Environmental and Social Implications of Solar Energy in India

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Abstract: In India, we face the grave challenge of securing energy supply to meet growing demand, providing everybody with access to energy services and curbing energy's contribution to climate change. We need energy to stimulate production, to generate income and to reduce the serious health problems caused by the use of fuel wood, charcoal, dung and agricultural waste. Sustainable social and economic development requires assured and affordable access to the energy resources necessary to provide essential and sustainable energy services. Solar energy is expected to play a significant role in providing energy services in a sustainable manner and, in particular, in mitigating climate change. The **2015 United Nations Climate Change Conference** was held in Paris, France, from 30 November to 12 December 2015. It was the 21st yearly session of the Conference of the Parties (COP) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 11th session of the Meeting of the Parties to the 1997 Kyoto Protocol.The conference negotiated the Paris Agreement, a global agreement on the reduction of climate change. Indian Prime Minister Narender Modi announced at the 2015 G-20 Summit that he, along with French President François Hollande, intends to propose creating an alliance of solar-rich countries similar to the Organization of the Petroleum Exporting Countries. Ahead of the climate summit, the two leaders sent written invitations to over 100 countries to join the coalition proposed to be called the International Agency for Solar Policy and Application.

This paper will present a brief outline of the development of solar energy in India and try to highlight its environmental and social implications. As we know, it will not only reduce GHG but also reduce the release of pollutants from the older fossil fuel plants that it replaces. It will also be highlighted whether India can make renewable resources such as the environmental friendly solar the backbone of its economy by 2050, without compromising its economic growth potential.

Keywords: Climate change, Sustainable development, energy resources, Kyoto Protocol, Paris Agreement**,** Solar Alliance, environmental implications, social implications, GHG

1. Introduction

In India, we face the grave challenge of securing energy supply to meet growing demand, providing everybody with access to energy services and curbing energy's contribution to climate change. We need energy to stimulate production, to generate income and to reduce the serious health problems caused by the use of fuel wood, charcoal, dung and agricultural waste. Sustainable social and economic development requires assured and affordable access to the energy resources necessary to provide essential and sustainable energy services. Solar energy is expected to play a significant role in providing energy services in a sustainable manner and, in particular, in mitigating climate

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Right from the beginning, the use of fossil fuels (coal, oil and gas) has increased to dominate energy supply, leading to a rapid growth in carbon dioxide (CO2), Greenhouse gas (GHG) emissions. Presently coal power accounts for around 61% of the electricity generation today. It is expected to be reduced to 57% by 2031/32. It is being said that if India is going to meet energy needs of all by 2030, the total installed renewable capacity would be in excess of 8, 00,000 MW from the present 2,60,000 MW. In order to achieve climate justice and eliminate extreme poverty in this century, a rapid peaking of the world's carbon emissions by 2020 and a complete phase out of carbon emissions by 2050 is required. Left unchecked, climate change will roll back decades of development progress and undermine prospects for future sustainable development and poverty eradication. But a global phase out of carbon emissions can only work if it is done fairly and as part of sustainable development while protecting the right to development, to make sure no one gets left behind. This just transition means that countries like India will have to take a non-fossil fuel dependent pathway to development.

Solar energy is expected to account for 18% of total power generation capacity in India by 2030 from 1% at present, playing a key role in the country's efforts to achieving 40% installed power

capacity from renewable energy. By 2030 Wind energy from current 9% to 10%, Nuclear power would remain at 2%, Hydro-electric power will decrease from 17% to 9% and Coal power reduced from 61% to 57%. Total Installed renewable capacity from present 2,60,000 MW to 8,00,000 MW.

Increasing the share of Solar energy in the energy mix will require policies to stimulate changes in the energy system. In this background, the government has set a target of generating 100 GW [i.e. 1, 00,000 MW] of Solar power by 2021-22 under the National Solar Mission. It is envisaged to generate 60 GW ground mounted grid-connected solar power and 40 GW roof-top grid interactive solar powers to meet the target. Government has also initiated several schemes for development of solar parks and ultra mega solar power projects. According to Press Information Bureau, Government of India, Ministry of New and Renewable Energy15-January-2016, Solar Power Capacity Crosses Milestone of 5,000 MW in India.

On the auspicious occasion of Makar Sankranti/Pongal, the installed capacity of solar power in India crossed the milestone of 5,000 MW yesterday. The Government has set the ambitious target of generating 100 GW of solar power by the year 2021-22 under the National Solar Mission.

It is envisaged to generate 60 GW ground mounted grid-connected solar power and 40 GW through roof-top grid interactive solar power to fulfill the 100 GW of solar power. The Ministry has also fixed year-wise targets to monitor the solar power generation in the country. The target for the current year is 2,000 MW and next year target is 12,000 MW. The Ministry is putting all efforts through various schemes of Central Government and State Governments to achieve the targets. It has been planned that around 18,000 MW tender should be out by 31st March, 2016.

Direct solar energy technologies harness the energy of solar irradiance to produce electricity using photovoltaic's (PV) and concentrating solar power (CSP), to produce thermal energy (heating or cooling, either through passive or active means), to meet direct lighting needs and, potentially, to produce fuels that might be used for transport and other purposes. The technology maturity of solar applications ranges from R&D (e.g., fuels produced from solar energy), to relatively mature (e.g., CSP), to mature (e.g., passive and active solar heating, and wafer-based silicon PV).

Solar technologies differ in levels of maturity, and although some applications are already competitive in localized markets, they generally face one common barrier: the need to reduce costs.

Utility-scale CSP and PV systems face different barriers than distributed PV and solar heating and cooling technologies.

Important barriers include: sitting, permitting, and financing challenges to develop land with favourable solar resources for utility-scale projects; lack of access to transmission lines for large projects far from electric load centres; complex access laws, permitting procedures, and fees for smaller-scale projects; lack of consistent interconnection standards and time-varying utility rate structures that capture the value of distributed generated electricity; inconsistent standards and certifications and enforcement of these issues; and lack of regulatory structures that capture environmental and risk-mitigation benefits across technologies. Through appropriate policy designs, governments have shown that they can support solar technologies by funding R&D and by providing incentives to overcome economic barriers.

Direct solar energy technologies are diverse in nature. Responding to the various ways that humans use energy—such as heating, electricity, and fuels—they constitute a family of technologies. There are four major types: 1) solar thermal, which includes both active and passive heating of buildings, domestic and commercial solar water heating, swimming pool heating and process heat for industry; 2) photovoltaic (PV) electricity generation via direct conversion of sunlight to electricity by photovoltaic cells; 3) concentrating solar power (CSP) electricity generation by optical concentration of solar energy to obtain high-temperature fluids or materials to drive heat engines and electrical generators; and 4) solar fuels production methods, which use solar energy to produce useful fuels.

- **Photovoltaic systems:** By these systems the electricity could be produced directly from the sunlight.
- **Solar Process Space heating and cooling:** It is the commercial and industrial use of sun's heat.
- **Solar Hot Water:** The process to heat water with the solar energy.
- **Solar Power plants:** Producing electricity by using the sun's heat.
- **Passive Solar heating and day lighting:** Use of solar energy to heat buildings

State Wise Solar Installations in India as of January 31, 2014: Total 2208 MW; January 2016: 5129 MW

- *Gujarat: 860 MW [*1024.15 *2016- 2 position]*
- *Rajasthan: 667 MW [2014] – 1264.35 MW [2016]*

- *Maharashtra: 238 MW [*378.7 *2016- 5 position]*
- *Madhya Pradesh: 195 MW [*678.58 *2016- 3 position]*
- *Andhra Pradesh: 93 MW [*357.34 *2016- 6 position]*
- *Tamilnadu :* 418.945 *at 4 position]*
- Telangana : 342.39 MW

A Comparative analysis of India and other major Solar Energy Producing Countries: [1 GW = 1000 MW]

Country	**2013 Energy (MW)**	**2016 Energy (GW)**
Germany	32,411	35.5
Italy	16,361	17.6
China	8,300	18.3
USA	7,777	12
Japan	6,914	13.6
Spain	5,166	5.6
France	4,003	4.6
Belgium	2,650	3
Australia	2,610	3.3
U K	1,829	2.9
India	1,205	5.1

Now if we compare the above mentioned countries on the basis of Total Solar Power Capacity MW] Per Million People, we find India lagging behind in 2013 but rapidly picking by2016. As well as having a large potential to mitigate climate change, Solar Energy can provide wider benefits. Solar Energy may, if implemented properly, contribute to social and economic development, energy access, a secure energy supply, and reducing negative impacts on the environment and health. For solar energy, though climate change is expected to influence the distribution and variability of cloud cover, the impact of these changes on overall technical potential is expected to be small.

Environmental

- Apart from its benefits in GHG reduction, the use of solar energy can reduce the release of pollutants—such as particulates and noxious gases—from the older fossil fuel plants that it replaces.

- Solar thermal and PV technologies do not generate any type of solid, liquid or gaseous by-products when producing electricity.
- The PV industry uses some toxic, explosive gases as well as corrosive liquids in its production lines. The presence and amount of those materials depend strongly on the cell type.
- However, the intrinsic needs of the productive process of the PV industry force the use of quite rigorous control methods that minimize the emission of potentially hazardous elements during module production.
- For other solar energy technologies, air and water pollution impacts are generally expected to be relatively minor.
- Furthermore, some solar technologies in certain regions may require water usage for cleaning to maintain performance.
- Land use is another form of environmental impact. For roof-mounted solar thermal and PV systems, this is not an issue, but it can be an issue for central-station PV as well as for CSP.

Social

- The positive benefits of solar energy in the developing world provide arguments for its expanded use.
- About 1.4 billion people do not have access to electricity. Solar home systems and local PV-powered community grids can provide electricity to many areas for which connection to a main grid is cost prohibitive.
- The replacement of indoor-polluting kerosene lamps and inefficient cook stoves;
- Increased indoor reading;
- Reduced time gathering firewood for cooking (allowing the women and children who normally gather it to focus on other priorities);
- Street lighting for security; improved health by providing refrigeration for vaccines and food products;

- Communications devices (e.g., televisions, radios). All of these provide a myriad of benefits that improve the lives of people.
- Job creation is an important social consideration associated with solar energy technology. Approximately 0.87 job-years per GWh are created through solar PV, followed by CSP with 0.23 job-years per GWh. When properly put forward, these job-related arguments can help accelerate social acceptance and increase public willingness to tolerate the perceived disadvantages of solar energy, such as visual impacts.

India launched an **International Solar Alliance (ISA)** at the CoP21 **Climate Conference in Paris, 2015** with an announcement by Prime Minister Modi that the revolution in the field would bring power to all citizens and create unlimited economic opportunity. The new body, which has invited all countries located fully or partly between the tropics of cancer and Capricorn to join, is to function from the National Institute of Solar Energy in India, Gurgaon. The centre will provide land and $30 million to form a secretariat for the Alliance, and also support it for five years, the Prime Minister said at an event that was co chaired with him by French President Francois Hollande. In its launch resolution, the ISA says it seeks to share collective ambitions to reduce the cost of finance and technology that is needed to deploy solar power widely; generation and storage technologies would be adapted to the individual country's needs.

Among the tasks that the Alliance would pursue are, cooperation in training, building institutions, regulatory issues, common standards and investment including joint ventures. Interim Secretariat of the ISA was inaugurated by Modi and Francois Hollande on 25th January, 2016 at National Institute of Solar Energy NISE] at Gurgaon with objectives such as Innovative projects & programmes, capacity building measures, R&D and to mobilize more than 1000 Billion US Dollars of investments for affordable solar energy.

In the book "Convenient Action- Continuity for Change," Prime Minister Modi talks at length about India's efforts to transform itself into a low-carbon economy. The PM has emphasized on the importance of collectively working together to achieve our desire of a clean and green India. Building on a model of positive partnership between people, businesses, scientific community, government and NGOs, Modi's proposal calls for delivering clean energy and prosperity through site-dependent initiatives and scaling up efforts to make rapid transformation.

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