

SOLAR ENERGY AS A GREEN POWER ALTERNATIVE: CURRENT INDIAN SCENARIO AND TRENDS

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Abstract: The demand for energy is ever increasing and the world is facing a real challenge of limiting the exploitation of natural resources by relying more on alternative sources of energy. There is also a tough challenge to ensure safer environmental impacts of alternative resources. Solar energy seems to be the ideal alternative to the conventional energy with its positive impact not only on environment but on socio-economical atmosphere too. Although the solar energy also proposes certain challenges yet the benefits offered outweigh the drawback.

This paper presents the details how solar energy can really be the targeted for narrowing the gap between demand and supply of domestic and commercial energy as well as providing immense benefits of better global environmental impacts. The current trends and changing scenario of solar energy generation in India is also discussed in this paper with special reference to the Union Territory Chandigarh and the state of Punjab.

Key words-solar power, domestic and commercial production, government initiatives, CREST, PEDDA

I. Introduction

We are living in a world where the lives depend upon technology and it demands constant supply of energy. Hence the demand for energy supply is always on the high and with each passing day the demand is further increasing. There are limited conventional sources of energy supply and they are being exploited to the fullest to meet the current demand. We are looking at a scenario in near future where this gap between supply and demand will become highly unfavourable and our conventional sources of energy will all exhaust up before alternative sources of energy are able to fill up the gap.

This situation of depleting conventional sources of energy coupled with ever increasing demand is playing a major impact on environment at global level. In the last 50 to 75 years this scenario was anticipated and efforts had been initiated to develop renewable sources of energy for positive impact on both to meet the demands and to reduce the dependence on conventional sources of energy.

II. Current scenario of demand and supply of energy in India

The problem of energy access in India is enormous. According to the International Energy Agency, some 237 million Indians (close to a fifth of the population) were living without electricity as of 2015. India currently has 77 millions of households (about 360 million people) who lack adequate access to grid-electricity, and another 20 million underserved households (approximately 95 million people) who receive less than four hours of electricity in a day [1]. While grid connectivity is expected to improve over the next 10 years, at the current rate of grid expansion, urbanization and population growth, 7075 million households will still lack access to grid electricity by 2024. Since 90% of these households live in rural areas, a significant reduction in the 83 million rural households who are currently not served or underserved by the grid is unlikely.

More than half of the total underserved rural population lives in five states: Uttar Pradesh, Bihar, Odisha, West Bengal and Madhya Pradesh. Rural underserved households are not equally distributed across India. Large sections of Northern and Eastern India have significant underserved populations. Furthermore, two-thirds of the underserved rural population, or about 55 million households, live in the states of Uttar Pradesh, Bihar, Odisha, West Bengal and Madhya Pradesh. The Climate Group, through its Bijli project, works with local delivery partners in Uttar Pradesh, West Bengal and Maharashtra[2]

Many more have only limited access, with some getting power for just a few hours per day. People often rely on diesel generators as a result, which are dirty, noisy and expensive — about the worst solution one can imagine from a public policy point of view. To handle rising demand, India will have to add about 15 GW of capacity per year for 30 years. Indian coal-fired plants, which currently provide 70 percent of the country's electricity, are particularly dirty. Although cheap on a per-kilowatt-hour basis for now, the environmental costs of relying on coal would be disastrous. Coal is becoming more difficult to obtain, sources of domestic gas are shrinking and negative environmental impacts of over exploitation of natural resources are reasons strong enough to reinforce our focus on renewable sources of energy. According to MIT Technology Review, if India grew its power supply through conventional means, by 2050, it would be adding more new carbon to the atmosphere every year than total U.S. emissions in 2013 [3].

Aside from coal, there are few other conventional options. About 15 percent of total capacity is from hydropower, but this is vulnerable to drought, and only a limited number of new dams can be built. About 3.2 percent of all electricity in India comes from nearly 6 GW of nuclear, but adding nuclear capacity is slow and carries its own significant risks. The country also has little in the way of natural-gas resources [3]. As such, renewable are seen as critical for the future.

III. In quest of alternative green power sources

Non renewable energy resources, like coal, nuclear, oil, and natural gas, are available in limited supplies. So the impetus was given to popularize renewable sources of power production. The five major renewable energy resources are solar, wind, water (hydro), biomass and geothermal.

3.1 Solar energy: Is it an ideal alternative?

Amongst various renewable sources of energy, solar holds tremendous potential. The sun is a huge source of energy which has only recently been tapped into. It provides immense resources which can generate clean, non-polluting and sustainable electricity, thus resulting in no global warming emissions. In recent years, it was discovered that the power of the sun can be collected and stored by various ways (photovoltaic, solar thermal, solar power) to be used on a global scale with the purpose of eventually replacing the conventional sources of energy. As the world is turning its focus to cleaner power, solar energy has seen a significant rise in importance. Solar will become a crucial component of India's energy portfolio in the next decade- perhaps more so than it is in most other countries.

3.2 Solar energy generation

Many technologies have been developed to make use of solar radiation. Some of these technologies make direct use of the solar energy (e.g. to provide light, heat, etc.), while others produce electricity.

Solar power plants convert sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaics converts light into electric current using the photoelectric effect. Solar energy absorbing panels are installed on the rooftops, over rivers and canals or in the open fields which are connected to main unit for the conversion of solar energy to electricity which can be used for heating or lighting or supplied to main electricity grid for consumption at other places. Though the solar lights, solar cookers and solar geysers are very common, now the masses are opting for individual units for production of solar energy for domestic as well as commercial utilization. In U.T. Chandigarh the Chandigarh Renewable Energy and science & Technology Promotion Society (CREST) and in the state of Punjab, the Punjab Energy Development Agency (PEDA), both promote the installation of solar energy units for domestic and commercial units. In an order issued by Chandigarh administration published on May 18, 2016, it has been made mandatory to have solar plants installed in dwelling as well as commercial units above 500 square yards in area. 30% subsidy is given for the same and is released to the consumer/applicant after commissioning of the project and receipt from MNRE, Govt. of India.

The schemes sponsored and floated by both CREST & PEDTA have become quite popular in Chandigarh and Punjab respectively, and many residential and commercial areas are now housing these solar production units. With initial hiccups in the process now the official procedures have been simplified and due to the better awareness more and more owners of big houses are coming forward to opt for solar power production. Few photos clicked by the authors in this area are displayed below.

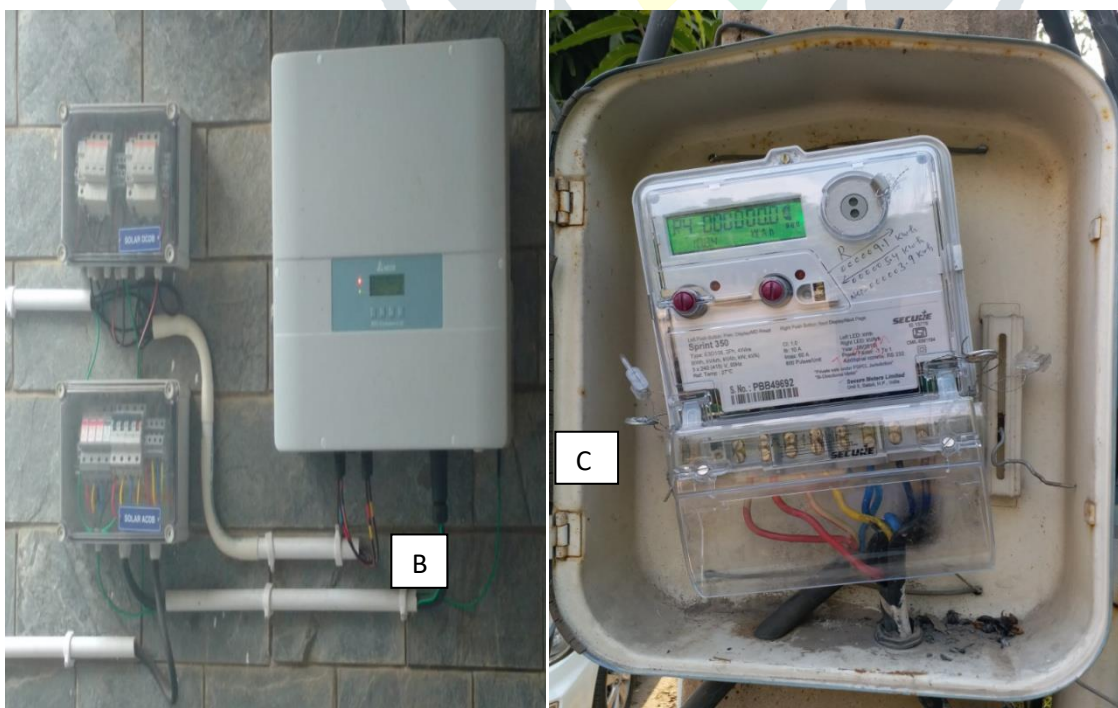


Fig.1 A. Solar panels on the roof top of a house in Mohali (Punjab) for domestic as well as commercial production of solar energy. B. AC- DC Converter and inverter C. Special in-out meter with double readings for supplying extra power produced in the household to the grid in the same dwelling unit, installed in September 2018.



Fig 2. Front and rear view of a solar geyser unit fitted atop a roof of a house in SAS Nagar Mohali (Punjab) subsidized by PEDDA, functional since December 2016.

3.3.1 Major environmental benefits of solar power

Conventional energy generation methods are damaging to air, climate, water, wildlife, landscapes, as well as raise the levels of harmful radiations. Renewable technologies are substantially safer offering a solution to many environmental and social problems associated with fossil and nuclear fuel [4, 5].

Technologies used to trap solar energy and store it for later use provide definite advantages in terms of being more environment friendly and thus provide advantage in comparison to conventional energy sources [6]. Use of solar technologies have a larger positive impact on environment besides obvious advantage of reduction in depletion of natural resources.

Most direct and important benefit of use of solar technology is in form of reduction in emission of the greenhouse gases, mainly CO_2 and NO_2 and prevention of toxic gases like SO_2 and particulate matter. The environmental benefits of solar power can be summed up as

- A. **Clean green energy:** As this does not require fossil fuel burning so it cuts the environmental pollution and saves the natural resources which are otherwise dwindling.
- B. **Reclamation of degraded land:** There are reports which indicate that the land left degraded after mining for fossil fuels can be reclaimed by solar energy production [7]
- C. **Lesser requirement of transmission grids compared to conventional electric system:** Can be used at the source and individual buildings can have their own solar plants

D. **Improvement of quality of water resources:** Solar energy doesn't pollute local water resources, because solar photovoltaic cells don't rely on water to generate power.

3.3.2 Socio-economic importance of solar power

Besides having positive impact on Environment, switching to solar technologies offer other positive socio-economic benefits like significantly increased work opportunities, better electrification in rural area and security of energy supply and reduction in dependency on import to meet energy demands. The socio economic impacts can be direct like expenses on wages and salaries, as well as attaining of goods and services required for project construction and operation, or indirect like project wages and salaries, procurement expenditures, which cause additional employment, income and tax revenues. Moreover the life of solar panels is quite long and if needed can be easily replaced [7]

3.3.3 Dual benefits of solar energy production

Knowing the dual benefits of solar energy generation will boost further individual production. A bi-directional meter is installed in the supply line to register import and export of power. Net metering arrangements, thus, combine elements of captive power consumption and exchange of power with the utility.

Net metering is the process through which you attain a “dual-benefit “by installing a solar power plant on the roof, open space, walls of the building to generate electricity. Generated power is first used in the building as per the requirement and the surplus power is fed to the grid of utility.

Thus individual consumers can now be the generators for their own requirements of electricity. They can not only reduce their electricity bills but make profit through energy generation. They can also eliminate their monthly meter rental charges etc. and save themselves from power cuts getting power supply continuously. CREST [8]

IV Status of solar power production in India

India is one of the few country in the world with highest solar electricity production per watt installed, Solar Power in India is the fastest growing industry and continuing to develop the electricity with solar power projects in Tamil Nadu, Rajasthan, Gujarat and Maharashtra. According to the current year's list, the top performing solar states in India are Tamil Nadu, Rajasthan, Gujarat, Telangana and Andhra Pradesh. Tamil Nadu takes the No.1 position with 1590 MW capacity installation (31st Jan 2017) as against 419 MW total installed capacity in January 2016[9].

4.1 Major boost in solar power production

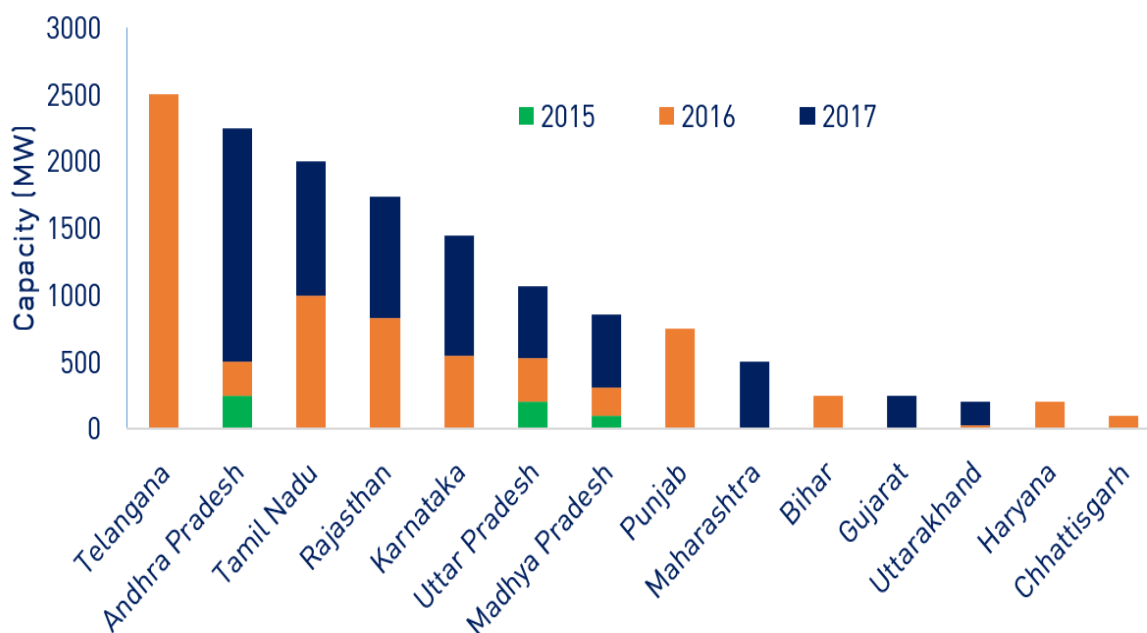
The government has decided to auction 30 GW solar energy capacities each in 2018-19 and 2019-20 to achieve the earlier target of 100 GW grid connected capacities by 2022.

Solar tariff has declined to lowest level of Rs 2.44 /kWh.

Government of India launched Jawahar Nehru National Solar Mission in (JNNSM) in 2009. The target now is to start Grid connected solar projects of 100 GW by 2022. The target will comprise of 40 GW rooftop and 57 GW through large and medium scale grid connected solar power plants .

In 2015 the installed solar grid capacity had reached 4.22GW. According to the Year End report of MNRE there has been biggest ever Solar Power capacity addition of 5525.98 MW in 2017-18. During 2017-18, a total 4323.1 MW (including 207.92 MW Solar Roof Top) capacity has been added till 30.11.2017, making cumulative achievement 16611.73 MW (including 863.92 MW Solar Roof Top). India ranks sixth in the world in terms of solar energy production [10, 11,12].

As on 30.11.2017, Solar Energy Projects with an aggregate capacity of over 16611.73 MW including 863.92 MW from Solar Roof Top projects has been installed in the country[13]



Note: Numbers include state NSM projects totalling 3,590 MW

Source: BRIDGE TO INDIA research

4.2 Solar parks in India

Ministry of New and Renewable Energy (MNRE) has drawn a scheme to set up number of solar parks across various states in the country, each with a capacity of Solar Projects generally above 500 MW [13]. The Scheme proposes to provide financial support by Government of India to establish solar parks with an

aim to facilitate creation of infrastructure necessary for setting up new solar power projects in terms of allocation of land, transmission and evacuation lines, access roads, availability of water and others, in a focused manner.

Solar Energy Corporation of India (SECI) a central public sector enterprises under MNRE, has been implementing various schemes to develop solar sector in the country. As per the policy, these solar parks will be developed in collaboration with the State Governments. The implementation agency is the Solar Energy Corporation of India (SECI) on behalf of Government of India (GOI). SECI handles funds to be made available under the scheme on behalf of GOI. The states shall designate a nodal agency for implementation of the solar park.

The Solar Park is a concentrated zone of development of solar power generation projects. As part of Solar park development, land required for development of Solar Power Projects with cumulative capacity generally 500 MW and above will be identified and acquired and various infrastructure like transmission system, water, road connectivity and communication network etc. will be developed. These parks will be characterized by well developed proper infra-structure where the risk & gestation period of the projects will be minimized. At the state level, the solar park will enable the states to bring in significant investment from project developers in Solar Power sector, to meet its Solar Purchase Obligation (SPO) mandates and provide employment opportunities to local population. The state will also be able to reduce its carbon footprint by avoiding emissions equivalent to the solar park's generated capacity.

4.3 Future Market trends and Indian Government efforts

The Government of India has set an ambitious target of generating over 175GW of total renewable energy by 2022. Realization of this target calls for the rapid creation of a positive enabling environment for investors and entrepreneurs alike. In next few years, considerable opportunities are anticipated around off-grid as well as grid-ready decentralized renewable energy in India

There has been strong indication from across the world that investment in renewables is yielding higher returns on investment. There is also a marked improvement in risk perception around renewable energy projects. Coupled with the emerging clean tech market in India, these aspects offer investors compelling motivation for venturing into renewable energy financing [13, 14, 15].

India's solar market potential is real big and it could achieve a forecast of 6 to 7 billion dollar capital equipment and approximately 4 billion dollar in annual revenue in grid connected solar generators in next ten years [10,11]. Overall, it is conservatively being estimated that the market size for solar home systems will grow at 60% per year to reach a market size of US\$200-250 million by 2018. In 2014 there were approximately 518,000 SHS (Solar Household Systems) units sold and a total of 900,000 households using

solar home systems. Given an average SHS price of US\$65, the total SHS market was worth US\$35 million. It is estimated that annual SHS sales will reach over 3 million units by 2018 resulting in a market worth over US\$215 million [9].

Government of India launched Jawahar Nehru National Solar Mission in (JNNSM) in 2009. The target now is to start Grid connected solar projects of 100 GW by 2022. In 2015 the installed solar grid capacity had reached 4.22GW. According to the Year End report of MNRE there has been biggest ever Solar Power capacity addition of 5525.98 MW in 2017-18. During 2017-18, a total 4323.1 MW (including 207.92 MW Solar Roof Top) capacity has been added till 30.11.2017, making cumulative achievement 16611.73 MW (including 863.92 MW Solar Roof Top). India ranks sixth in the world in terms of solar energy production now.

4.4 Some Drawbacks with Solar System

Major problem with solar energy is availability of solar radiations but luckily India receives enough sunshine to harvest enough power to meet the demands.

Large land area is required, which sometimes is not feasible but now the projects are using large buildings roof panels and canals covered with panels for harvesting solar power. These are the areas otherwise not used and freely get lots of sunshine.

Storage problem is also very serious. Suppose if the demand of power is not so high then the electricity produced by the solar plant will have to be stored somewhere to supply when demanded. This increases the cost of the project.

Recycling of solar panels can be an issue of concern. Currently there are not enough locations to recycle solar panels and there are not enough non operational solar panels to make recycling them economically attractive.[7]

Lack of awareness regarding the manufacturing process of solar panels and to the issue of recycling these, as well as absence of much external pressure are the cause of the insufficiency in driving significant change in the recycling of the materials used in solar panel manufacturing, a business that from a power generation standpoint, already has great environmental credibility.

4.5 Scope for improvement

So as to make solar energy production and utilization as popular as electricity, it will still need some time. There are a few ideas that can be applicable for hastening the process and making solar power as popular as electricity.

- i) Awareness about benefits of solar power generation has to be spread among the masses.
- ii) Trained technicians are needed to handle the projects.
- iii) Promotion schemes should reach the masses without hassles. The procedure for getting permissions and subsidies need to be simplified.
- iv) Subsidies need to be increased so that even poor can switch to solar power
- v) Areas are to be analysed and data listed where such new projects can be set up at large scale.
- vi) New government schemes and projects which are launched mostly end up mid way so quick maintenance and up gradation has to be ensured to derive maximum benefits. So regular follow up and strict supervision has to be ensured.

V Conclusion

Energy prices in India are rising, and the supply though growing is not able to keep the pace with its steep demand. There is dearth of non-renewable energy resources all over the world. Moreover there is a need of better green alternatives of energy production. Solar Power, despite initial challenges, is becoming a multibillion dollar opportunity with a potential to be as the safe and alternative future energy resource for India. Government backing is needed to make solar power generation and utilization more common. Mass awareness about the importance of solar power is required and above all efficient execution of the solar power projects is the need of the hour to make the country power sufficient.

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