

"SOLAR ENERGY: STRENGTH, LIMITATIONS AND ROLE AS A SUSTAINABLE ENERGY SOURCE".

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INTRODUCTION:

Solar energy is one of the most promising and practical options in the light of the growing environmental enterprises and the demand for sustainable energy results. Solar power, which is generated from the sun's abundant and renewable energy, is one way to reduce our reliance on fossil energies, decelerate climate change, and make a further sustainable future. This composition examines the advantages, difficulties, and implicit benefits of solar energy to a sustainable energy future as it emerges as a major force in the global energy transition.

THE DEVELOPMENT OF SOLAR POWER :

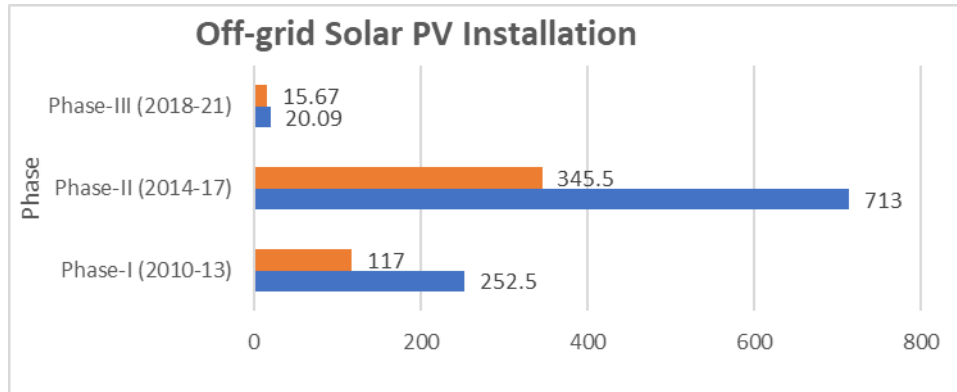
Because of mortal exertion, an estimated 8 billion metric tons of carbon is released into the atmosphere each time. 6.5 billion from fossil energies and 1.5 billion from deforestation.[1] After the United States and China, India, which is home to around 17.5 of the world's population, is the third-largest emitter of carbon dioxide(CO₂) from energy burning. It thus understands that to strike a balance between sustainable development and comprehensive development, environmental knowledge must propel its expansion. [2] Although solar energy has been used for thousands of times in a variety of ways, its use as a source of energy has increased dramatically in recent decades. The "Jawaharlal Nehru National Solar Mission"(JNNSM) was approved by the Indian government. To attain equality with grid electricity tariffs by 2022, the Mission seeks to develop and apply solar energy results throughout the nation [3].

India's total solar power affair capacity was roughly 39.6 MW as of June 2011. This is roughly 0.002 of the 22 GW target set by JNNSM for 2022 [4]. Although this will be enforced in three phases, the first phase would include installing 200 MW of out-grid solar operations using both solar thermal and photovoltaic technologies, as well as 1100 MW of grid solar power, by March 2013 [5].

94.17 GW of solar power has been achieved cumulatively as of November 30,2025[6] The aggregate for Maharashtra is 8363.55 MW, which includes 4802.12 MW from ground-mounted solar, 2733.86 MW PM- Surya Ghar Yojna (Solar Rooftop), and 827.57 MW from out-grid solar/ KUSUM.

India has achieved 5th rank in the world in solar power deployment. As on 30-06-2023, solar projects of capacity of 70.10 GW have been commissioned in the country. The capacity of 70.10 GW includes 57.22 GW from ground-mounted solar projects, 10.37 GW from rooftop solar projects, and 2.51 GW from off-grid solar projects [7].

Phase	Sanctioned (MW)	Installed (MW)
Phase-I (2010-13)	252.5	117
Phase-II (2014-17)	713	345.5
Phase-III (2018-21)	20.09	15.67



The operation of solar energy in the marketable, artificial, and domestic sectors has increased due to technology advancements that have made solar panels more affordable and effective.

As the world moves down from fossil energies, solar energy has grown in fashion ability due to its advantages for frugality and terrain. Unlike coal, oil painting, or natural gas, solar energy is abundant, clean, and does not release any hothouse feasts or other dangerous adulterants that contribute to global warming. Thermal energy can be used to capture the heat from the sun, or photovoltaic(PV) cells can be used to convert sunlight into electrical power.

THE STRENGTH OF SOLAR ENERGY AS A SUSTAINABLE SOLUTION :

An abundant and sustainable source of energy. Solar energy is a renewable resource that will last for billions of times. The sun provides significantly further energy than anyone could ever bear because one hour of sun covers the Earth's face enough to meet all the world's energy requirements for a time. Long-term sustainability depends on solar energy because, in contrast to fossil energies, it is virtually indefatigable.

REDUCING GREENHOUSE GAS EMIGRATIONS

Solar energy is pivotal for reducing carbon emissions and mollifying climate change. Carbon dioxide(CO₂) and other greenhouse gases (GHGs) are substantially produced during the energy product process using traditional fossil energies. By converting coal and gas power shops to solar energy, we can drastically reduce hothouse gas emigrations and the detriment they cause to the terrain. When solar systems induce power, no air pollution or dangerous derivations are created.

DROPPED ENERGY COSTS

Although solar panel installation can be expensive at first, there are significant long-term advantages. Businesses, families, and indeed entire communities can reduce their electricity bills by using solar energy to induce their own electricity. Over time, technological developments have reduced the cost of solar systems, and numerous countries offer duty immunity, rebates, or subsidies to make solar energy more extensively available.

ENERGY INDEPENDENCE

Solar energy promotes energy independence by reducing reliance on imported reactionary energies. Solar-powered countries and people can induce their own electricity, making them less vulnerable to oscillations in the prices of the world's energy requests and

dislocations in force. Likewise, this can enhance energy security and adaptability, especially in remote or off-grid areas.

PROFITABLE EXPANSION AND JOB CREATION

The solar initiative has created millions of jobs worldwide, from manufacturing and installation to exploration and development. As demand for solar energy grows, assiduity will continue to produce good-paying, green jobs that will advance the green frugality and strengthen original husbandry. According to the transnational Renewable Energy Agency (IRENA), the solar energy assistance employs further people encyclopedically than any other energy sector.

TECHNOLOGICAL INNOVATION AND PROGRESS

In recent times, solar technology has advanced dramatically. New technologies like solar batteries and energy storehouse systems are making it simpler to store and manage solar power, and solar panels have gotten more cost-effective, long-lasting, and effective. Also, developments in solar thermal energy and concentrated solar power (CSP) hold promise for large-scale energy.

LIMITATIONS IN GROWING SOLAR POWER :

Indeed, though solar energy has numerous advantages, there are still obstacles to be addressed before it can become the primary energy source encyclopedically. In India, the cost of solar panel installation ranges between ₹45,000 and ₹70,000 per kW. This figure depends on the factors including location, panel type, and subsidies.

INTERMITTENCY AND STORAGE

Because solar electricity is intermittent, it can only be produced while the sun is shining. As a result, grid drivers might have trouble balancing force and demand. Nevertheless, advancements in energy storehouse technology, similar to solar batteries, are addressing this issue by making it possible to store and use redundant energy when the sun is not present.

ORIGINAL INSTALLATION

Costs The original investment needed to buy and install solar systems may still be prohibitive for numerous individuals and businesses, particularly in poor countries, despite the recent sharp decline in the cost of solar panels. Still, the long-term energy bill reductions and government impulses may make the investment more enticing.

SPACE CONDITIONS

Large-scale solar power shops bear a lot of land, which can be an issue in areas with thick populations. Land-use considerations are still important when planning solar structures, still rooftop solar panels and solar granges may help alleviate this issue in lower populated locales.

EFFECTS OF MANUFACTURING AND DISPOSAL ON THE ENVIRONMENT

The operation of raw materials like silicon, tableware, and rare earth rudiments during the manufacturing and disposal of solar panels may have an adverse effect on the terrain. Reducing the environmental impact of solar technology is a nonstop challenge, although recovering enterprise and further environmentally friendly product ways are being

developed to address these problems.

THE ROLE OF SOLAR ENERGY IN A SUSTAINABLE FUTURE :

Notwithstanding these obstacles, solar energy is formerly making a substantial donation to the world's shift to sustainable energy. When solar energy is extensively used, it could decarbonize the energy sector. By moving down from fossil energies and toward solar energy, we can drastically reduce emigrations and lessen the effects of climate change.

PROMOTE SOCIAL AND PROFITABLE JUSTICE

The affordable electricity produced by solar energy can help communities in remote or underserved locales, reducing energy poverty and perfecting quality of life.

CONNECT WITH OTHER RENEWABLE ENERGY SOURCES

To meet the world's global energy requirements, a strong and varied energy blend may be created by combining solar energy with wind, hydro, and geothermal energy.

CONCLUSION :

Solar energy is a sustainable choice because of its multitudinous benefits for terrain, society, and frugality. As technology advances, costs continue to decline, and global mindfulness rises, solar power is anticipated to play an ever-larger part in the world's energy blend. Investments in solar energy not only reduce our carbon footprint but also contribute to a more indifferent, sustainable, and energy-independent future for coming generations. As we continue to address the issues brought on by climate change, solar energy is an important tool in our cooperative effort to produce a cleaner, greener earth.

Solar energy's role in the future will be pivotal in creating a cleaner, more sustainable, and more equitable global energy system. By addressing pressing challenges like climate change, energy access, and energy security, solar power will continue to lead the way in shaping the future of energy. Its widespread adoption, fueled by technological advancements and cost reductions, will make it a cornerstone of a sustainable energy future for generations to come.

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