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# Prospects of Solar Energy in Rural Areas

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**Abstract:** ***Today's world is fighting a war which is bigger and severe than any war fought in the past and that is the fight against pollution and depletion of natural resources in every context, be it quantity or quality. This war is being fought in every region of this world as we speak and there is a immediate requirement for a solution to these issues. Amongst all these major problems being faced, usage and implementation of renewable energy is the best and most suitable alternative. For a major aspect of this war, which is now a basic human necessity - electricity, Solar energy is the most viable alternative in order to solve problems related to its production and distribution. In this project we will study facts and figures for implementation of Solar energy and its usage. It is the most abundant form of energy available on the planet which is easy to access and nothing other than a equipments required for electricity production through sunlight which is a 'Solar pannel' is required in order to access it. India is one of those country in this world which is located directly in the position to get huge amount and has high quality of sunlight through the year. Solar power implementation is the best option for people in this country to fight against these problems of pollution and preservation of natural resources.***

**Keywords**: Sustainable energy, Solar power implementation, Rural India

## 1. Introduction

In today's world, where all the natural resources; fuel, gas, water, forests etc are diminishing at a significant high rate. The major factor responsible for such effect on the resource availability and atmospheric conditions is largely shared by the high rate of the increasing population worldwide. It has increased in the numbers which are substantially countable in millions, in the last ten years. This not only increases the rate for the consumption of such resources but also takes a huge toll on the atmosphere in terms of pollution: increased use of plastic, less knowledge of recycling and reusing resources, whereas regulated use of such resources is also not visible.

Increase in number of human life also constitutes a huge amount of requirement for the basic necessities such as food, shelter and electricity. It has become difficult, for the government bodies, to provide each and every individual living in different regions of their countries with such basic requirements. For this, new plans are laid down which include construction of new food sectors, residential complexes and electrical power plants. Further explaining, food and residential necessities are fulfilled by the implementations made as mention above whereas production of electricity, to meet such high demands requires development of new power plants which run on the natural resources such as petroleum or coal as a fuel. This leads to increasing pollution in the atmosphere, and is a major reason for global warming but even with such enormous rate of pollution, production of electricity cannot be decreased as it is required by nearly every sector in an economy. To fight this problem, there is an alternative resource which can be used as a source of electricity with microscopic emission and low investment which is – 'Solar energy'. It is one of those natural resources present in our environment which is most abundant and is available at nearly every place where human life exists.

With the use of solar energy, we can produce electricity through 'solar panels'. They produce electricity when they are directly exposed to sunlight. These panels consist of a number of Solar Cells which are made from a compound - 'Silicon'. When exposed, the light (photons) striking the compounds, in particular metals, causes the surface of the material to emit electrons which, through further movement and emission of these electrons, produces electricity. This phenomenon is what we term as the 'photo-electric effect' which means sunlight converting into a flow of electrons (electricity). Solar power is a rapidly developing energy source around the world. The potential for using the sun to directly supply our power needs is huge. Also, once made, solar panels can generate electricity without nearly any waste or pollution. This means that there is no dependence on the Earth's natural resources which can be a potential alternative for consumption of these resources and reduction in pollution. They have no moving parts so modules are very reliable and have a long life span. The most important benefit of Solar panels is that they are relatively easy to install and are very low maintenance, also Solar panels allow you to generate power close to the place of consumption. This removes the need to transport and distribute electricity over long distances to remote areas.

## 2. Review of Literature

**Palit, Debajit (2014)** mentions that solar photovoltaic technology has been used for providing electricity access in remote, forested habitations and islands in India. Under the Remote Village Electrification Programme by the Government of India, around 12,000 villages and hamlets have been electrified using solar energy. The state of Chhattisgarh in Central India has alone been able to electrify around 1,400 remote and forested villages through solar mini-grids. The strong policy support and an effective maintenance and an oversight mechanism have been the key contributing factors for the success of this initiative.

**Jolly, Suyash (2017)** highlights that rapidly developing countries like India face numerous challenges related to social and environmental sustainability, which are associated with their fast economic growth and rising energy demand. For this, the initiative of off-grid PV solar energy in India, specifically homing in on the innovative business models are evolving. This is found to be quite successful, but have difficulty in terms of reaching the poorest of the poor.

**Venkateswaran, Jayendran (2018)** highlights that around 1.2 billion people in the world lack electricity, 244 million of which are in India. Most reside in low-income households in geographically dispersed rural areas. Many households are dependent on inefficient kerosene for lighting. Indoor

kerosene combustion without proper ventilation poses significant health risks including pulmonary disorders and dermal ailments and its byproducts also contribute to climate altering black carbon emissions. Solar PV technology offers an immediate lighting solution for rural households with limited or no access to electricity. Advantages of solar PV include decentralized availability capable of reaching remote areas, easy management, sufficient light output, portability for indoor and outdoor domestic lighting, and no indoor pollution.

**Dhiman, Brajesh (2019)** mentions in his book that societal relevance plays an important role in the dissemination of solar photovoltaic home system design in rural context, as it syndicates economic benefits for livelihood improvement along with social and environmental advantage. Furthermore, socially constructed design facilitates the progress of a rural community in a wider context such as upscaling the rural livelihood, generating microenterprise opportunities, etc. Energy poverty is one of the main concerns especially for the development of Northeastern states of India. This creates a disparity, leading to economic backwardness of the region. In this regard, socially constructed energy solutions emerged as an integral part of growth and development with the adoption of small-scale solar photovoltaics home system in the rural northeast India. This approach could overcome present challenges like lack of involvement of local stakeholders and lack of employment-related opportunities necessary to facilitate the diffusion of solar photovoltaics home system to the rural household. As a result, socially constructed energy solutions can become a part of the rural development promoting local self-reliance. In addition, this may facilitate dissemination of renewable energy technologies along with socioeconomic development of the rural community in the region.

**Central Question**

Can solar energy be a successful alternative to produce electricity and meet the demand of the rapidly growing and developing world needing electricity as a necessity?

**Related Questions**

1) Would solar power be innovated or developed to such an extent that it can fullfill the high electricity demands of each sector?
2) Even after having minimum 50% subsidy by government, can solar power implementation cost match the affordability of people in rural areas?
3) Would Solar power, being a eco-friendly substitute for electrical grids, cab be implemented in every developed areas as it requires large open area in order to operate?

**Hypothesis**

As India being one of the hottest country of this world and considering the amount of sunlight it receives and last but not the least its zero percent emission rates, solar power has huge potential to replace power generation through electrical grids and other techniques currently being used.

**Objectives of the study of 'Solar Energy'**

- Promote the use of sustainable, economic and least-cost decentralized electrification solutions for areas not feasible for grid connection/extension in partnership with the local government units, semi-private and private sectors.
- Plan and execute an integrated programme on development and implementation of renewable energy projects
- Apply solar energy technology as the enabling technology for sustainable development.

## 3. Methodology

In the following project, the knowledge and facts are gathered from newsletters and reports published in newspapers and online on blogs and journals written by various environmental activists which are working and promoting solar energy as a most valuable source of renewable energy. We take into consideration the unique nature of solar power generation in which systems produce electricity on peak, produce power at the location of use, do not require continuous fuel purchases, and have significant security and environmental advantages over fossil fuels. These characteristics generally increase the value of solar electricity as they allow utilities to avoid the costs of fuel, plant, reserve capacity, transmission, and distribution in their centralized assets.

**Solar Energy Analysis in Rural Areas**

In India, rural population accounts for 67 per cent of the total population and 37 per cent of its GDP. While the overall Indian economy is expected to grow in excess of 7 per cent – the fastest amongst large global economies – rural India still lags behind substantially. (Statistic Report, 2019)

The primary hindrance to growth in rural productivity and subsequent economic growth is the lack of basic infrastructure such as electricity, clean water and sanitation. Nearly 300 million people in rural India lack access to grid-connected power, promoting use of archaic sources of energy such as kerosene, diesel, wood-fired chulhas, etc, which not only results in huge government subsidies, but also substantial health and environmental hazards. Solar power offers an opportunity to bridge the massive infrastructure gap and improve the social, economic, environment health indicators.

Solar power has been around for a while, historically high costs have necessitated it to be driven by philanthropic capital or government subsidy, thus limiting its scope, however with a drop in capital cost by nearly 70 per cent over the last few years, solar energy has now become commercially mainstream, thus attracting private capital and entrepreneurs. This truly makes solar power the much awaited solution for the millions living without electricity. (Dawra, 2016)

**Government in promoting Solar Energy in rural areas**

The Central government, under the leadership of Prime Minister Narendra Modi, has strongly supported solar power. As part of the government's vision of 'Electricity for all by 2019', the Centre has placed special emphasis on incentivising distributed solar power, having already sanctioned 4,604 distributed solar project in rural area to power 4,745 villages/hamlets. (Dawra, 2016)

- The modular nature of solar power makes it easy to deploy for multiple rural applications, impacting key facets of rural population such as productivity, safety, health benefits, access to clean water, heating solution and livelihood. Solar lighting, for example, not only provides a high quality solution to improve rural productivity, but also substantially reduces health hazards by enabling replacement of kerosene lamps. Even 4-5 hours of additional lighting can improve productivity and income of rural household.
- Nearly 3.5 million solar lighting solutions have been installed till date and the demand for these has been substantially growing. (Dawra, 2016) Earlier the funding was done by government-backed programs, of late most products are sold on a commercial basis, backed by financing support from cooperative banks and now a number of national and international companies have come into the market, hence the competition has increased, resulted in decrease in the price for solar panels and building solar power plants by huge numbers which makes it more affordable. Private players like Jain Irrigation, Tata Solar, Greenlight Planet, etc, now dominate the market. Simpa Networks is an excellent example of a private enterprise providing commercially viable micro grid solution to the poorest of poor districts – it has provided pay per use solutions to eight districts in UP, thus lighting nearly 15,000 homes.
- Another important application is solar powered agriculture pumps, which have the potential to substantially improve productivity of Indian farmers. The agricultural sector needs proper irrigation facilities and other amenties to reap proper benefits. Most of the farmers use pumps which are connected to the grid while major of them run on diesel and other fossil fuels which leads to almost 20 per cent of the installed power in India. The Indian government has launched various schemes to promote the installation of grid connected solar power plants and solar pumps. Through this scheme, the government has a target to 25,750 MW of combined solar capacities by the year 2022. (Team Productline, 2019)
- Clean water remains a big challenge in rural India, since water treatment requires power. Solar energy is finding important applications in this field. For example, Nagaland recently installed a solar powered water treatment plant in Tsiesma, a village near Kohima, which works on an advanced membrane filtration system producing pure drinking water.

It is evident that adoption of solar power as an alternative source of energy could alter the socio-economic problem of rural India, for the better and rural India will indeed have 'Sunny Days' in the upcoming years.

**Evidences of Solar Energy from Indian states**

Worldwide, solar energy is emerging as the technology for new power generation capacity and it has increased substantially over the past few years. In India there is a shift of energy from the conventional towards the renewable energy resources and developing an in-built consciousness about the necessity for a change of energy in upcoming future. An analysis by IRENA (The International Renewable Energy Agency) found that the costs for setting up solar PV projects have dropped by about 80 per cent in India between 2010 and 2018. Besides In 2010, the total installed solar capacity was 10 MW and in 2016, the installed capacity stood at 6000 MW - a rise by 600 times in just 6 years. The country's solar installed capacity reached 30.709 GW as of 31 August 2019. Today, solar has reached 30 per cent of the 2022 target of 100 GW contributing 38 per cent to the renewable energy mix. (Karan, 2019)

India is the fourth largest energy consumer in the world after China, America and Russia respectively. Moreover, India is the third largest coal producer and consumer in the World which leads to more carbon emission. With India being a growing economy, power consumption is only going to rise, so adoption of alternate forms of energy is the ideal way to manage balance between economic growth and sustainable environment.

India had adopted the use of solar energy long ago. Gujarat was the first state to adopt and develop solar generation capacity and Tamil Nadu has the second largest plant in the world. Over the years many states have shifted towards the use of solar energy. There are many regions in India with huge availability of land where solar panels can be installed and have high potential for solar power generation. The states are as follows-

**Gujarat**- One of the first state to adopt and one of the India's most solar-developed states, Gujarat has been a leader in solar-power generation in India due to its high solar-power potential, availability of vacant land, connectivity, transmission and distribution infrastructure and utilities. On July 2, 2019, the state government of Gujarat in its budget announced to launch a new scheme for Solar Rooftop. This scheme will benefit more than 2 Lakh families, who will adopt solar by the end of this year. (Mukherjee, Upadhyay, 2019)

In September 2019, National Thermal Power Corporation Limited planned to set up the biggest solar park in the country having 5 GW capacity. (NTPC, 2019)

**Rajasthan**- One of India's most solar-developed states, with its total photovoltaic capacity of 2289 MW. The Dhirubhai Ambani Solar Park at Dhursar village in the Jaisalmer district of Rajasthan is a 40 megawatt photovoltaic power station since 2012. Jodhpur district leads the state with installed capacity of over 1,500 MW, followed by Jaisalmer and Bikaner. On October, 2019 in Jaipur, 29 government colleges have come forward who fulfill their 100 per cent power needs through solar energy. The solar panels were set up in these colleges last year under the previous government to reduce the expenditure on power. Earlier these colleges used to pay electricity bills in lakhs and now the amount can be saved in lakhs yearly and these savings can be utilized for development of these colleges. (Doshi, 2019)

**Maharashtra**- The 125-MW Sakri Solar Plant, is the largest solar-power plant in Maharashtra. The Shri Saibaba Sansthan Trust has the world's largest solar steam system.. This system is used to cook 50,000 meals per day for pilgrims visiting the shrine, resulting in annual savings of

100,000 kg of cooking gas, and was designed to generate steam for cooking even in the absence of electricity to run the circulating pump.(Shri Saibaba Sansthan Trust,2019). The Osmanabad region in Maharashtra has abundant sunlight, and is ranked the third-best region in India in solar insolation. A 10 MW solar power plant in Osmanabad was commissioned in 2013. The total power capacity of Maharashtra is about 500 MW. (Maharashtra Energy Development Agency, 2018)

**Telangana**- ranks second when it comes to solar energy generation capacity in India. The state is trailing behind Karnataka with a solar power generation capacity of 3400 MW and plans to achieve a capacity of 5000 MW by 2022. National Theramal Power Corporation in Ramagundam has placed work order on BHEL to install 100 MW floating solar PV plant on its water supply reservoir. (National Thermal Power Corporation Report, 2018)

**Tamil Nadu**- has the second largest Solar power plant in the world in Kamuthi. It has the capacity of 648 megawatts and covers an area of 10 square kilometers at a single location. At full capacity, it is expected to produce enough electricity to power approximately 150,000 homes.

**Dadra & Nagar Haveli** - Union Territory in India, has been chosen as one of the Union Territories for the POWER FOR ALL Programme run by the government which aims to provide 24*7 power in the region. The government and UT administration has the target to install 449MW of solar capacity by the year 2022. Dadra & Nagra Haveli has the highest per capita power consumption in the country at 13,769 units as per the year 2015 against the national average of 1010 units. The primary reason behind this huge difference that 97 per cent of the power consumption in Dadra and Nagar Haveli is from the industries in the area. (Team Productline, 2019)

**Jammu and Kashmir** - known to be the second largest state in terms of having the potential for solar power generation in the country and the Ladakh region, popularly known as the 'solar capital' of India as the city receives solar radiation in its most original condition. The solar power plant has been set up in the Katra railway station and has a generation capacity of 1 MW. The government has also laid down several policies to support the installation of rooftop solar systems in the state.

**Andhra Pradesh**- Kurnool Ultra Mega Solar Park is a solar park in Panyam Mandal of Kurnool district in Andhra Pradesh spread over a total area of 5,932.32 acres (24.0072 $km^2$) with a capacity of 1,000 MW is the largest single operational solar park in the world. The project was implemented by the Andhra Pradesh Solar Power Corporation Private Limited (APSPCL). New and Renewable Energy Development Corporation of Andhra Pradesh Limited (NEDCAP) have aim to generate electricity through renewable resources and conserve energy in rural areas. (Jaiswal, 2017)

**Solar power implementation by government of India**

India is blessed with abundant solar energy potential with 300 days of sunlight. About 5,000 trillion kWh per year energy is experienced over India's land area with most parts receiving 4-7 kWh per sq. m per day. Hence, the government aims to create solar schemes to use this renewable source of energy efficiently. Below is a list of some of the most successful and known solar schemes in India –

**Jawaharlal Nehru National Solar Mission**

The Jawaharlal Nehru National Solar Mission was launched in January 2010 by former Prime Minister, Dr. Manmohan Singh. Its aim is to reduce the cost of solar power generation and install 20,000MW of grid-connected solar power via Long-term policy, Large-scale deployment goals, Research and Development, Domestic production of raw materials. The aim of JNNSM mission is not limited to offering large-scale grid-connected power but also transform India's rural economy. The quick spread of solar lighting systems, water pumps, and other solar power-based applications will change India's rural economy. The mission is to expand and establish India as a global leader in solar energy sector. (Ministry of New and Renewable Energy Report, 2019)

**Rooftop Solar Scheme**

Under the rooftop scheme executed by SECI (Solar Energy Corporation of India), 200 MW of projects has been allocated, out of which 45 MW of capacity have been commissioned. Addition to this, special schemes including 73 MW for warehouses and 50 MW for the CPWD (Central Public Works Department) have been launched. SECI launched a tender which is the largest global one of its kind offering 30% subsidy to the residential sector, private not for profit education organizations, social sector, and the health institutions. The tender is a part of MNRE's (Ministry of New and Renewable Energy) initiative to generate momentum for achieving the target of 40GW of rooftop solar power generation by 2022. Similarly, SECI is planning to issue a 1,000 MW rooftop tender soon which will may not include a subsidy. (Solar Energy Corporation of India Report, 2019)

**Solar Park Development**

MNRE has come up with a scheme to set up a number of solar parks across several states, each with a capacity of almost 500 MW. The scheme proposes to offer financial support by the Government of India to establish solar parks to facilitate the creation of infrastructure required for setting up new solar power projects in terms of allocation of land, transmission, access to roads, availability of water, etc. As per the policy, these solar parks will be developed in collaboration with the State Governments. Land required for the development of solar power projects with a cumulative capacity generally close to 500 MW and above will be identified and acquired. (Ministry of New and Renewable Energy, 2019)

**Government Solar Energy Subsidy**

Under this Scheme, financial assistance and capital subsidy will be provided to the applicant to the extent of 50 percent, 75 percent and 90 percent of the basis of basic cost of the solar energy plant. The Government Yojana explains that a person is eligible for a subsidy if he has solar panels installed on the rooftop. The subsidy is decided as per the capacity of the solar power plant. The scheme is mainly

formulated to encourage the power loom by utilizing solar energy. The scheme will eradicate the light problem and the plant will use the solar energy to grow the textile business by increasing production. Another benefit is that people will be able to cut down on their electricity bills and the load on thermal power plant will reduce increasing power generation. (Ministry of New and Renewable Energy,2019)

**UDAY Scheme**

UDAY or Ujjwal Discom Assurance Yojna was launched in November 2015 as a revival package for electricity distribution companies of India initiated by the Government of India with the idea to find permanent solar power solutions to the financial mess that the power distribution was facing at that time. It aims at reforming the power sector, operational improvement, development in renewable energy, reduction of cost of generation of power, energy efficiency, and conservation. This scheme is optional for the states to join. Under this, the state government takes up-to 75% of the debt by issuing the sovereign bonds to pay back the lenders while the remaining 25% will be issued in the form of bonds. UDAY expects to have a permanent solution for past as well as potential future issues of the power sector. (Ministry of Power, 2019)

## 4. Issues Faced in Implementation of Solar Power

India Facing Unique Solar Challenges

Solar Energy is on the way to become one of the largest sources of energy in the whole world. It is expected to supply 16% of overall energy requirements by 2050. India alone has set up a target of 100 GW solar by 2022. Out of which, 40 GW is to come from rooftop solar power solutions implemented in residential and industrial areas. Nonetheless, this journey doesn't seem easy. (Petronas Group, 2018) There are obstacles at every step:

1) Capital cost -
   The capital cost required for a solar project is too high compared to the savings it generates. The general balancing period for the investment is 7-10 years which is considerably long. Hence, people don't want to undergo this hassle for meagre savings and commercial/industrial establishments and don't want to direct away the capital from the non-business activities.
2) Lack of trust for performance -
   Despite the numerous benefits provided by the government for solar power solutions such as subsidies, direct and indirect tax benefits etc. consumers are not ready to invest. This is because there are huge doubts and lack of data about the performance of plants in India. A majority of the companies in the area have little or no experience as these companies are fairly a new startups or mediaters for foreign investors in this field, hence the gap in trust exists.
3) Inferior Technology and Quality -
   The efficiency and quality of solar panels produced by the Indian brands is not able to compete with its global counterparts. This is because of the lack of technical expertise and intellectual property with Indian companies.
4) Atmospheric conditions -
   Another major issue is of dust in our environment. India being a highly populous developing country, literally lives in a dust storm. And, as a matter of fact, even a single grain of sand can affect the performance of a solar PV cell/module. These challenges have had an overtly deep impact on the abilities of Indian Solar Panel Manufacturers.
5) Higher Pricing
   The global counterparts in Indian solar market are backed by Japan's Softbank and Goldman Sachs hence they are quoting ever low prices to win big projects while Indian players are still competing for grid parity. Panels produced domestically face multiple challenges due to lack of innovation and technical support and development in this field which lead to increase in their price.
6) Incompatibility and limitations in technology in India
   In the draft national electricity plan released by the central electricity authority in December 2016, the CUF (Elemental composition) of a solar power plants was stated to be around 20%. Hence, A 10-KW solar plant that can power three air-conditioners and is sufficient for a three-bedroom apartment needs around 1,000 square feet of terrace area. Unlike in Europe and America, houses in India do not have standardized roofs and getting the required shade-free area is a big challenge. Hence, there is not enough space for economically feasible solar installations. Apart from this, most residents do not want to block their rooftops. They use the terraces for various purposes such as drying clothes, installing water tanks and split ACs.

## 5. Finding of the Study

After doing the research and studies, following can be derived:

a) India, the country facing major issues with pollution and population has opted solar power as the most viable and helpful alternative for fulfilling electricity demands.
b) Solar power has been promoted and implemented in India taking in consideration both rural and developed areas as one.
c) Every sector of its economy be it the one in need of electricity or already having enough facilities to produce it, has been promoted and supported by the government to migrate to solar power.
d) India has turned out to be a country leading globally with exceptional numbers in development and implementation of solar power.
e) India is also one of those countries which provide equipments like solar pannels at one of the cheapest rates compared to other countries, possible with huge government support through subsidies and foreign investment in this technology.

## 6. Conclusion

Solar power in India is indeed, if not the fastest, is one of the rapidly developing industry. It has been criticized internationally in terms of development on nearly each sector of its economy but when comes to development in the field of renewable energy, it has performed remarkably. It can be supported by facts that; The country's solar installed

capacity reached 31.124 GW as of 30 September 2019. It also has the lowest capital cost per MW globally to install the solar power plants. The Indian government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule which was also recognised by the UN itself. In 2015 the target was raised to 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022, targeting an investment of US$100 billion. India has established nearly 42 solar parks to make land available to the promoters of solar plants.

India is also the home for the 2nd largest Solar power plant n the world which is - Kamuthi, Tamil Nadu, India;

This solar farm in the southern state of Tamil Nadu in India has a capacity of 648 megawatts and covers an area of 10 square kilometres. In 2016, this project was deemed to be the largest solar power plant at a single location. The project comprises 2.5 million individual solar modules and cost approximately 679 million USD to build. At full capacity, the Kamuthi solar power plant is expected to produce enough electricity to power approximately 150,000 homes.

India is running renewable energy initiatives in a big way and has emerged as the second most attractive market for renewable energy equipment in the world.

In recent years, growth of solar energy in emerging markets had been phenomenal. India has already overtaken the US and has become the second largest solar power market in the world (in terms of solar power installations). The country currently stands with ~25 GW of grid-connected solar power capacity as compared to 9 GW in 2015. Large scale solar installations in India account for 87 percent solar capacity while rooftop sector is all set to pick up. Last year, solar accounted for nearly 53 percent of new energy capacity additions in the country. It has the potential to become the largest manufacturer of electricity through Solar power and the current facts and figures show that the rate of growth of development in this sector, with the support of Ministry of New and Renewable Energy and MNC's which take India as a potential for investment in development of this technology and manufacturing of solar panels. It is expected that by the year 2022, it can me the World's largest producer of electricity through solar power.

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