[20]</sup>			
Fuel	1950	1988	2001 <sup>[20]</sup>
<b>Coal</b>	50%	18.1%	16.8%
<b>Hydro</b>	33%	4.6%	4.0%
<b>Oil</b>	17%	57.3%	50.2%
<b>Natural gas</b>	-	10.1%	13.6%
<b>Nuclear</b>	-	9.0%	14.4%
<b>Other</b>	-	1.3%	1.0%

operation, with a total generating capacity of approximately 33 GW. The ratio of nuclear power generation to total electricity production increased from 2% in 1973 to 23.6% in 1990. During the 1980s, Japan's nuclear power program was strongly opposed by environmental groups, particularly after the Three Mile Island accident in the United States. In the 2000s, Japan had a few of the world's most modern reactors, including some of the first new advanced Generation III reactors. A facility was built to enrich nuclear fuel, deal with nuclear waste, and recycle spent nuclear fuel.

After the 2011 earthquake and tsunami some nuclear reactors were damaged, causing much uncertainty and fear about the release of radioactive material, as well as highlighting the ongoing concerns over Japanese nuclear seismic design standards.<sup>[26]</sup> On 5 May 2012 Japan shut down the last nuclear reactor, the first time there has been no nuclear power production since 1970.<sup>[27]</sup> On 16 June Prime Minister Yoshihiko Noda ordered the restart of Ōi nuclear plant's reactors number 3 and 4, saying that people's livelihood needs to be protected.<sup>[28]</sup> Ōi nuclear plant's reactor No. 3 was restarted on 2 July,<sup>[6]</sup> and No. 4 began operation on 21 July.<sup>[29]</sup>

Japan's new energy plan, approved by the Liberal Democratic Party cabinet in April 2014, calls nuclear power "the country's most important power source".<sup>[30]</sup> Reversing a decision by the previous Democratic Party, the government will re-open nuclear plants, aiming for "a realistic and balanced energy structure".

## Natural gas

Because domestic natural gas production is minimal, rising demand is met by greater imports. Japan's main LNG suppliers in 1987 were Indonesia (51.3%), Malaysia (20.4%), Brunei (17.8%), United Arab Emirates (7.3%), and the United States (3.2%).

## Renewable energy

Japan currently produces about 10% of its electricity from renewable sources. The renewable share goal is 20% by 2020.<sup>[32]</sup>

### Hydroelectricity

The country's main renewable energy source is hydroelectricity, with an installed capacity of about 27 GW and a production of 69.2 TWh of electricity in 2009.<sup>[33]</sup> As of September 2011, Japan had 1,198 small hydropower plants with a total capacity of 3,225 MW. The smaller plants accounted for 6.6 percent of Japan's total hydropower capacity. The remaining capacity was filled by large and medium hydropower stations, typically sited at large dams. Cost per kilowatt-hour for power from smaller plants was high at ¥15-100, hindering further development of the energy source.<sup>[34]</sup>

### Geothermal energy



The 2011 Fukushima Daiichi nuclear disaster, the worst nuclear accident in 25 years, displaced 50,000 households after radioactive isotopes were dispersed into the air, soil and sea.<sup>[24]</sup> Radiation checks led to bans of some shipments of vegetables and fish.<sup>[25]</sup>

Carbon dioxide emissions  
(thousands of metric tons of CO<sub>2</sub>)  
compared to 1990 level<sup>[31]</sup>

Year	CO <sub>2</sub>	Change
<b>1990</b>	1,072,420	0%
<b>1991</b>	1,094,350	2.04%
<b>1992</b>	1,106,500	3.18%
<b>1993</b>	1,081,490	0.85%
<b>1994</b>	1,132,560	5.61%
<b>1995</b>	1,138,750	9.19%
<b>1996</b>	1,169,550	9.06%
<b>1997</b>	1,170,120	9.11%
<b>1998</b>	1,130,600	5.43%
<b>1999</b>	1,165,720	8.7%

Of other renewable energy sources, Japan has partially exploited geothermal energy.<sup>[35]</sup> The country had six geothermal power stations with a combined capacity of 133 megawatts in 1989. By 2011, the country had 18 geothermal plants.<sup>[36]</sup>

### Photovoltaic electricity

In addition, although it only makes a minor contribution to the total, Japan was the world's second largest producer of photovoltaic electricity in early 2000s, until overtaken by Germany in 2005, a year in which it had 38% of the world supply compared to Germany's 39%.<sup>[37][38]</sup> In December 2011, Tohoku Electric Power began operating a solar power plant in Hachinohe, Aomori. The 10,000 panel plant, occupying a 50,000 square meter site, is expected to produce 1.6 million kwh of electricity a year, about the equivalent needed to power 500 households.<sup>[39]</sup> On 1 July 2012, new tariffs for renewable energy were introduced by the Japanese government. Tariffs, set at ¥42 per kWh over the next 20 years to solar power producers, are among the highest in the world. They are expected to provide incentive for widespread expansion of solar power energy sources in the country.<sup>[40][41]</sup> With the incentives in place after the nuclear disaster at Fukushima, Japan has added 1,394 MW of renewable energy in 2012. One third of the renewable energy is solar energy, with production increasing for additional solar installations in 2013.<sup>[42]</sup> Tariffs are expected to increase Japan's share of renewable energy to 20% by 2020. Japan's total solar capacity was 7.4GW at the end of 2012. A gigawatt can supply power to an estimated 250,000 homes.<sup>[32]</sup>

<b>2000</b>	1,207,980	12.64%
<b>2001</b>	1,191,390	11.09%
<b>2002</b>	1,205,480	12.41%
<b>2003</b>	1,233,640	15.03%
<b>2004</b>	1,259,659	17.46%
<b>2005</b>	1,238,181	15.46%
<b>2006</b>	1,231,298	14.81%
<b>2007</b>	1,251,169	16.67%
<b>2008</b>	1,207,686	12.61%
<b>2009</b>	1,101,134	2.68%

### Wind energy

Japan had 1,807 wind turbines with a total capacity of 2440 MW as of September 2011. A lack of locations with constant wind, environmental restrictions, and emphasis by power utilities on fossil and nuclear power hinders the employment of more wind power in the country.<sup>[43]</sup> However, it has been estimated that Japan has the potential for 144 GW for onshore wind and 608 GW of offshore wind capacity.<sup>[44]</sup>

### Waste and biomass energy

As of September 2011, Japan had 190 generators attached to municipal waste units and 70 independent plants using biomass fuel to produce energy. In addition, 14 other generators were used to burn both coal and biomass fuel. In 2008, Japan produced 322 million tons of biomass fuel and converted 76% of it into energy.<sup>[45]</sup>

### Ocean energy

In 2012, the government announced plans to build experimental tidal power and wave power plants in coastal areas. Construction on the projects, the locations for which have not been determined, would begin in 2013.<sup>[46]</sup>

## Carbon emissions

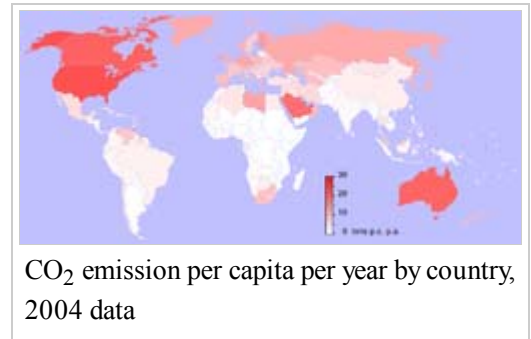
In 2003 Japan was the 5th largest producer of carbon emissions, generating 5% of the world total. In 2003 Japan ranked 36 in the list of countries by carbon dioxide emissions per capita.

In 2007, the BBC reported that Japan was having difficulty in meeting its 6% reduction target under the Kyoto



Protocol partly because Japanese businesses were already very energy efficient.<sup>[47]</sup> Despite this, in May 2007, the former Prime Minister Shinzo Abe said that world emissions should be reduced by 50% by 2050. He expected Japan to play a leading role in such an effort. "We must create a new framework which moves beyond the Kyoto Protocol, in which the entire world will participate in emissions reduction," Abe said.<sup>[47]</sup>

However, since the events of the Tohoku Earthquake, carbon emissions from energy production have increased to near record levels, with 1227Mt released from energy production as opposed to the Kyoto Protocol target of 1136Mt (8% reduction from 1235Mt), just a 0.6% decrease in energy production emissions.<sup>[48]</sup> The increased use of gas and coal to make up for lost nuclear capacity increased CO2 production by over 3% despite an electrical demand drop of nearly 15%.



## See also

- Energy Law (Japan)
- Electricity sector in Japan
- Japan Electric Association
- Japan Oil, Gas and Metals National Corporation
- World energy resources and consumption
- List of countries by energy consumption and production
- List of countries by energy consumption per capita


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## External links

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  - Energy White Paper 2010 (<http://www.enecho.meti.go.jp/topics/hakusho/2010energyhtml/index.html>) **(Japanese)**

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