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SOLAR ENERGY – PATH TO SUSTAINABILITY

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ABSTRACT

The issue of climate change is becoming more and more relevant as climate is getting worse at a progressive rate. Fossil fuels are main contributors to climate change. This recent interest in climate issues has helped the rise of alternative energy sources. . But even after 50 years of all the furore, we knowingly or unknowingly have been involved in reckless, mindless and directionless exploitation of our scarce resources in the name of development. This paper discusses the concept of sustainable development and various options to the Path to Sustainability. The word Sustainable has its roots in hindi language word ‘DHARNIY’ –jo dharan karne yogay ho, jise vahan kiya ja sake- means what we are able to bear. These lines are in conformity with the need of much talked about concept of sustainable development and were perhaps written even before the famous 1972 Stockholm Conference. One of the much talked about and important option is Solar Energy. This paper discusses the current status of rooftop solar energy initiatives at industry and household level. The paper discusses the need to boost domestic users by exploring the opportunities and challenges in the way of installing rooftop solar power panels.

KEYWORDS: *Solar Energy, Renewable , Fossil Fuels, Challenges, Potential.*

INTRODUCTION

With the development of civilizations and societies the concept of development has also perfected gradually. It had become more inclusive by adding social and human angle besides economic growth in its definition. Development which is oriented towards conservation and reasonable use of resources is Sustainable Development. However there are various huedles to Sustainability like Pollution, Overpopulation, Waste disposal, Climate change, Global warming, Greenhouse Effect etc. Irresponsible development planning and policies lead to unmindful exploitation of resources, generation of waste and pollutants, environmental degradation and collapse of eco system. The issue of climate change is becoming more and more relevant as climate is getting worse at a progressive rate. Fossil fuels are main contributors to climate change. This recent interest in climate issues has helped the rise of alternative energy sources like, Wind Energy, Solar Energy, Hydroelectric Energy, Geothermal Energy, Bio energy, Nuclear Energy, Hydrogen Energy, Tidal Energy and Wave Energy.

Among all the alternatives, Solar Energy is the most popular clean renewable energy source, with a potential of 5000 trillion kWh per year. With nearly 300 clear and sunny days in a year, solar power is fast developing industry in India. A small fraction of total incident solar energy

can meet the entire country's power requirements. In order to encourage participation of states in ecological sustainable growth and deal with energy security challenge the National Solar Mission was launched by the Government of India, on 11th January, 2010. As per National Institute of Solar Energy, solar PV modules on 3% of waste land has a solar potential of 748GW.

Objectives of the Study:

To understand the need of switching to more sustainable energy sources

To understand the challenges on the way of path to solar energy

To discuss the potential of India in Solar energy

To discuss the steps taken in this direction

To list some suggestions

Case for and against Solar Energy:

Solar energy is becoming an increasingly cost-competitive alternative to fossil fuels. Solar energy is a sustainable energy source, has a low environmental impact, and promotes energy independence. However, it remains somewhat expensive in certain markets. The largest solar energy plant in the entire world is located in Rajasthan, India. The Bhadla Solar Park, was completed in April 2020. The plant occupies 10,000 acres and has an installed capacity of 2,245 megawatts. The total investment in the project is estimated to be around \$1.4 billion. The largest solar park in the United States is known as the Solar Star park near Rosamond, California. The power station consists of two separate installations named Solar Star-1 and Solar Star-2, with respective capacities of 314MW and 265MW. Like the plant in India, the location was selected due to its large exposure to the sun and minimal rain¹.

1. Solar energy is a renewable energy source and reduces carbon emission and other heat-trapping "greenhouse" gases. It avoids the environmental damage associated with mining or drilling for fossil fuels. Furthermore, solar energy also uses little to no water, unlike power plants that generate electricity using steam turbines.

2. Solar energy can reduce domestic electricity bill and rather if domestic solar energy systems have excess power that they can sell to the electricity board. Instead of paying for electricity, the households get paid by the board. Solar lights and other such alternatives that are powered by the sun instead electricity provided by the electricity board, to help save money. Homes with solar panels installed may get more sale price.

3. Solar systems are fairly easy to install and require very little maintenance.

4. Solar panels have low maintenance costs. Solar panels are easy to maintain, as they have no moving parts that wear out over time. Just keeping them clean and in good physical condition is enough to keep them working properly. Due to the low maintenance costs and average lifespan of 25 years, it is feasible to get back money invested in solar panels.

5. Solar energy can generate electricity in any climate. Solar energy systems can generate electricity in any climate. One of the disadvantages of solar energy is that it's subject to temporary weather disruption. Cloudy days reduce the amount of electricity you produce. Cold, however, doesn't affect productivity. Snowfall can actually help your solar system, as the snow

cleans the panels as it melts and sun reflected off the snow increases the amount of light hitting your panels. The result is more electricity production.

6. Old technology for storing solar energy, like lead acid batteries are being replaced by alternatives. Lithium ion batteries offer greater power at a lower cost. Nickel-based batteries have an extremely long life. New technologies, like flow batteries, promise scale and durable power storage²

The disadvantages of solar energy can be listed as following:

The disadvantages of solar energy are becoming fewer as the industry advances and grows, creating economies of scale. Technological advances are helping solar go mainstream. Here are some of the disadvantages of solar energy.

1. The high initial costs of installing panels

The most commonly cited solar energy disadvantage is cost. The initial cost to buy and install the equipment is not cheap. Batteries are one of the more expensive components of your system. Unlike solar panels, they do wear out and need careful maintenance to lengthen their lives. Still, if cost is an issue, leasing options may reduce the amount of your initial outlay. If you do choose to buy, you will need to live in your home for a number of years before the system pays for itself. It's a long-term investment better suited to property owners than renters.

2. The temporary decline in energy production during bad weather has been a major issue. Days with low solar energy, however, are having less of an effect due to advances in battery technology.

3. Solar doesn't work for every roof type. Not every roof will work well with solar panels. If the roof doesn't face the sun, it won't be able to capture enough solar energy. Roofs that angle into the sun tend to work better than flat roofs.

4. Solar panels are dependent on sunlight. It's obvious that solar panels need sunlight to generate electricity. They won't produce electricity at night and they can be inefficient during storms and gloomy days. The solar energy system needs batteries if one plans to fully depend on solar energy to power the home.³

5. In comparison the solar power wind will keep generating electricity at night and during storms, as long as there is enough wind.

Today India is one of the biggest importers of energy in the world and about 85% of the total energy and fuels needed are imported from several other countries leading to a high expenditure on energy resources amongst all other expenses. With the scope to harness solar energy, there is a huge potential to meet the demand avoiding the dependency on imports. With about 300 clear and sunny days in a year, the calculated solar energy incidence on India's land area is about 5 quadrillion kilowatt-hours (kWh) per year (or 5 EWh/yr). This energy if harnessed for a year will surpass the total fossil fuel energy reserves in India.⁴

Many states in India have already recognized and identified the opportunity that solar energy can offer in addition to being an everlasting source of power. In the near future, solar energy will have a huge role to play in meeting India's energy demands in multiple sectors like electricity, automobile, manufacturing and commercial. Theoretically, a small fraction of the total incident solar energy (if captured effectively) can meet the entire country's power requirements.

Technologies of Solar Energy in India

Solar energy has already touched millions of lives in India by meeting their cooking, lighting and other energy needs in an environment-friendly manner. While there has been a visible impact of solar energy in the Indian energy sector in the last few years, the generation of these resources has not even met 10% of the total demand of the country. Some of the technology that can revolutionize the energy sector are:

1. **Solar PV Technology** - Solar Photovoltaic (PV) cells convert solar light directly to electricity. The setup is directly installed on land or on top of homes where there is direct exposure to the sun and is used to power lighting and other electrical appliances we use on a daily basis.
2. **Solar Thermal Technology** - In this case, solar energy is used as a heat source for heating purposes for direct use and to generate steam for generating electricity through turbines. This is then supplied to residential buildings to be used directly.
3. **Floating Solar Technology** - This type of solar energy generation is similar to Solar PV but instead of land, the panels will be set up on floats resting on a water body. This is very helpful where the population density is high and the land area available is limited.

The application of solar energy is widespread and diverse. Some of them include solar electricity, solar water heating, solar heating, solar ventilation, solar lighting, portable solar, solar transportation, etc.⁵

The deployment of rooftop solar, though an important component of India's solar target, has lagged. Moreover, rooftop solar installations lean more towards industrial and commercial projects than residential solar. Developing residential rooftop solar capacity while helping achieve India's solar targets will also enable just transitions since individuals, including from vulnerable and underprivileged communities, stand to benefit from it.

A rise in Residential Rooftop Solar Installations

As earlier mentioned, India could see a huge increase – around 60% – in residential rooftop installations in the financial year 2022-23, the report said “The Indian residential rooftop solar segment is at the cusp of a robust growth phase,” said the report's co-author, Vibhuti Garg, director – South Asia, IEEFA, in a press release. “From the 2 GW cumulative installed capacity (as of fiscal year 2022), the residential market will likely reach 3.2 GW by FY23.”⁶

Currently, India's residential rooftop solar capacity, as of March 2022, is only 2,010 MW, but this will increase to 3,214 MW in March 2023, the report said. However, residential consumers face numerous challenges in adopting rooftop systems. These include tedious net-metering processes, delayed subsidy disbursement, limited access to affordable finance, lack of reliable solar developers, etc

Challenges Involved In Solar Development

While solar energy can be a boon for the Indian energy sector as an alternative source of power generation, there are still many challenges that we face in today's time limiting us from scaling up. Some of these challenges include:

1. Solar power costs have come down considerably but the costs of small solar power projects is higher than other sources. The Union Government is facilitating establishment of large solar parks. Residential consumers and Small and Medium Enterprises (SMEs) who want to

install solar rooftop projects face financial constraints as initial investments are generally high. A critical issue is an absence of innovative financing options offering higher sums at lower interest and longer durations

2. In the absence of needed innovations and research, modern development facilities and manufacturing infrastructure, the development of solar panels, equipment and inverters to meet complete demand has been not upto the mark.⁷ This inevitably leads to increase in imports from countries like China, Germany, etc. thereby increasing the cost of the system. : India at present lacks the capability to produce solar wafers or polysilicon. During the fiscal year 2021-22, India imported solar cells and modules worth about US\$ 76.62 billion from China alone. This accounted for 78.6% of India's total imports (2021-22)
3. Solar systems require a substantial amount of investment in the beginning and have longer payback periods. This investment will not only burden the flow of investments in other energy sectors but also increases the debt. This challenge discourages many people and entities from adopting solar energy.
4. Lack of awareness amongst the general public is one of the key challenges slowing down the adoption of solar energy. Education on solar energy, especially in the rural areas of the country should be addressed more actively where the benefits, advantages and accessibility perks are taught.
5. Large Solar Parks face hurdles in acquiring large tracts of land. Other challenges include high transmission and distribution losses, grid integration etc. Grid integration is a challenge due to intermittent nature of solar energy and the problem of load balancing (e.g., high load during night but non-availability of solar power at night).
6. Establishment of large solar parks has led to conflict with the local communities and issues in bio-diversity protection e.g., in Rajasthan and Gujarat, some projects have been halted because the transmission lines encroach upon the habitat of the critically endangered Great Indian Bustard.
7. Some of the administrative issues like ease of land acquisition, government approvals, material supply limits, etc. affect the setup of solar generation plants and thereby lead to delays in development. This can be addressed by setting up dedicated government entities that work towards solar energy implementation.
8. The overall setup warranty provided by the implementation partner is also one of the challenges that we face today. Many companies today are providing limited support and warranty for the implementation of solar panels and systems which is raising concerns for many customers.
9. India's solar waste is estimated to grow to 1.8 million tonnes by 2050. However, India's e-waste rules do not mandate solar cell manufacturers to recycle or dispose of waste from this sector.⁸
10. India's Domestic Content Requirement (DCR) clause has faced legal challenges at the World Trade Organisation (WTO). DCR mandates the use of both solar cells and modules manufactured domestically as per specifications and testing requirements fixed by the Ministry of New and Renewable Energy (MNRE).

Steps taken to enhance Solar Energy generation in India:

The MNRE launched the Jawaharlal Nehru National Solar Mission in 2010 to achieve 20 GW of grid connected solar power by 2022 in three phases through several steps including Solar Park Scheme, Central Public Sector Undertakings (CPSUs) scheme for grid connected solar PV power projects, and Viability Gap Funding (VGF). The target was revised to 100 GW in 2014-15.

The Government has also launched the *Pradhan Mantri Kisan Urja Suraksha Uttan Mahabhiyan Yojana* (PM-KUSUM) for grid connected agricultural solar pumps.

Suryamitra Skill Development Programme by the National Institute of Solar Energy (NISE) focuses on Solar Energy project's installation, operation & maintenance.

Atal Jyoti Yojana has been launched to provide solar street lighting systems for public use.

Under the Solar Transfiguration of India (SRISTI) Scheme, financial incentives are provided to the beneficiary for installing solar power plant rooftop projects.

Green Energy Corridor Scheme: It is related to laying of new transmission lines and creating new sub-station capacity for evacuation (from region of production to region of consumption) of renewable power.⁹

In 2014, the Government announced the 'Solar Parks and Ultra-Mega Solar Power Projects' policy to facilitate the creation of large solar parks.

The Government has also provided financial incentives for expansion of solar energy. These include: (a) The Government has provided a 10-year tax exemption for solar energy projects; (b) Waiver of Inter-State Transmission System (ISTS) charges for inter-state sale of solar and wind power for projects to be commissioned by 30th June 2025; (c) The Ministry of New and Renewable Energy provides 30% subsidy to most solar powered items such as solar lamps and solar heating systems. It has further extended its subsidy scheme to solar-powered cold storages; (d) The Government has allowed 100% Foreign Direct Investment (FDI) under the automatic route; (e) Government has issued orders that power shall be dispatched against Letter of Credit (LC) or advance payment to ensure timely payment by distribution licensees to renewable energy generators; (f) Government has also launched Green funds like the National Clean Energy and Environmental Fund, Green Masala Bond etc.

The Government has also undertaken initiatives for international collaboration. India is the founding member of the International Solar Alliance (ISA) which is headquartered in India. India has proposed the idea of "One Sun, One World, One Grid" as a means of tapping into the copious solar electricity available on a worldwide scale.

Suggestions:

Manufacturing of solar equipment is dominated by a handful number of countries. In order to become a world leader in solar power, India must develop the entire manufacturing value chain ecosystem to become competitive and achieve sustainable growth in the long run. The Government should also focus on last mile connectivity in remote areas where developing transmission infrastructure is a challenge. This can be achieved through small solar installations or solar community grids by using domestically manufactured products with small power inverters or batteries in every home. It may be helpful to ensure power for all. The Government should invest prudently in new and emerging solar technologies through strong financial measures that include green bonds, clean energy funds and institutional loans. There is a need to promote R&D particularly in renewable energy storage technology and tackle bureaucratic

hurdles in implementation of such efforts. India must also take proactive steps towards formulation of an efficient Solar PV Waste Management and Manufacturing Standards Policy for sustainable waste management. The Government should also leverage on the Ministry of External Affairs's New and Emerging Strategic Technologies (NEST) Division to engage in technology diplomacy and negotiate technology governance to favour India.

CONCLUSION

India is endowed with vast solar energy potential. India receives nearly 3000 hours of sunshine every year. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day¹⁰. Solar photovoltaics power can effectively be harnessed providing huge scalability in India. National Institute of Solar Energy has assessed India's solar potential to be about 750 GW assuming 3% of the waste land area to be covered by Solar PV modules. Gujarat and Rajasthan have the highest solar energy potential. In 2014-15, the Government had set a target of producing 175 Gigawatt (GW) of renewable energy by 2022, with 100 GW of solar energy. The present installed capacity of solar energy is only 60% of the target. While, the Government is set to miss the ambitious target, nevertheless the progress in expansion of renewable and solar energy has been commendable. The installed renewable energy capacity has trebled from 38GW in 2014. The Government should take steps to address the challenges facing the sector and further enhance the pace of transition to clean energy.

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