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# SOLAR ENERGY HARNESSING; SCENARIO IN ODISHA

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## Abstract

Demand of power is indicative of growth of Nation; simultaneously it is a problem to be handled with utmost futuristic visions. Requirements of energy to powering the Development, Industrialization and enhancement of general life quality of citizens have increased while the limited supply of the precious fossil fuel has been depleted proportionately. From all angles of consideration, use of solar power is the key to sustenance. Due to massive R&D in this sector, technology has reached a suitable level of scalability. Government promotion and people's responsibility are now the only pivotal factors. India as a nation is already in the race and all parts of India should equally foster the idea.

## Introduction

The quality of human life depends directly or indirectly to a large degree on the availability of energy. This energy has been mostly derived from conventional energy sources like fossil fuels. The limited supply of these age old preservations and the environmental impact of their use makes the requirement of development of renewable or hybrid (that can prolong the exhaustion of conventional sources) energy resources more apparent for the mankind to be able to maintain its living quality in coming years, let alone the growth & development.

All life is bottled sunshine. But to carter to our daily energy requirement we need to harness the energy that is continually being poured on us. Sun radiates energy in a very wide range. There are natural processes in operation all the time to capture fractions of this energy in form of heat or light. However, efficiently harnessing solar energy for human use involves lots of technical innovations. The same way as nature does, technological capturing of sunlight directly to produce electricity is called the **photovoltaic**(PV) and harnessing of the heat of solar radiation is known as **concentrated solar power** (CSP)

## A. Photovoltaic

Solar PVs convert radiant sunlight into electrical currents. The average solar cell is approximately 15% efficient.

Silicon-based solar cells are predominantly used as low-cost PVs with nearly 20% efficiency. The efficiency of a solar cell has a maximum thermodynamic limit depending on the band gap of the semiconductor. By technical modifications the efficiency can be made to reach a level of nearly the thermodynamic limit of 25% [2]. Their cost of production on an industrial scale is high. This constitutes the first generation wafer based solar cell.

Advent of thin film technology opens possibility of polycrystalline thin film solar cells which are cost effective(lower cost per watt). This is the second generation of solar PV which has lower efficiency than the wafer based Si solar cells. One drawback to this technique is that it employs a thin coating of CdTe or Copper Indium Gallium Diselenide (CIGS) which is toxic and not abundant.

Solar cells based on the sensitization of mesoscopic oxide films by dyes(Dye sensitized solar cell (DSC)) or ***quantum dots*** have already reached conversion efficiencies exceeding 11%.[10] These are advanced third generation solar cells with better efficiency and improved cost effectiveness. Recently organo-metal halide ***perovskite*** films of high crystallinity are used in solar cells to reduce cost and simultaneously increase efficiency.

Efficiency of the solar cells are tried to be further increased by utilizing the non-harnessed thermal energy emitted by panels to get electricity called the solar thermo photovoltaic device (STPV) [2]. Quantum dots or Light-Sensitive Nanoparticles are potential candidates of cost-effective flexible solar cells with nearly eight percent more efficient. In spite of that, the chemical instability of quantum dots in the presence of air is a major setback for their outdoor use. Currently this is an active field of exploration and successes are looming over.

Triple junction solar cells based on GaAs chemically responsive to sunlight and observed to be few times more efficient than the existing solar PV. The III-V semiconductors have high direct band gap and variety of bandgap options are available. When stacked with decreasing bandgap, the photon absorption is maximized. These multi-junction solar cells are highly efficient than any single junction cell. In **concentrator photovoltaics** (CPV) multi-junction solar cells are used with optical arrangements to gather light from a wide area and focused on it so as to achieve efficiency of nearly 40% with reduction in the cost of manufacturing.

Another rapidly emerging PV technology is organic photovoltaic (OPV) cells. At a reasonable efficiency range(~13.2%), OPV are becoming popular because of ultra-low cost, diverse options in organic materials and very stable lifetime.

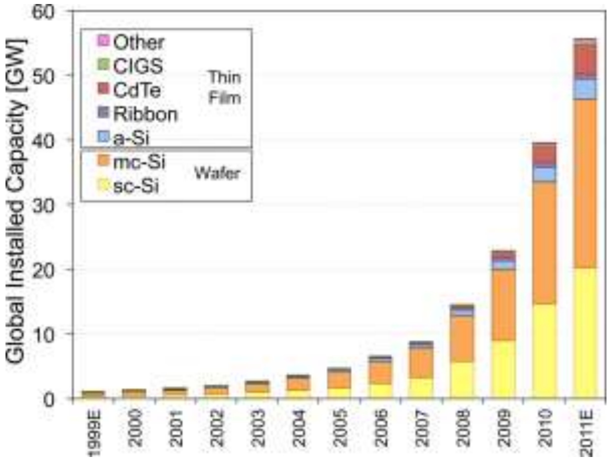


**Figure 1. Cumulative installed capacity disaggregated by the major technologies (Source [13]).**

## B. Concentrating solar power (CSP)

CSP captures the thermal energy and uses it to produce electricity like thermal plants. Its technology is complicated and unsuitable for small scales[14]. Due to indirect mode of the use of energy, It significantly lags behind solar photovoltaic (PV) by cumulative capacity. As it stores the heat energy, which makes it a dispatchable renewable energy technology that in right conditions has the ability to flexibly deliver electricity 24 hour a day. Use of proper technology with molten salt[1] as heat reservoir has been observed[2] to significantly improve the CSP efficiency.

Solar technologies have evolved a lot with many technical breakthroughs. Solar PV generated electricity is not dispatchable and it gets lost, if not used immediately. So, solar plants can be best used to serve peak demand. Without proper storage battery technology, solar plants may not be able to serve as base load plants.

The solar power harnessed in PVs in addition to the solar cells conversion efficiency is also limited by inverter efficiency, battery technology. Use of the off-grid portable solar PVs for small appliances bypassing inverting and transmission losses will definitely have far reached effects on energy problems. Off grid PV installations are suitable for Indian conditions.

A metric that indicates the relative affordability of solar panels is *cost per watt*. Solar industry is now in a race to top the panel efficiency and cost per watt.

# Scenario in India

Human Development Index is one to one correlated with the energy supply per capita. India being a developing country has yielded to a growth of energy demand that almost doubled from its value in 2000 to that in 2015. The demand is expected to only rapidly grow further. The limited fossil fuel even without any accord to the environmental impacts and CO2 emission is not enough to fulfill the pervasive requirements of growth. Total production of renewables in India has soared; from the year 1975 to 2015, it almost doubled (Graph. 1) whereas the share of renewables in total energy continuously declined to almost half in the same period (Graph. 2) [6]. So it is essential to grow in capacities to produce energy from non-conventional sources. One potential solution is the nuclear energy which is draws multifaceted debates of safety, security, politics and diplomacy.

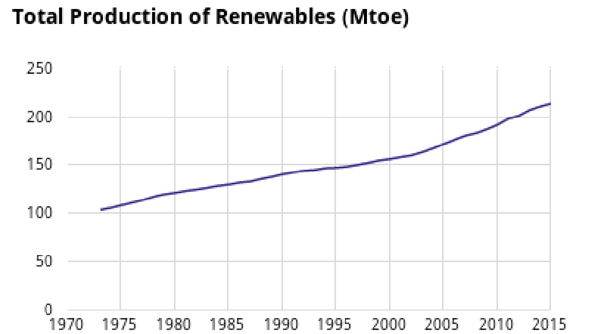


**Figure 2. Energy Production has nearly doubled**

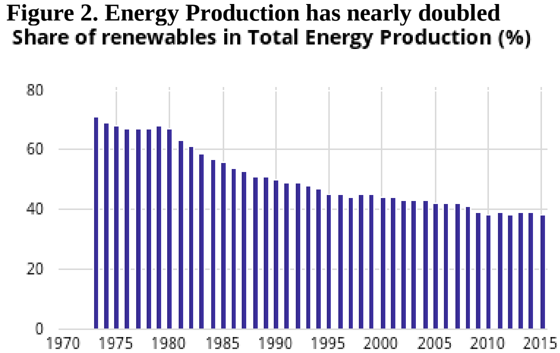


**Figure 3. Share of renewables could not keep the pace**

By 2015, in India, the total domestic electricity generation had a contribution of 10% by hydro electricity production, 3.1% by wind electricity production and 0.4% by solar PV.[6] The solar energy received by India remained completely unutilized. Solar capacity of India is 12.2 GW.

India has set the ambitious target of deploying 1,00,000 MW grid connected solar power and achieve grid tariff parity by 2022 under the Jawaharlal Nehru National Solar Mission(JNNSM)[5]. With this ambitious target, India will become one of the largest Green Energy producers in the world, surpassing several developed countries. Solar tariff of ₹ 2.44 /unit has already been achieved in some parts of India (Rajasthan). The overall increase in the installed capacity of power generation from renewables is 24.46% for 2016-17.

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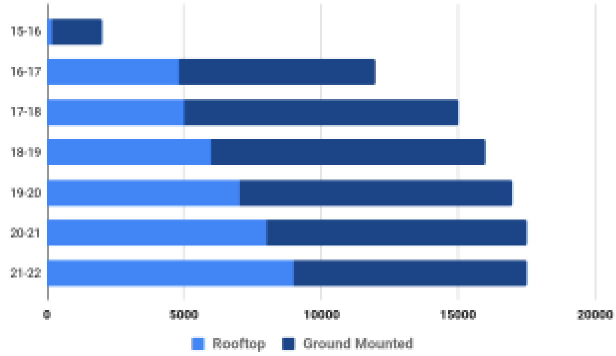


**Figure 4. Revised target set by Solar Mission of India**

# Scenario in Odisha

The backbone of power supply in Odisha has been the thermal and hydro. The depletion in hydro reservoirs witnessing the monsoon cycle disturbances and increasing water scarcity problems, and the thermal power stations not delivering to their full capacity due to obvious reasons of non-availability good quality coal have lead the state to a severe energy crisis. As on date 19% of the rural households of India are not electrified. Among the mainland eight coastal states of India, Odisha has the minimum household electrification level of 62% whereas excepting Karnataka (93%) the other states are all above the 98% level.[4] The massive industrial development, that the state dreams upon, has the basic requirement of power supply before any political or technical difficulties.

**Table 1. Odisha Estimated Energy Potential**

| **Resources** | **Potential** |
|---|---|
| Solar PV power | 14,000 MW |
| Small Hydro | 156.76 MW |
| Wind Energy | 236 MW |
| Biomass power | 350 MW |
| Waste to Energy | 28.5 MW |

The Dept. of Science & Technology, Govt. of Odisha through the nodal agency OREDA has estimated the potential energy capacity obtainable from different resources (Table. 1) of the state [8]. Power from nuclear sources is not available for the state. Wind power harvesting has been tried almost to the full capacity. Erratic weather conditions and timely maintenance of wind turbines has a running overload burden. The state is naturally adaptive to small hydro generations and solar power harvesting. Even though, the average solar energy incident in this part of India is not high(~5.5 kWh/sq. m), it is not less to have substantial contributions to power production. Bhubaneswar/Cuttack is in the phase II stage of implementation of solar capacity expansion of National solar mission with a capacity of 1 MW.

Furthermore, Kittner *et. al.*,[9] have shown that mini-grid solar PV has excellent Energy return on investment(EROI), better than the mini-hydropower plants. Mini-grids utilize the local distribution of renewable resources and optimize the payback.

The state has most part of it covered with green forests and hills. So, large patch of unutilized barren lands suitable for solar plants are not plenty available. Covering irrigation canals with solar panels has been observed to make aquatic ecosystem of the canal stagnant. Deployment of PVs is needed with well thought out and meticulous planning.

Reduction of requirement of power by reducing wastage and increasing efficiency of power usage is the most inevitable solution to any energy shortage problem. Unfortunately, in this area, technology leads much ahead of awareness of society.

Instead of conventional rooftop mounting of solar panels or large solar plants for industrial scale use needing a vast patch of land, some local alternative options can be exploited. **Solar Roadways** is one such possibility. Long highways and roads can be used for solar panels installation that can deploy large amounts of electricity to the grid. Government rolled out plans recently to encourage smart metered rooftop PV installations with subsidy of 30% to the cost. Financial provisions of interest free installments could attract many low income households. Small PVs or hybrid solar supported co-generated power utilization in handheld electronic devices and smart instruments in decentralized ways can alleviate energy problems. It is desirable that useful *energy generation* from alternate renewable sources should be corroborated by *energy conservation* and *energy efficiency*. If 4.54 billion years of age of earth is compressed to one year, modern humans are in existence for nearly only about 23 minutes. The time has come where everyone needs to realize that the energy stored in Earth which took billions of years to be collected was squandered in a matter of 200 years of *industrial age* and if we don't pay attention and don't apply sustainable corrective measures, we won't know where we end.

# Acknowledgments

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# References

[1] Novatec Solar(™)

[2] https://www.nrel.gov/

[3] David M. Bierman et al.,“Enhanced photovoltaic energy conversion using thermally based spectral shaping”, Nature Energy, volume 1, 16068 (2016) doi:10.1038/nenergy.2016.68.

[4] http://saubhagya.gov.in/Dashboard#2 as on 08/03/18

[5] http://seci.co.in/

[6] International Energy Agency(IEA)

[7] https://powermin.nic.in

[8] http://oredaodisha.com

[9] Noah Kittner et al., “Energy return on investment (EROI) of mini-hydro and solar PV systems designed for a mini-grid”, Renewable Energy 99 (2016) 410-419

[10] Michael Gra1tze, “Solar Energy Conversion by Dye-Sensitized Photovoltaic Cells”, Inorg. Chem. 2005, 44, 6841-6851.

[11] Emilio J. Juarez-Perez, et. al., “Thermal degradation of CH3NH3PbI3perovskite into NH3and CH3I gases observed by coupled thermogravimetry–mass spectrometry analysis”. Energy Environ. Sci., 2016; DOI: 10.1039/c6ee02016j

[12] Yasuo Chiba, et. al., “Dye-Sensitized Solar Cells with Conversion Efficiency of 11.1%”, Japanese Journal of Applied Physics, 45(25), pp. L638–L640 (2006)

[13] Michael Dale, et al., “Energy Balance of the Global Photovoltaic (PV) Industry - Is the PV Industry a Net Electricity Producer?” Environ. Sci. Technol. 2013, 47, 3482−3489, doi: 10.1021/es3038824

[14] Paul Gauche, et al., “System value and progress of CSP”, Solar Energy, Volume 152 (2017) Pages 106-139, 10.1016/j.solener.2017.03.072.