



SOLAR ENERGY MISSION: PAVING THE WAY FOR INDIA'S TRANSFORMATIONAL FUTURE

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Abstract: *Renewable energy, especially the solar power, has been garnering a lot of interest from governments, international development organizations, civil society, and the private sector for the last few years. Among the various renewable energy resources in the country, solar energy potential is the highest. The sun produces an unbelievable amount of energy that reaches to the earth. With its abundance of the sunlight, India has tremendous potential to emerge as one of the leaders in solar power generation.*

On the national front, firstly, solar power stands to partially address the issue of shortage of power for economic growth. There is an established positive correlation between energy requirement and Gross Domestic Product (GDP) growth. Secondly, solar power can foster energy security for India by reducing dependence on imported fuel. At the international level, firstly, India has already demonstrated that it is an industrial low-cost destination worldwide. It has the potential to capture cost reduction leadership for solar power as well. Secondly, cleaner energy production through solar power also contributes to India's international commitment in Paris to draw 40% of electricity from renewable source by 2030. According to the Government of India's policy for the solar sector –Jawaharlal Nehru National Solar Mission (JNNSM) – a target of 100 (GW) of solar installations by 2022 has been set.

The present paper provides an overview of Solar Mission in India and its three phases. This paper also discuss about the various advantages of solar energy and Government of India's initiatives towards solar energy with examples. At last the paper also suggests strategies that can help India in becoming Solar Super Power.

Keywords: *Renewable Energy, JNNSM, MNRE, Rooftop Solar, Solar Cities*

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I. INTRODUCTION:

India's carbon output, by contrast, is growing faster than any other country. Should that trend continue—and there is reason to think that it will—India could surpass China in 25 years to become the world's greatest emitter. The Indian power sector is predominantly based on fossil fuels, with about 3/5th of the country's power generation capacity being dependent on vast indigenous reserves of coal. But in the last few decades Indian government has taken several steps to reduce the use of fossil fuels-based energy while promoting renewable generation. Solar energy constitutes the most abundant renewable energy resource available and in most regions of the world. There is a green energy revolution underway in India that can increase prosperity for millions of poor families by harnessing the abundant and clean energy of sun. With the right policies in place, India can easily become a world leader in the solar energy. This solar endeavor could also help address acute power shortages, and make a real difference in slowing the pace of climate change.

India is endowed with abundant free solar energy. Using the country's deserts and farm land and taking advantage of 250 to 300 sunny days a year, India could easily generate 5,000 trillion kilowatt-hours of solar energy. In other words, India could easily install around 1,000 GW of solar generation — equivalent to four times the current peak power demand (about 250 GW) — using less than 1 percent of its land. India is both densely populated and has high solar insolation, providing ideal conditions for the exponential growth of solar power as a future energy source. With GDP growing at about 8 percent, solar photovoltaic power is the only renewable energy resource that can bridge the 'gap' between supply and demand of energy. Solar energy can transform India and help to bring about decentralized distribution of energy, thereby empowering people at the grassroots level and eliminating the need for costly expansion of transmission and distribution systems.

India has already taken positive steps by announcing very aggressive goals to meet 40 percent of its energy needs through renewable source by 2030. I firmly believe that, with favorable policies and strategic economic investments, India could meet all of its energy needs through renewable source by 2050.

OBJECTIVE:

The study has been geared to achieve the following objectives;



1. To understand the detailed concept of JNN Solar Mission in India
2. To study the advantages of solar energy
3. To study the Government of India's initiative in promoting solar energy
4. To examine the live example of solar energy in India
5. To understand the concept of solar cities in India
6. To suggest some strategies for making India Solar Super Power.

RESEARCH METHODOLOGY:

The research paper is an attempt of exploratory research, based on the secondary data sourced from various journals, magazines, articles and the websites. Available secondary data was extensively used for the study.

RENEWABLE ENERGY SOURCES IN INDIA:

Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from sun, or from heat generated deep within the earth. Included in the definition are electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, bio fuels and hydrogen derived from renewable resources.

SOLAR ENERGY:

Solar Energy is bright light and heat from the sun harnessed by using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture and artificial photosynthesis. In 2011, the International Energy Agency (IEA) said that "the growth clean solar energy technologies will result in following benefits:

- 1) Affordable.
- 2) Inexhaustible and indefinite
- 3) Increase the countries' energy security
- 4) Reliance on an indigenous, inexhaustible
- 5) Import-independent resource.
- 6) Enhances sustainability,
- 7) Reduces pollution,
- 8) Lowers the costs of mitigating global warming,
- 9) Helps to keep fossil fuel prices lower than otherwise.



These advantages are universally accepted. Hence the additional costs of the incentives for early use of solar energy should be considered learning investments. They must be spent prudently and be widely shared.

CURRENT STATUS OF SOLAR POWER IN INDIA:

As of 31 August 2015, the installed grid connected solar power capacity is 4,229.36 MW and India expects to install an additional 10,000 MW by the year 2017 and a total of 100,000 MW by 2022.

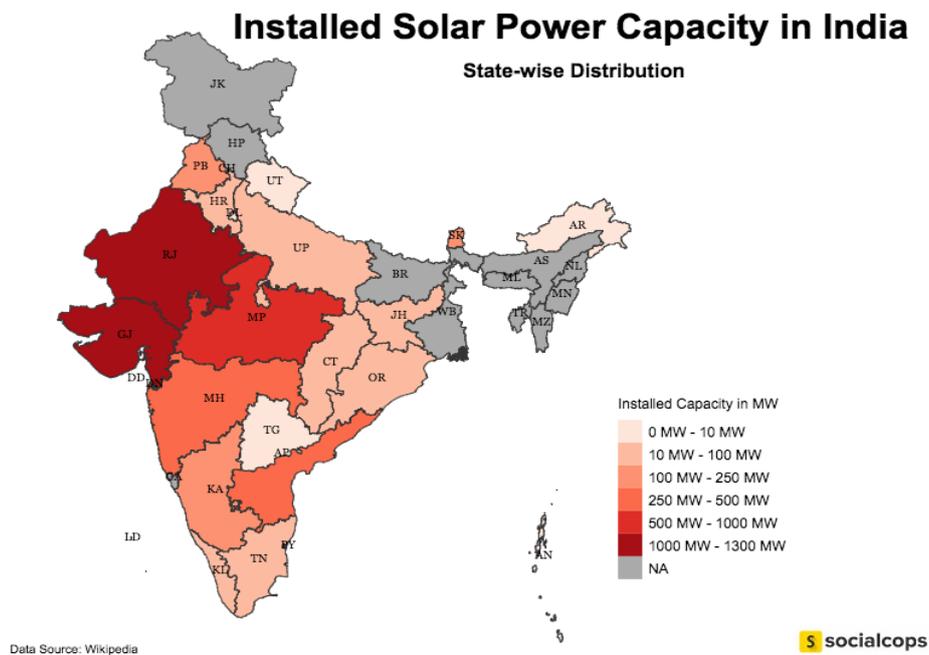


Figure 1: Installed Power Capacity in India

Source: Wikipedia

II. SOLAR MISSION OF INDIA:

The **Jawaharlal Nehru National Solar Mission** (also known as the National Solar Mission) is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenges. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. Named after first Prime Minister Jawaharlal Nehru, the Mission is one of the several initiatives that are part of National Action Plan on Climate Change.

The program was inaugurated by then Prime Minister of India, Dr. Manmohan Singh on 11th January, 2010 with a target of 20GW by 2022 which was later increased to 100 GW in 2015 by NDA government.



OBJECTIVE OF SOLAR MISSION:

The objective of the National Solar Mission or to say JNNSM is to establish India as a global leader in field of solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible. The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralised and decentralised level.

3 PHASES OF SOLAR MISSION:

The Mission under the aegis of Ministry of New and Renewable Energy (MNRE) will adopt a 3-phase approach, spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013–17) as Phase 2 and the 13th Plan (2017–22) as Phase 3. During the mid-term of 12th and 13th Plans, there will be an evaluation of progress, review of capacity and targets for subsequent phases, based on emerging cost and technology trends, both domestic and global. The aim would be to protect Government from subsidy exposure in case expected cost reduction does not materialise or is more rapid than the expected one.

YEAR WISE TARGET OF SOLAR MISSION:

To meet the scaled up target of 100,000 MW by 2022, MNRE has proposed to achieve it through 40,000 MW through Rooftop Solar Projects and 60,000 MW through Large and Medium Scale solar projects.

Year wise Target in MW

Category	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Total
Rooftop Solar Project	200	4,800	5,000	6,000	7,000	8,000	9,000	40,000
Ground Mounted Solar Project	1,800	7,200	10,000	10,000	10,000	9,500	8,500	57,000
Total	2,000	12,000	15,000	16,000	17,000	17,500	17,500	97,000 Approx.

Source: MNRE Website

III. ADVANTAGES OF SOLAR ENERGY:

The benefits of solar energy would be numerous. Broadly the benefits can be envisaged in three parts, Viz. People, Profits, Planet

People

- Solar Energy systems require a very low maintenance.
- Solar Power gives a chance to be energy independent i.e. generate own power



- Sun creates clean and renewable energy that will sustain and support the health of future generations.
- Solar power being a distributed energy source generation it can mitigate national security concerns about energy disruption (As it happened in 2012 when all of North India was plunged in darkness due to failure of northern grid)
- Solar power can be installed anywhere and is capable of changing lives by bringing electricity and new sources of livelihood for Indian villages and cities.

Profits

- At a time when cost of electricity from conventional sources such as coal and diesel is soaring, solar provides liberation from rising fossil fuel prices
- The government gives huge tax benefits to the users
- Standard life of a system is around 25 years
- Solar systems can be installed faster than any other traditional or renewable power plants.
- Reliable over a long term period. Fixed (no moving parts) photovoltaic systems last longer than other energy sources.
- By paying “Time of Day” tariff, solar gives maximum benefit as it generates free electricity in the daytime, i.e. when TOD is at the highest.

Planet

- Absolutely Zero emissions and No noise pollution ever.
- Predictable energy curve and is most efficient when the utility rates are at their highest.
- Capable of placement in virtually every geographical region as the sun is universal.

IV. PM NARENDRA MODI’S SPECIAL INITIATIVE IN SOLAR MISSION:

Indian Prime Minister, Sh. Narendra Modi is pro-solar. He lays stress on switching to renewable energy. He aims to make India self-sufficient in terms of its energy needs by adopting solar energy i.e. clean and green energy. In his former position as chief minister of the western state Gujarat, Modi oversaw the construction of Asia’s biggest solar park, a giant utility with battalions of solar panels. Soon after being elected prime minister in 2014, he has revised the solar mission target to 100 GW by year 2022 from mere 20 GW as set in Jawaharlal Nehru National Solar Mission in year 2010. The revised capacity has been divided



into two parts i.e. 40 GW for rooftop solar electricity generation and 60 GW for large and medium-scale grid-connected projects. Earlier this year, India unveiled plans to build the world's biggest solar park, in the northern state of Madhya Pradesh. This path is next to impossible because No nation has ever expanded its renewable-energy infrastructure at the speed Modi envisions. India could easily spend huge sums and still fall short of its ambitions, leaving tens of millions of people in the dark.

DIVISION DETAIL:

Now the 100 GW solar power capacities have been divided into rooftop solar electricity generation (40 GW) and medium scale grid connected solar projects (60 MW). According to Ministry of New and Renewable Energy (MNRE) officials, it is expected that the total investment for upgrading to 100 GW solar power capacity will cost around Rupees 6,00,000 crore (\$94 billion) to the government.

According to the Cabinet, "(The) Government of India is providing Rupees 15,050 crore as capital subsidy to promote solar capacity addition in the country. This capital subsidy will be provided for rooftop solar projects in various cities and towns, for viability gap funding-based projects to be developed through the Solar Energy Corporation of India (SECI) and for decentralised generation through small solar projects."

BULDING MECHANISM:

Apart from capital subsidy, which is similar to what previous government had also done in the first phase of JNNSM; Rs 90,000 crore would be created using the bundling mechanism with thermal power. In common language, bundling refers to selling electricity in bundles, for instance, the sale of one unit of solar power bundled with four units of thermal power.

NARENDRA MODI CALLS FOR INDIAN SOLAR ARMY:

Prime Minister Narendra Modi calls for Indian Solar Army. In line with the ambitious target of solar installation of 1, 00,000MW (100 GW), the Government of India (GoI) is planning to train around 50,000 people in areas related to solar power. The pro-solar Indian Prime Minister, who named his solar mission as the Saffron Revolution, calls for Indian Solar Army. The workforce (Narendra Modi's Solar Army) will be trained through the Industrial Training Institutes (ITI) under the Government's Skill Development Mission. The Skill Development Mission of the Government aims to train 500 million people by the year 2022 that will



provide job-ready workforce to the Industrial Sector in India under the leadership of Rajiv Pratap Rudy, Hon'ble Minister of National Skill Development and Entrepreneurship.

"To achieve this ambitious target there will be a requirement of land, labour and capital. This 50,000-strong solar army will be provided 3-6 months training in the solar energy related areas, which will also prepare them for the job opportunities that the sector will have to offer." Keeping in view the ambitious targets set by the National Democratic Alliance (NDA) government installing 1, 00,000MW solar by 2022, there is an urgent need to build the requisite Solar Energy workforce.

V. GOVERNMENT SUPPORT AND INITIATIVES:

The Indian government is making continuous aggressive moves to accelerate the country's solar energy supply. According to Bridge to India, a Delhi-based solar energy firm, India's solar industry is expected to grow 250 percent this year, putting the country on track to become one of the top five solar countries globally. Indian Prime Minister Narendra Modi's government has just approved a plan to develop 60 solar cities. The world's first airport that runs entirely on solar power was recently built in the southwestern Indian in Cochin. And India is soon to have the world's largest solar power station in Madhya Pradesh. Describing solar energy as the "ultimate solution," Modi pledged to give all Indians access to electricity and called on the country's scientists to develop more efficient solar energy equipment. The Ministry of New and Renewable Energy provides 70 percent subsidy on installation cost of a solar photovoltaic power plant in North-East states and 30 percentage subsidy in other regions. But now the MNRE also proposed a subsidy cut on rooftop solar power plants from 30% to 15%, reasoning that the lower price of components would offset the proposed subsidy reduction.

INCENTIVES OFFERED BY THE GOVERNMENT FOR THE DEVELOPMENT OF THE SOLAR ENERGY SECTOR INCLUDE:

The Government of India offers following incentives for solar energy sector:

- Exemption from excise duties and concession on import duties on components and equipment required to set up a solar plant.
- A 10-year tax holiday for solar power projects.
- Wheeling, banking and third party sales, buyback facility by states.
- Guaranteed market through solar power purchase obligation for states.



- Schemes for small solar projects connected to a grid below 33KV.
- Reduced wheeling charges as compared to those for conventional energy.
- Special incentives for exports from India in renewable energy technology under renewable sector-specific SEZ.
- A payment security mechanism to cover the risk of default by state utilities.
- A subsidy of 30% of the project cost for off-grid PV and solar thermal projects.
- Loans at concessional rates for off-grid applications.

SETTING UP OF THE SOLAR INSTITUTES/AGENCIES BY GOVERNMENT:

Following two institutes/agencies has been set up by MNRE to promote solar energy:

A. NATIONAL INSTITUTE OF SOLAR ENERGY (NISE):

National Institute of Solar Energy, an autonomous institution of Ministry of New and Renewable (MNRE), is the apex National R&D institution in the field Solar Energy. The Government of India has converted 25 year old Solar Energy Centre (SEC) under MNRE to an autonomous institution in September, 2013 to assist the Ministry in implementing National Solar Mission and to coordinate research, technology and other related works.

B. SOLAR ENERGY CORPORATION OF INDIA (SECI):

Solar Energy Corporation of India (SECI) was set up on 20th September 2011, as a not-for-profit company under Section-25 of the Companies Act 1956 as an implementation and facilitation institution dedicated to Solar Energy sector. SECI is established under the administrative control of the Ministry of New and Renewable Energy, Government of India. Mandate of SECI allows wide ranging activities to be undertaken with an overall view to facilitate implementation of JNNSM and achieving the targets set therein. The Corporation has the objective of developing Solar Technologies and ensuring inclusive solar power development throughout India.

DEVELOPMENT OF 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 infrastructures like transmission system, water, road connectivity and communication network etc. will be developed. The parks will be characterised 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.

SOLAR FINANCING TO SOLAR DEVELOPERS:

The Government of India has also encouraged solar developers by arranging finance facility for their projects. The Reserve Bank of India has added renewable energy under priority lending. The financial institutions, which led debt financing to solar developers could be classified into four categories such as Scheduled Commercial Banks, Non-Banking Financial Institutions, Multilateral/Bilateral Agencies and Export credit agencies.



Figure 2: Types of Debt Financing

Source: Author's Presentation

AUCTION OF SOLAR POWER PROJECTS AND INVESTORS MOVE TO CAPITALISE ON INDIA'S SOLAR ENERGY PUSH:

Under the National Solar Mission, which calls for 100 gigawatts—about the total electricity capacity of Spain—of new solar power generation to be built by 2022, the government has begun to auction off 15 gigawatts of solar power projects across the country. Early results from those auctions are striking.



In Madhya Pradesh, Canadian developer Sky Power won the bidding with an offer of 5.05 rupees (about \$.07) per kilowatt-hour. That auction, intended to bid out 300 megawatts of solar generation, attracted bids totaling 2,200 megawatts, at rates below six rupees per kilowatt-hour. That is well below the 7.04 rupee per kilowatt-hour that the Central Electricity Regulatory Commission has determined is the threshold of viability for solar PV projects. Earlier, U.S. provider First Solar bid 5.25 rupees (\$.08) per kilowatt-hour for a solar project in Andhra Pradesh. The US Company Sun Edison in November month won a bid to sell solar power at a record low tariff in India of 4.63 rupees per kilowatt-hour at a 500MW project in Andhra Pradesh, south India, Reuters reported. This undercut the 5.05 rupees per kilowatt-hour tariff for the Canadian company SkyPower's project in the central Indian state of Madhya Pradesh, according to the newswire.

WHERE WE STANDS IN TARIFF RATE:

In the US, solar power installations offer power against 20-year power purchase agreements (PPAs) at a tariff of under 4 cents a unit. India, on the other hand, has seen the lowest tariff of just around Rs.5.50/kWh (a little over 8 cents). That makes India's solar power at least twice as expensive as that which can be got in the US (or even in the Middle East or Israel). But now due to efforts of Indian Government tariff has come down to Rs. 4.63/kWh in November 2015. This rate is expected to come down in near future.

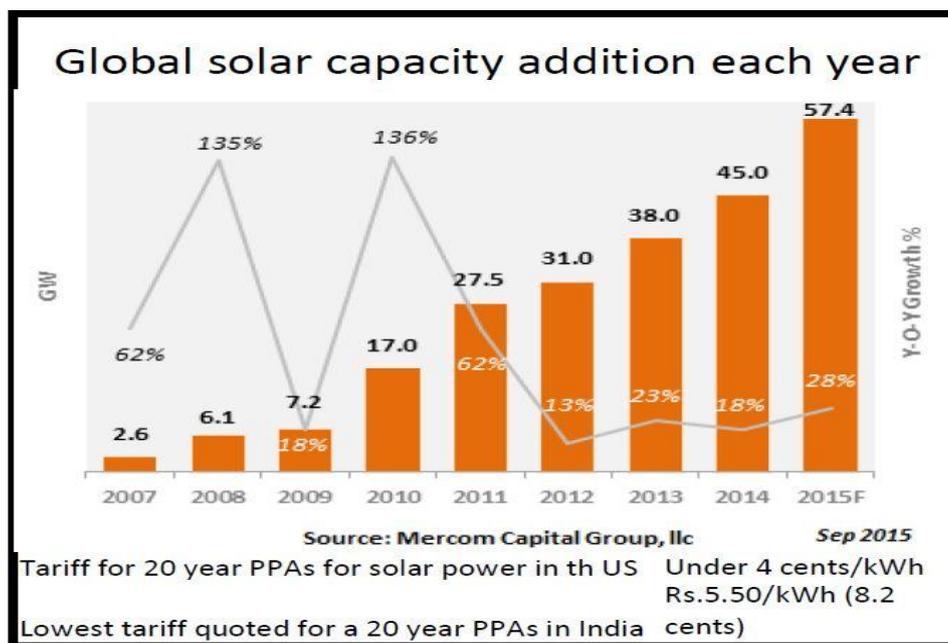


Figure: 3

Source: Mercom Capital Group



VI. BENEFITS OF ENTERING SOLAR MARKET IN INDIA:

Factors driving growth of Solar Market in India:

DEMAND SIDE:

- Average demand-supply gap of 12%;
- National Solar Mission (NSM) aims at increasing investment in the solar energy sector in India thereby increasing the market and driving down costs;
- Increasing consumption from 660kWh to 1900kWh by 2032.

SUPPLY SIDE:

- Fast depletion of non-renewable sources of energy;
- Favorable environment by providing various subsidy schemes;
- Huge demand of electricity from rural area lacking grid connectivity;
- Power Generation Companies to resort to renewable sources.

Apart from this the revised targets of National Solar Mission (NSM) by the National Action Plan on Climate change adds to the overall market capitalization of solar energy sector in India.

- National Solar Mission Target revised to 1,00,000 MW;
- Market potential of INR. 2000 Billion;
- Prime Minister Narendra Modi calls for India Solar Army: GoI to train 50000 people; this creates multiple opportunities in the Solar Sector in India.

VII. LIVE EXAMPLES OF SOLAR ENERGY:

INDIA'S COCHIN INTERNATIONAL TO BECOME WORLD'S FIRST COMPLETELY SOLAR-POWERED AIRPORT:

It may not be the first airport to fit solar panels to its terminals, but India's Cochin International Airport is set to become the first in the world powered entirely by solar. Situated in Kochi, the airport handled 6.8 million passengers in the financial year 2014-15 and forecasts a 300,000-tonne reduction in carbon emissions over the next 25 years as a result of the switch to solar.

The Cochin International Airport, which is the first in India developed under a public-private partnership model, first dipped its toes into the solar power waters in 2013 when it built a 100 kilowatt peak (kWp) rooftop photovoltaic (PV) plant on its arrivals terminal. This was



followed by a 1 MWp PV plant that was split between the rooftop and the ground at its aircraft maintenance hangar facility.



Figure: 4

Source: <http://cial.aero/Default.aspx>

Now it scales things up in a big way. Unveiled on 18 August 2015, the new 12 MWp solar plant stretches across 45 acres (18.2 ha) and is made up of more than 46,000 photovoltaic solar panels that are located alongside the cargo terminal. The airport claims that the power it generates each year would be enough for 10,000 homes. In combination with the pre-existing solar plants, the plant is expected to make the airport completely carbon neutral.

The company says the mitigation of carbon emissions over the next 25 years is equivalent to planting three million trees or not driving 750 million mi (1.2 billion km). Al Jazeera reports that the plant took six months to build at a cost of US\$10 million, with the airport expecting to recover that outlay through energy savings within five years. The solar plant is also expected to generate more power than is required to run the airport, which will be connected to the grid to allow excess power to be sold to the state electricity board. The Airport will be operational from May 2016.

VIII. CONCEPT OF SOLAR CITY:

The Solar City is a city which aims at minimum 10% reduction in projected demand of conventional energy at the end of 5 years, through a combination of enhancing supply from renewable energy sources and energy efficiency measures. The basic aim is to motivate the local government and its bodies for adopting renewable energy technologies and energy efficiency measures. In a Solar City all types of renewable energy based projects like solar,



wind, biomass, small hydro, waste to energy etc. may be installed along with the possible energy efficiency measures.

CRITERIA FOR CHOOSING A CITY FOR DEVELOPING SOLAR CITY:

The solar city is identified based on its population, potential and commitment for adoption of renewable energy and energy conservation in the city activities, initiatives already taken by City Council/ Administration/ Private Developers/Industry/General Public in promoting renewable energy and energy conservation, regulatory measures taken on deployment of renewable energy technologies and their willingness to provide resources and sustenance of activities initiated under the program. The cities may have population between 0.50 lakh to 50 lakh, however, relaxation could be considered for special category States including North-Eastern States and hilly States, Islands and Union Territories for promoting solar energy.

NUMBER OF CITIES TO BE DEVELOPED AS SOLAR CITIES:

A total of 60 cities/towns are proposed to be supported for development as Solar Cities during the 11th Plan period. At least one city in each State to a maximum of five cities in a State may be supported by the Ministry.

OBJECTIVES OF THE SOLAR CITY PROGRAMME:

The Solar City programme aims:

- To enable and empower Urban Local Governments to address energy challenges at the City - level.
- To involve various stakeholders in the planning process.
- To create awareness among all sections of civil society.
- To provide a framework and support to prepare a Master Plan including assessment of current energy situation, future demand and action plans.
- To oversee the implementation of sustainable energy options through public-private partnerships (PPP).

ASSISTANCE TO THE URBAN LOCAL GOVERNMENTS:

The program assists Urban Local Governments/Bodies by providing financial assistance and technical help:

- In preparation of a master plan for increasing renewable energy supply and energy efficiency measures.



- In setting-up institutional arrangements for the implementation of the master plan.
- In awareness generation and capacity building activities.
- In implementation of projects as per financial incentives under various programmes of Ministry of New and Renewable Energy.

FINANCIAL ASSISTANCE UNDER SOLAR CITY PROGRAMME:

Up to Rs. 50.00 Lakh per city/town is provided depending upon population and initiatives decided by the City Council/ Administration as following details:

- Up to Rs 10.00 lakh for preparation of a Master Plan within a year along with some implementable Detailed Project Reports.
- Up to Rs. 10.00 lakh for setting up of Solar City Cell (SCC) and it's functioning for a period of three years.
- Up to Rs. 10.00 lakh for oversight of implementation during three years.
- Up to Rs. 20 lakh for capacity building and other promotional activities to be utilised in three years.

In addition to above, the financial and fiscal incentives available under various programmes of the Ministry will also be applicable on the Solar Cities for installation of renewable energy projects, systems and devices.

CITIES IDENTIFIED FOR DEVELOPING AS SOLAR CITIES:

In-principle approval is given to those Cities which fulfill the requirement as per criteria, have commitment for undertaking renewable energy installations and energy efficiency measures and have submitted their proposals in the prescribed format. So far, based on the proposals received and the cities identified by some of the State Governments, in-principle approval has been given to 48 Cities such as Agra, Moradabad, Chandigarh, Gurgaon, Faridabad etc.

IX. SOLAR ALLIANCE WITH 120 COUNTRIES:

Keeping in mind India's pledge to the Paris summit offered to draw 40% of its electricity from renewable Source by 2030, Prime Minister Narendra Modi has launched an International Solar Alliance (ISA) of over 120 countries with the French president, François Hollande, at the Paris COP21 climate summit on 30 November 2015. Speaking in conference Prime Minister said "Solar technology is evolving, costs are coming down and grid connectivity is improving. The dream of universal access to clean energy is becoming more



real. This will be the foundation of the new economy of the new century.” PM described the solar alliance as the sunrise of new hope, not just for clean energy but for villages and homes still in darkness, for mornings and evening filled with a clear view of the glory of the sun.

The Indian government is investing an initial \$30m (£20m) in setting up the alliance’s headquarters in India. The eventual goal is to raise \$400m from membership fees, and international agencies.

X. STRATEGIES FOR MAKING INDIA ‘SOLAR SUPER POWER’:

By implementing the following nine strategies, India can begin to become a solar super power-

- 1. Develop a national renewable energy (RE) policy:** Enact and deploy a comprehensive new energy roadmap or innovative RE policies (e.g., PPAs, Net Metering, FIT, etc.) without any further delay. In addition, it is desirable to set National Renewable Energy Standards/Policy such as 20 percent by 2020, 40 percent by 2030 and 100 percent by 2050 — to create demand, new industries and innovation, and a new wave of green jobs.
- 2. Electrifying transportation:** Expedite a move to electrify transportation by encouraging expanded use of electric vehicles (EV) and plug-in hybrids, and setting up of solar-powered EV charging stations around the country. Develop and implement time-of-day pricing to encourage charging of vehicles at night and other times when peak demand is low. In addition, launch the public transportation system of the future with zero-emission battery-powered Electric Buses in all major cities to reduce the air pollution and reverse climate change.
- 3. Energy efficiency:** Make energy efficiency a high priority by expediting the development and implementation of cost-effective energy efficiency standards. To reduce the long term demand for energy, engage states, industrial companies, utilities and other stakeholders to accelerate energy efficiency investments such as large scale nationwide use of LED bulbs.
- 4. Develop large-scale “Solar Manufacturing Hubs”** in India to facilitate the mass production of PV, CSP and CPV equipments.



5. **Invite international developers** to meet the revised JNNSM targets of 100 GW of solar and 75 MW of wind by 2022.
6. **Utility-Scale projects:** Phase out the conventional energy subsidies and develop a long term plan to replace fossil and nuclear plants with utility-scale renewable generation.
7. **Innovative financing solution:** Provide innovative financing (including Tax-Free Solar Bonds or Green Infrastructure Bonds, accelerated depreciation mechanism and access to credit at globally competitive rates etc.) to instill more confidence from potential investors and decrease the cost of financing for renewable energy projects. Create and fund a national smart infrastructure bank for renewable energy.
8. **Develop Energy Storage including thermal, grid battery storage** (e.g., Tesla Power wall home battery backup), compressed air/gas, vehicles-to-grid/home, pumped hydro, fuel cells or hydrogen (H₂ – produced from renewable energy only), flywheels, superconducting magnets and super capacitors. Develop a “hydrogen economy” plan. If done successfully, hydrogen and electricity will eventually become society’s primary energy carriers for the twenty-first century.
9. **Decentralized energy:** Avoid future fossil fuel investments in India and, instead, emphasize nationwide deployment of community scale solar projects (installing 100 million solar roofs, solar co-operatives, and solar cities, etc.) and micro grids with storage. India’s present 40 GW solar targets should be extended to include photovoltaic panels on the rooftop of every home in India, generating enough power to reduce the country’s massive dependence on fossil fuels.

XI. CONCLUSION:

India is standing on threshold of green energy revolution that can light up a new era of energy, economic and environmental security. To achieve this goal India needs to fundamentally transform the manner in which it produces, distributes and consumes the energy. By doing so, India can reduce its dependence on fossil fuels, create millions of new jobs and enhance its global competitiveness while decreasing carbon emissions and slowing the pace of climate change.

Given its abundant solar insolation, India has already outlined clear plans for future energy production from the sun. Barriers to implementing this renewable energy plan seem to be



primarily social and political rather than technological or economic. The technology is well established and available. If properly developed and used, India's abundantly available renewable resources could meet all of its energy demand by 2030. The solar energy offers India the theoretical potential to provide all its long-term power needs. Toward that goal, India has revised its target to reach 100 GW of solar capacity by 2022 and recently announced that 40 percent of its total energy mix would come from alternative sources by 2030. These targets are very much realistic, desirable and fully achievable.

All that is needed now to make this concept a reality is political commitment and appropriate investments and funding for building many more solar power systems, solar farms, hybrid solar-natural gas plants, solar thermal storage and advanced battery-based grid energy storage systems. Excess energy generated from solar could be stored in various forms and then used during times of peak demand. Solar energy provides a golden opportunity for India to move toward a 100 percent clean energy future while reducing poverty, ensuring energy security and combating the climate change. Solar energy has the potential to propel India forward as a "Solar Super Power." However, for India to meet its future energy needs, it can no longer afford to delay deployment of solar energy plans.

REFERENCES:

1. Singh, D., Goyal, N. and Tayal, P.K. (2013), "Promotion and Developments of Renewable Energy in Power System Technology and Energy Markets in India," *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. 3, No. 10, pp. 1437-1444.
2. Upadhyay, A. and Chowdhury, A. (2014), "Solar Energy Fundamentals and Challenges in Indian restructured power sector," *International Journal of Scientific and Research Publications*, Vol. 4, No. 10, pp.1-13.
3. Ministry of New and Renewable Energy, Government of India's website: <http://www.mnre.gov.in/>
4. Solar Energy Corporation of India's website: <http://seci.gov.in>
5. National Institute of Solar Energy's website: <http://nise.res.in>
6. https://energypedia.info/wiki/Jawaharlal_Nehru_National_Solar_Mission
7. https://en.wikipedia.org/wiki/Solar_power_in_India



8. <http://www.downtoearth.org.in/news/modi-government-sets-revised-solar-mission-target-at-100-gw-50236>
9. http://articles.economictimes.indiatimes.com/2015-05-20/news/62413666_1_solar-installations-jnnsr-renewable-purchase-obligation
10. <http://www.indiaenvironmentportal.org.in/files/mission-document-JNNSM.pdf>
11. <http://qz.com/562602/indias-solar-alliance-is-a-great-idea-with-one-fatal-flaw/>