SCIENCE HOLIDAY HOMEWORK

Renewable sources of energy for electricity generation in four leading countries (India, China, Japan and USA)

INDIA

- **HYDROELECTRIC POWER**

India is globally in 5th place for installed hydroelectric capacity. In India, nearly a quarter of our energy requirements are met by hydro power plants. There are also additional smaller hydroelectric power units which have been installed, with a total capacity of more than 4,300 Megawatts, which is still only 1.3% of its total utility power generation capacity. In 1898, a hydro-electric power plant was established in Darjeeling, and four years later in 1902, another one at Shivanasamudra, Karnataka. These power plants were among the very first ones in Asia. India is a dominant player in global hydroelectric power development. India also imports the surplus hydroelectric power from Bhutan

and puts it to good use. However, the hydroelectric power potential from the Godavari, Narmada, Mahanadi, Nagavali and Vamsadhara river basins in central India has not been majorly developed due to the potential opposition from the tribal populace. Nearly 93% of India's hydroelectric power production is accounted for by the public sector.

Source	2014-15	2015-16	2016-17	2017-18	2018-19	2019-2020
Large Hydro	129,244	121,377	122,313	126,134	135,040	155,970
Small Hydro	8,060	8,355	7,673	5,056	8,703	9,366

❖ WIND POWER

The development of wind power in India began in the 1990s, and has significantly increased in the last few years. India is a relative newcomer to the wind industry compared with Denmark or the US but domestic policy support for wind power has led it to become the country with the fourth largest installed wind power capacity in the world. As of June 30th, 2018, India's wind power capacity was nearly 34,300 Megawatts, and was mainly spread across the states of Tamil Nadu [over 7,250 MW], Maharashtra [approximately 4,100 MW] , Gujarat [over 3,400 MW], Rajasthan [over 2,700 MW] , Karnataka [around 2,300 MW] , Andhra Pradesh [nearly 750 MW], and Madhya Pradesh with 423.40 MW of wind power. Wind power accounts for 10% of India's total installed power capacity. India has set an ambitious target: to generate 60,000 Megawatts of electricity from wind power by the next year.

❖ SOLAR POWER

India is densely populated and has high solar insolation which is an ideal combination for using solar power. Over the last three years, more than 16,000 solar home systems have been financed through 2,000 bank branches, particularly in rural areas of South India where the electricity grid does not yet extend. It has helped many people living in comparatively underdeveloped areas of the country.

❖ BIOMASS

India is an ideal environment for biomass production as well. Given its tropical location, sunshine and rains. The country's vast agricultural potential which provides agro-residues, can be used to meet energy needs, both in heat and power applications. According to the IREDA, Biomass is capable of supplementing the coal to the tune of about 260 million tonnes, which would save a lot of money, about Rs. 250 billion every year.

CHINA

China is the world's leading country in renewable electricity production, with over double the generation of the second-ranking country, the United States. By the end of 2019, the country had a total capacity of 790GW of renewable power, mainly from hydroelectric, solar and wind power. 40% of China's total installed electric power capacity and 26% of the total power generation comprises of renewable energy with solar and wind combined having more capacity than hydropower.

- **HYDROELECTRIC POWER**

By the end of 2019, China's hydropower capacity reached 356 GW. Since the end of 2014, hydroelectric power remains the largest component of renewable electricity production at 1,064 TWh [Terawatt- hours]. Hydropower plays a big part in the energy policy of the country, due to China's insufficient reserves of fossil fuels and the government's preference for energy independence. China's potential hydropower capacity is estimated at up to 400 GW. There is considerable potential for further hydro development.While hydroelectricity represents the largest renewable and low greenhouse gas emissions energy source in the country, the social and environmental impact of dam construction in China has been large.Millions of people were forced to relocate and there was large scale damage to the environment

- **WIND POWER**

As of 2020, wind power capacity of China was 282 Gigawatts. Followed by biofuels at 44 TWh, Wind power provided the second largest share of power, with 156 TWh. China also has the largest wind resources in the world.Three-quarters of this natural resource is located at sea.

- **SOLAR POWER**

Installed capacity of solar power in China reached 252 Gigawatts. Solar PV power started from a low base of just 152 GWh in 2008, but has grown rapidly since then and reached over 29 TWh by the year 2014. China is the producer of 63% of the whole world's solar photovoltaics (PV), and it has emerged as the world's largest manufacturer as of June 2015.China has become a world leader in the manufacture of solar photovoltaic technology, with its six biggest solar companies having a combined value of over $15 billion. Around 820 MW of solar PV were produced in China in 2007, second only to Japan.

- **BIOMASS**

China emerged as the world's third largest producer of ethanol-based bio-fuels at the end of the 10th Five Year Plan Period in 2005.As of present, ethanol accounts for 20% of total automotive fuel consumption in China. Bioenergy is also used at the domestic level in China, both in biomass stoves and by producing biogas from animal manure.

JAPAN

Currently, about 10% of Japan's energy is produced from renewable sources.

- **HYDROELECTRIC POWER**

The main renewable energy source of the country is hydroelectricity, with an installed capacity of about 27 GW and a production of 69.2 TWh of electricity in 2009. According to the International Hydropower Association Japan was the world's sixth largest producer of hydroelectricity in 2020.

- **WIND POWER**

As of September 2011, Japan had 1,807 wind turbines with a total capacity of 2440 Megawatts. Due to the lack of locations with constant wind, environmental restrictions, and emphasis by power utilities on fossil and nuclear power, the employment of more wind power in the country is hindered. However, it has been estimated that Japan still does have the potential for 144 Gigawatts of onshore wind and 608 Gigawatts of offshore wind capacity.

- **SOLAR POWER**

Since the late 1990's, solar power in Japan has been expanding. The country is a leading manufacturer of photovoltaics (PV) and a large installer of domestic PV systems as well, with most of them being grid connected. Japan has an insolation of about 4.3 to 4.8 kWh/(m2·day). Solar power has become an important national priority, ever since the country's shift in policies toward renewable energy after the Fukushima Daiichi nuclear disaster in the year of 2011.

- **BIOMASS**

As of September of 2011, Japan had 190 generators attached to municipal waste units and 70 independent plants using biomass fuel to produce energy. In addition to that, 14 other generators were also used to burn both coal and biomass fuel. In the year 2008, Japan produced 322 million tons of biomass fuel and converted 76% of it into energy.

USA

- **HYDROELECTRIC POWER**

In the USA, Hydroelectric power was the largest producer of renewable power, until 2019, when it was overtaken wind power. The amount of hydroelectric power generated is strongly affected by the changes in precipitation and surface runoff. It produced 79.89 TWh which was 7% of the nation's total electricity in 2018 and provided 40.9% of the total renewable power in the country.

- **WIND POWER**

Wind overtook hydroelectric power as the largest source of renewable electricity generation in 2019 in the USA. It accounted for 9% of the country's total electricity

generation in the last year. Wind and solar power accounted for two-thirds of new energy installations in the United States in the year 2015. United States wind power installed capacity exceeds 81 Gigawatts as of 2017. This capacity is exceeded only by China.

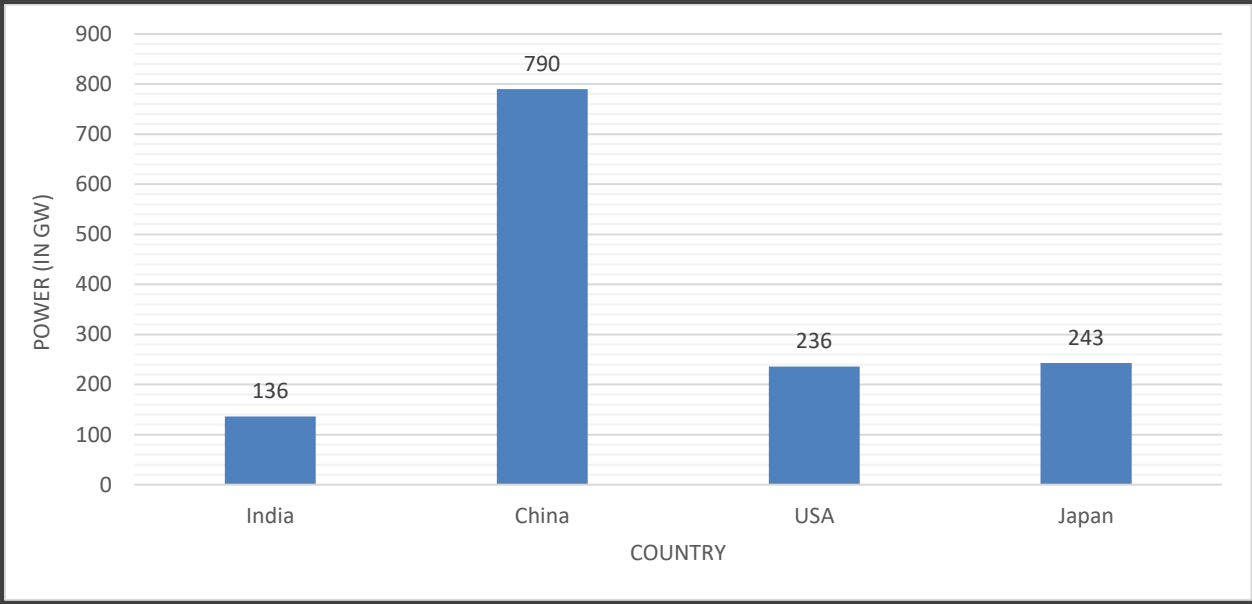
- **SOLAR POWER**

The United States is one of the world's largest producers of solar power. As of the end of the last year, the United States had 97,275 megawatts (MW) of installed photovoltaic and concentrated solar power capacity combined.

- **BIOMASS**

In the year 2019, biomass generated electricity was equal to 58.412 terawatt-hours, which was 1.41% of the country's total electricity production. Biomass was the largest source of renewable primary energy in the US, and the fourth-largest renewable source of electrical power in the US, after wind, hydropower, and solar power.

COMPARITIVE STUDY



This chart shows the total renewable energy in each country [as of 2019] in Gigawatts.

COUNTRY	TOTAL ENERGY
China	790
USA	236
India	136
Japan	243

The table below briefly states the differences in each of the countries' power produced from different sources:

China	India	Japan	USA
Hydropower produced energy is about 356 GW.	*Hydropower produced energy is about 4300 MW.*	*Hydropower produced energy is about 27 GW.*	*Hydropower produced energy is about*
Wind power produced energy is about 282 GW.	*Wind power produced energy is about 34,000 MW.*	*Wind power produced energy is about*	*Wind power produced energy is about 81 GW.*
Solar power produced energy is about 252 GW.	*Solar power produced energy is about*	*Solar power produced energy is about*	*Solar power produced energy is about 97,000 MW.*
Biomass produced energy is about 14.88 GW.	*Biomass produced energy is about 800 MW.*	*Biomass produced energy is about 2,300 MW.*	*Biomass produced energy is about*

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