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COMBATING CLIMATE CHANGE IN INDIA: ROLE OF CHANDIGARH RENEWAL ENERGY AND SCIENCE AND TECHNOLOGY PROMOTION SOCIETY (CREST) IN THE IMPLEMENTATION OF SOLAR POWER GENERATION SYSTEM IN CHANDIGARH

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ABSTRACT

The Earth's climate has been changing continually, for hundreds of thousands of years because of ever increasing population, rapid industrialization and overconsumption of natural resources. However, the most alarming change is the rate of this change, specifically that's of earth's temperature. These climatic changes have serious repercussions such as increased incidence of extreme weather conditions like droughts, storms, landslides, tsunamis, famines, rising in sea levels, shifting of seasons, changing agricultural patterns, increasing global temperatures etc. Resultantly, there is a problem of an acute energy crisis all over the world. Natural Resources are both renewable and non-renewable in nature. Non-Renewable resources such a coal, petroleum, natural gas, etc. are available on earth in limited quantity and will diminish soon. Also these resources release harmful greenhouse gases, which cause environmental degradation and global warming. So there is a greater need to shift towards renewable sources of energy such as, wind energy, tidal energy, solar energy etc., which are environmental friendly and are abundant in quantity. Also, it results in little to no emission of greenhouse gases, consequently helps in mitigating the climate change. Government of India has begun to recognize the importance of solar energy to the country's economic growth and its ability to transform India. The Jawaharlal Nehru National Solar Mission (JNNSM) is a major initiative of Union and State government launched in 2010 under the brand name 'Solar India', which aims at making India's economic development energy efficient. Chandigarh is one of the cities which have been selected to be developed as a Model Solar City by the Ministry of New and Renewable Energy. Under this scheme, CREST is the executing agency for the installation of rooftop based Solar Photovoltaic Plants in Chandigarh. Therefore, the objectives of the paper are to study the initiatives taken by the Govt. of India under Jawaharlal Nehru National Solar Mission (JNNSM) in the direction of developing renewable energy through solar power in India and to evaluate the role of CREST in

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its implementation. The findings of the study will be beneficial for the policy makers and for future research.

Keywords: Climate change, Chandigarh renewal energy, Solar power, CREST, India

Section-I

1.1 Introduction

Climate change is the long-term change in Earth's climate due to astrophysical, geophysical or human-induced parametric variations. The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings or to persistent anthropogenic changes in the composition of the atmosphere or in land use".

The Earth's climate has been changing continually, for hundreds of thousands of years. However, the most alarming change is the rate of this change, specifically that's of earth's temperature. In the normal course, the heat gained by earth gets dissipated to the atmosphere, maintaining the general balance. But increasing concentration of greenhouse gases like carbon dioxide and others act as a barrier to this dissipation as they block heat to escape to the atmosphere, thereby resulting in warming of earth. As per National Aeronautics and Space Administration (NASA) "…Earth has warmed since 1880. Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past 12 years…the year2014 ranks as the warmest on record."

There has been a mutual consensus in the scientific community now that human activities have altered this delicate balance of greenhouse gases, which in turn has contributed to the warming of Earth's surface. Over the last century, humans are increasingly influencing the climate and the Earth's temperature by burning fossil fuels, cutting down rainforests and farming livestock. This adds enormous amount of greenhouse gases to those naturally occurring in the atmosphere, increasing the greenhouse effect and global warming. Some gases in the Earth's atmosphere act a bit like the glass in a greenhouse, trapping the sun's heat and stopping it from leaking back into space.

These climatic changes have serious repercussions such as increased incidence of extreme weather conditions like droughts, storms, landslides, tsunamis, famines, rising in sea levels, shifting of seasons, changing agricultural patterns, increasing global temperatures etc.

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1.2 Combating Climate Change Globally

The awareness on the degradation of the environment and its impact on the climate system and the natural resources have gained momentum after the efforts of the United Nations, especially after the Stockholm Conference held during June, 1972. The Stockholm conference recognized the concept of 'Sustainable Development' and the impact of development and industrialization on the environmental quality of a nation. This conference led to the formation of the United Nations Environment Programme (UNEP). United Nations Statistics Division (UNSD) recognized the subject of Climate Change as one of its priorities in the Environment Statistics. Climate Change comes under the ambit of the UN framework Convention on Climate Change (UNFCCC) wherein different countries are required to report their Green House Gases (GHGs) emission to the UN. There is also Inter Governmental Panel on Climate Change (IPCC) which reports to UNFCCC. With the financial assistance from UNEP, the UNSD brought out a framework for the collection of data on environment and related variables in 1984, called 'Framework for the Development of Environment Statistics' (FDES). FDES sets out the scope of environment statistics by relating the components of the environment to information categories that are based on the recognition that environmental problems are the result of human activities and natural events reflecting a sequence of action, impact, and reaction.

Below are some of the key events in the international community's fight against climate change, which began more than 25 years ago.

Creation of the Intergovernmental Panel on Climate Change (IPCC) - November 1988

Rio Earth Summit- June 1992

Kyoto Protocol- December 1997

Launch of the European Union Emissions Trading System- January 2005

Copenhagen Climate Change Conference- December 2009

Cancun Climate Change Conference- December 2010

Rio+20 Conference- June 2012

Doha UN Climate Change Conference- December 2012

Paris Climate Change Conference-December 2015

Marrakech Climate Change Conference-November 2016

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Recently, the twenty-second session of the Conference of the Parties (COP 22) and the twelfth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP 12) was held in Bab Ighli, Marrakech, Morocco from 7-18 November 2016.

On 5 October 2016, the threshold for entry into force of the Paris Agreement was achieved. The Paris Agreement entered into force on 4th November, 2016. As a result, the first session of the Conference of the Parties took place in Marrakech.

1.3 Objectives of the Study

The objectives of the study are:

1 to study the initiatives taken by the Govt. of India under Jawaharlal Nehru National Solar Mission (JNNSM) in the direction of developing renewable energy through solar power in India and
2 to evaluate the role of CREST in its implementation.

1.4 Methodology

This paper is based on case study method. The data have been collected from CREST using personal interviews and the other sources include the Government reports, circulars, notifications, official record, along with relevant books, journals, newspapers and related websites.

Section-II

1.5 Climate Change: India at a glance

India's growing population, along with increased economic development, has put severe burden on the infrastructure, and ultimately on the country's environment. The present state of environment in terms of degradation of the natural resource base and increasing industrial pollution, continue to worsen the situation. While deforestation, soil erosion and land degradation are hindering economic development in rural India. Moreover, rapid industrialization and urbanization has been causing serious concern.

A recent national socio-economic census 2011 indicates that economic and social deprivations are much higher in terms of availability of proper houses, access to education, lifeline availability of energy, and stable sources of income. This is more so in rural India where 48% of the households lack basic socio economic services and were categorized as deprived. India also has the largest cattle and buffalo population in the world of about 300 million, which faces

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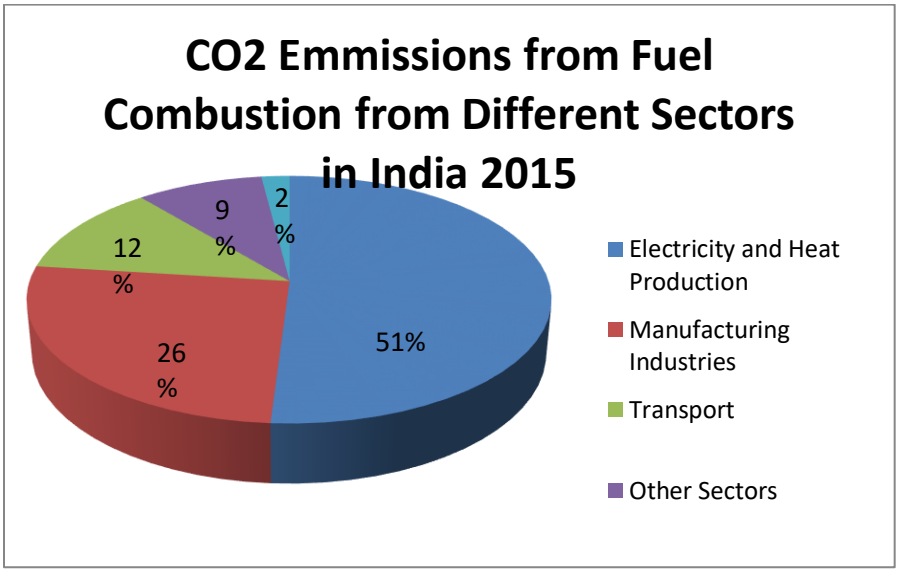
multiple challenges including diseases, inadequate supply of fodder etc. as a result of changing climate.

Chart-1.1



Source: Based on International Energy Agency (IEA) CO2 Emissions from Fuel Combustion OECD/IEA, Paris 2015

The data presented above depicts that sectoral CO2 emissions from fuel combustion, electricity and heat production was the largest contributor for India in 2015 followed by the manufacturing industry and transport sector.

1.5.1 Efforts to Combat Climate Change in India

a) Paris Agreement

India ratified the Paris Agreement (on Climate Change) on 2nd October 2016, the day of birth anniversary of Mahatma Gandhi. The Instrument of Ratification was deposited by India with the UN at an event organized in New York to commemorate 'International Day on Non-Violence' on the occasion of Mahatma's birth anniversary.

The Paris Agreement was adopted last year on 12th December 2015 and India signed the Paris Agreement in New York early this year on 22nd April 2016. A total of 191 countries have signed to the Paris Agreement so far. As per the provisions of the Paris Agreement, the treaty will come into force as and when 55 countries contributing to 55% of total global emission ratify the agreement. India's decision to ratify the agreement has pushed the cumulative level of emission of countries that have ratified the agreement as on 2nd October 2016 to 51.89%.

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With the gathering momentum and willingness expressed by several other countries to ratify the agreement before the end of this year, it is expected that the Agreement will enter into force soon and give a thrust to the global actions to address climate change. Given the critical role that India played in securing international consensus on Paris Agreement, this step further underlines India's responsive leadership in the community of nations committed to global cause of environmental protection and climate justice.

While agreeing to ratify the Paris Agreement, India has declared that it will treat its national laws, its development agenda, availability of means of implementation, its assessment of global commitment to combating climate change, and predictable and affordable access to cleaner source of energy as the context in which the Agreement is being ratified.

Paris Agreement pertains to post-2020 climate actions. In the pre-2020 period, developed countries are to act as per the Kyoto Protocol to the United Nations Framework Convention on Climate Change, while some developed and developing countries have taken voluntary pledges under the Cancun Agreements under the Convention.

b) First Biennial Update Report

As per First Biennial Update Report (BUR) submitted by India on 22nd january, 2016 to the United Nations Framework Convention on Climate Change (UNFCCC), towards fulfillment of the reporting obligation under the Convention. As per the provisions of the Convention, countries need to periodically provide information in the form of their National Communication.

BUR contains national Greenhouse Gases (GHG) inventory of India for the year 2010, prepared in accordance with the guidelines of Intergovernmental Panel on Climate Change (IPCC). The inventory covers six greenhouse gases, viz. Carbon dioxide (CO2), Methane (CH4), Nitrous Oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF6) and five categories, namely- energy, industrial processes and product use (IPPU), agriculture, waste and Land-use, Land-use, Change and Forestry (LULUCF).

As per BUR, India emitted 2,136.84 million tonnes of CO2 equivalent greenhouse gases in 2010. Energy sector was the prime contributor to emissions and with 71% of total emissions in 2010. Energy sector includes - electricity production, fuel combustion in industries, transport and fugitive emissions. Industrial processes and product use contributed 8%; agriculture and waste sectors contributed 18% and 3% respectively to the national GHG inventory. About 12% of emissions were offset by carbon sink action of forests and croplands, considering which the national GHG emissions are arrived at a total of 1,884.31 million tonnes of CO2 equivalent. India's per capita GHG emission in 2010 was 1.56t CO2 equivalent, which is less than one- third

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of the world's per capita emissions and far below than many developed and developing countries. A reduction of emission intensity of GDP by about 12% between 2005 and 2010 has been achieved against our voluntary pledge to reduce the emission intensity of its GDP by 20–25% by 2020, compared with the 2005 level. BUR showcases a range of climate-friendly measures initiated through eight National Missions under National Action Plan on Climate Change and other programs such as Integrated Power Development Scheme, Renewable Purchase Obligations, enhancement of cess on coal, Perform Achieve and Trade Scheme and National Program for LED based lighting. At the national level, 137 and at state level 286 policies and measures relevant to climate change have been mapped in the report on non-exhaustive basis.

BUR has different sections elaborating various aspects on climate change in the country, such as institutional arrangements to implement the reporting process, national circumstances in which country is responding to climate change, national greenhouse gas inventory for 2010; initiatives of the government to tackle the problem of climate change along with domestic arrangements to measure, report and verify these programs. A section on finance, technology and capacity-building needs and support received has also been provided.

BUR has been prepared by the Ministry of Environment, Forest and Climate Change under its NATCOM project funded by Global Environment Facility (GEF) through UNDP. Several studies were carried out by 17 national-level institutions, including CSIR laboratories (CIMFR, CRRI, IIP, NEERI and NPL), ICAR institutes (CRIDA, IARI, NDRI), organizations of the MoEFCC (FSI and ICFRE), premier educational institutions (IIM Ahmedabad and IISc), Non-governmental research organizations (TERI and IRADe) and other institutions (CII, EESL and NRSC) involving more than 60 researchers along with inputs from various Ministries, Government departments and independent experts. BUR has also undergone multi-tier review process and has been approved by the Union Cabinet.

As per the rules of UNFCCC, BURs are subjected to an international process known as International Consultation and Analysis (ICA). It is a process that includes international scrutiny of BUR in a manner that is non-intrusive, non-punitive and respectful of national sovereignty. All BURs are subjected to ICA process. As on 13 January 2016, 23 countries other than India, including Brazil, South Africa, South Korea have submitted their BURs. China, world's largest emitter of greenhouse gases is yet to submit its BUR. Brazil has submitted its BUR, but has given only provisional inventory. Developed countries are required to submit a report known as the Biennial Report (BR), which is to be submitted every alternate year and is subjected to International Analysis and Review (IAR). Paris Agreement calls for developing country Parties

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to submit their first biennial update reports as soon as possible. India has submitted its first BUR.

India had submitted its first national communication in 2004 and second national communication in 2012. The UNFCCC in its sixteenth session of conference of Parties (COP) had decided that the developing countries will submit updates to their national communication on biennial basis in the form of 'Biennial Update Report'. The scope of a BUR is to provide an update to the latest National Communication submitted by the country to the UNFCCC. Accordingly, India's first BUR is an update to the Second National Communication.

Section-III

1.6 Mitigation strategies in India

India's on-going mitigation and adaptation strategies and actions are detailed in the following sections, along with the expected direction of activities in the near future.

a) Clean and efficient energy system

Energy is a vital input for production and growth. Considering universal energy access and energy security as one of the fundamental development goals for the country, Government of India (GoI) has undertaken a two pronged approach to cater to the energy demand of its citizens while ensuring minimum growth in carbon emissions.

On the generation side, the Government is promoting greater use of renewables in the energy mix mainly through solar and wind power and shifting towards supercritical technologies for coal based power plants. On the demand side, efforts are being made to efficiently use energy through various innovative policy measures under the overall ambit of Energy Conservation Act.

For the promotion of clean energy, the predominant contributors to the renewable energy growth in India are-

1) Wind Energy

2) Solar Power

3) Biomass Energy

4) Hydropower

5) Nuclear Power

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6) Clean Coal Power

1.6.1 Solar Power: Power Generation from Solar Photovoltaic (SPV) System

Photovoltaic is the name of a method of converting solar energy into direct current electricity. Power generation from SPV has long been seen as a clean sustainable energy technology which draws upon the planet's most plentiful and widely distributed renewable energy source – the sun. India has tremendous scope of generating solar energy because it is a tropical country and receives solar radiation almost throughout the year, which amounts to 3,000 hours of sunshine. This is equal to more than 5,000 trillion kwh. Solar energy available in a year exceeds the possible energy output of all fossil fuel energy reserves in India. Therefore, Solar PV is now, after hydro and wind power, the third most important renewable energy source in terms of globally installed capacity.

SPV Rooftop Systems can be installed on rooftops of Residential, Commercial, Institutional and Industrial Buildings. Electricity generated could be fed into the grid at regulated feed-in tariffs or used for self consumption with net-metering approach. Such systems is advantageous as it saves time in transmission, distribution losses, low gestation time, no requirement of additional land, Improvement of tail-end grid voltages and reduction in system congestion with higher self-consumption of solar electricity, local employment generation, reduction of power bill by supplying surplus electricity to local electricity supplier, battery elimination make easy installation and reduced cost of systems.

1.6.2 Institutional Framework

The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. The functions entrusted to the Ministry have been to facilitate research, design, development, manufacture and deployment of new and renewable energy systems/devices for transportation, portable and stationary applications in rural, urban, industrial and commercial sectors through

To assist the Ministry in implementing the National Solar Mission and to coordinate research, technology, skill development, training, consultancy, incubation and other related works, the following institutions work under the Ministry in India-

1 National Institute of Solar Energy (NISE), Gurugram, Haryana
2 National Institute of Wind Energy (NIWE),Chennai, Tamilnadu

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3 Sardar Swaran Singh National Institute of Renewable Energy (SSSNIRE), Kapurthala, Punjab
4 The Indian Renewable Energy Development Ageny (IREDA),New Delhi
5 Solar Energy Corporation of India (SECI)

1.6.3 Jawaharlal Nehru National Solar Mission

The Jawaharlal Nehru National Solar Mission (JNNSM) is a major initiative of Union and State government under the brand name 'Solar India' which aims at making India's economic development energy efficient. It was launched on the 11th January, 2010 by the Prime Minister Dr. Manmohan Singh. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 is aimed at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022. Mission will create an enabling policy framework to achieve this objective and make India a global leader in solar energy.

1. Grid Connected Solar System
   Solar park scheme
   Central public sector undertakings scheme
   Defence Scheme
   Viability Gap Funding Scheme
2. Off-Grid Solar System
   Solar photovoltaic system
   Solar thermal system

Section-IV

1.7 Solar Energy through Photovoltaic System in Chandigarh

Chandigarh is a Union Territory situated in the northern part of India covering a population of around 10,55,450, (as per 2011 census). It serves as the capital of the states of Punjab and Haryana. Chandigarh is located near the foothills of the Shivalik range of the Himalayas in northwest India. It covers an area of approximately 114 km^2. It shares its borders with the states of Haryana and Punjab.

The city of Chandigarh was the first planned city in India post-independence in 1947 and was known internationally for its architecture and urban design. The master plan of the city was prepared by French architect Le Corbusier.

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The foundation stone of the city was laid in 1952. Subsequently, at the time of reorganization of the state into Punjab, Haryana and Himachal Pardesh, the city assumed the unique distinction of being the capital city of both, Punjab and Haryana (under Section 4 of the Punjab Re-Organisation Act, 1966, with effect from November 1, 1966) and it was declared a Union Territory.

1.7.1 Administration of Chandigarh

The administrative control of Chandigarh lies directly under the overall control of Ministry of Home Affairs. Under the Act, there is a provision of appointing an Administrator for the overall control and supervision of the city. The practice of appointing Administrator of the UT designated as Chief Commissioner continued up to May 31, 1984. Thereafter, on June 1, 1984, the Governor of Punjab took over the direct administration of the Union Territory as the Administrator. Chief Commissioner was re-designated as Adviser to the Administrator. Since then, the Governor of Punjab has been functioning as the Administrator of Union Territory of Chandigarh. Next to the Governor of Punjab is the Adviser to the Administrator. He is an officer belonging to the Indian Administrative Services and is appointed by Ministry of Home Affairs. He advises the Administrator on policy matters and oversees the day-to-day administration of the Union Territory. There are number of departments working under the Chandigarh Administration for the overall development of the city. A few of the important departments' are-

1. Agriculture
2. Animal Husbandry and Fisheries
3. Chandigarh Police
4. Cooperation
5. Education
6. Employment
7. Engineering
8. Environment
9. Excise and Taxation
10. Food and Supplies and Consumer Affairs
11. Rural Development and Panchayats
12. Social Welfare, Women and Child Development
13. Chandigarh Transport Undertaking
14. Registering and Licensing Authority
15. Science and Technology and Renewable Energy

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1.7.2 Department of Science and Technology and Renewable Energy

The Department of Science and Technology was established in UT Chandigarh in the year 1991-92. The main objective was to make use of the most of in-house Scientific and Technical Institutional Infrastructure in the Union Territory of Chandigarh and to prepare Science & Technology Plans relevant to the development of subjects. The work of Non-Conventional Energy Sources was also entrusted to the Department. Department has constituted a registered society under it with the name Chandigarh Renewal Energy and Science and Technology Promotion Society (CREST) with a mandate to develop Chandigarh into a model solar city.

1.7.3 Chandigarh Renewal Energy and Science and Technology Promotion Society (CREST)

Chandigarh has been selected to be developed as a Model Solar City by the Ministry of New and Renewable Energy. Solar City is an umbrella scheme with solar as umbrella tag.

Solar City: The Concept

A 'solar city' is an urban area that aims to:

a) Reduce dependence on fossil fuels for its energy needs
b) Limit emission levels to sustainable levels even while maintaining the desired socio-economic development growth

This scheme includes the promotion of renewable energy resources in Chandigarh such as-

a) Solar Photo Voltaic Power Generation(Grid Connected)
    i) Roof Top Based Solar power Generation
    ii) Use of Landfill site for Solar Power Generation
b) Solar Water Heating System
c) SPV Street Light system in Parks, Gardens etc

As per guidelines of the Govt. of India, initial financial support up to the maximum of Rs.9.50 Crore for developing Chandigarh as Model Solar City based on the Master Plan prepared under the scheme has been provided by GOI. The master plan submitted has been approved by MNRE, Govt. of India. Besides this, 30% central financial assistance is being provided for SPV projects by GOI. As per master plan of Solar City, there is a target of 10 MWp rooftop SPV Plant in 10 years i.e. upto 2022.

Under this scheme, CREST is the executing agency for Department of Science & Technology for rooftop based SPV Plant. Department of Science and Technology is also installing SPV Plants of

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smaller size on the Govt. residential buildings to promote the use of Solar Energy and as demonstration effect.

1.7.4 Procedure of Getting SPV System Installed

As per Solar Power - Grid Connected, Ground Mounted and Solar Rooftop and Metering Regulations, 2015, SPV/Solar Thermal Power Projects of capacity equal to or more than 500 kWp, and Rooftop Solar Power of capacity equal to or more than 1 kWp but not more than 500 kWp at one location owned by one individual or entity or a house/ factory / Ware house / Government building / Panchayat Bhavan / Community centre/ School/ dispensary / hospital / parking Shed or place/ a solar plant on elevated structure / Group housing society / Resident welfare society/ market roof top or any such entity, based on the technologies approved by Ministry of New & Renewable Energy of Government of India are eligible in Chandigarh for connecting the project with Grid. The Rooftop projects of ratings higher than 500 kWp can be considered by the distribution licensee if the distribution system remains stable with higher rating Rooftop Solar Projects getting connected to the grid.

Solar Power connection with Gross / Net metering has been allowed for the consumers of the Distribution Licensees at one location owned by one Solar Power Developer with / without battery back-up support. Consumers generate solar power for self-consumption and are allowed to feed the excess solar power into the grid which is adjusted under net metering as per provisions of the regulations, or consumer can opt for gross metering. Any electricity consumer/resident can sell Solar power @ Rs 8.51 per unit (kWhr) from solar plant without subsidy and @Rs 6.14 per unit with capital subsidy of 30%. A Rooftop or Land Owner may lease out / rent the Rooftop Space/ Land to a Solar Project Developer on a mutual commercial arrangement.

CREST has empanelled 48 agencies by for the installation of SPV up to 1kwp to 20kwp plants in Chandigarh. As per guidelines of Ministry of New and Renewable Energy the residents of Chandigarh interested to install SPV plants get subsidy of 30% (approx. Rs.22,500/kwp) on benchmark cost of Rs. 75,000/kwp. However, the subsidy is released to the consumers only after the commissioning of project and receipt from the Ministry.

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Table-1.1

Sr.no.	Description of Categories	Rate per kwp
1.	1kwp to 5kwp	Rs. 85,000
2.	More 5kwp to 10kwp	Rs. 80,000
3.	More than 10 kwp to 20 kwp	Rs. 75,000

Steps to be followed for getting SPV installed

1. **Filling up of application form**:
   Firstly, a citizen needs to go to the office of CREST in sector-19B, Chandigarh for getting application form.
2. **Submission of form:**
   After filling up the application form, it needs to be submitted to the CREST office.
3. **Screening of form:**
   After submission of form, the form is being screened by the office.
4. **Filling up of application form:**
   The applicant again has to fill the form and submit it to the electricity department to obtain permission.
5. **Submission of feasibility report:**
   The electricity department has to submit the feasibility report to CREST regarding the approval or rejection of application after assessing the roof top with regard to the resource available (including shadow effects) and the energy needs & load profiling (In electrical engineering, a load profile is a graph of the variation in the electrical load versus time).
6. **Selection of vendor:**
   Once permission is obtained, the applicant has to select the vendor for executing the installation from the list of 48 empanelled vendors.
7. **Setting up of plant:**
   The applicant can now set up the plant and submit the work completion report that confirms that the plant is installed as per the approved standards and specifications.
8. **Verification by CREST**
   Once the site has been verified by CREST, the plant can be commissioned for net/gross metering.

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1.8 Major Findings

With the wide-scale introduction of renewable energy technologies for a variety of applications in the country, Chandigarh Administration took initiative to develop Chandigarh city as a solar city. CREST has prepared a Master Plan in 2009 to develop Chandigarh as a solar city in collaboration with the Energy and Resources Institute, Mumbai (TERI) and with the assistance of other departments of Chandigarh Administration such as Public Works Department, Municipal Corporation, Water Supply Department, Forest Department, Electricity Department (Master plan to make Chandigarh a Solar City, TERI 2009). The philosophy behind Master Plan is to ensure that Chandigarh's energy demands are met in affordable, technologically advanced, and environment friendly manner. This plan however, does not include the industrial and transportation sectors. Major findings of the study are-

1. Chandigarh is well ahead in terms of achievement and has already installed and commissioned nearly 7MWp (6.531kwp) Grid tied Rooftop Solar plants as on 30th April, 2016 as against approved Master plan of 'Chandigarh Solar' City envisaged mid-term target of 5 MWp Rooftop Solar (by 2017) and long term target of 10 MWp rooftop solar plants installation by 2022 to be achieved.

Table-1.2

Commissioned Rooftop SPV Power Plant Projects of CREST as on 31.03.2016.

Sr.no.	Institutions	Total Number	Total Capacity Installed
1.	Govt. Institutions	35	1333 KWp
2.	Govt. Hospitals	02	170KWp
3.	Govt. Colleges	10	2680KWp
4.	Govt. Schools	59	2290KWp
5.	Govt. Residential Houses	28	58KWp
6.	Total	133	6531KWp
	Total Capacity in MWp	-	6.531MWp

Source: http://www.crestchd.org.in/docs/PRSPV310316.pdf

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2. In view of enhanced target of 100 GW to be achieved by 2022 as announced by Govt. of India last year, MNRE, GOI has set 50 MW as Solar PV target for Chandigarh Administration to be achieved by 2022 in tune with Revised Power Tariff policy of 2016.
3. As on 30th April, 2016, Chandigarh has already generated 10.4 MU of solar energy (in last 2.5 years) which is equivalent to reduction of 7176 metric ton of CO2 and in turn equivalent to planting of 777920 trees.
4. UT Chandigarh has recently notified the amended Building By-laws by making Solar PV Installation mandatory on all buildings in U.T., Chandigarh above plot size of 500 Sq yard to promote Chandigarh as a Model Solar City.
5. A new online website/software platform launched as part of ease of Business and transparency facilitating all citizens to be able to obtain subsidy from CREST as well as all regulatory clearances from Electricity department within a fixed time frame.
6. In a unique initiative in the region CREST has installed a 10 KWp floating solar photovoltaic (SPV) power plant at Dhanas Lake. The plant, which has been set up as a pilot project at a cost of Rs 12 lakh. The floating plant has a total of 34 photovoltaic of 300 watts each. The plant has been set up on a platform that includes a large outer ring that floats on water, and grid supporting 34 panels which are arranged on 7 rows in a hexagonal pattern.

1.9 Conclusion

CREST has been playing an effective role in the promotion, development and implementation of solar energy in Chandigarh as per Govt. of India guidelines. For this, it has been running mass awareness programmes to spread awareness among people about the use of solar energy. Consequently, people have now been switching over from the conventional to non-conventional energy resources in big way. Thus, CREST has been working towards meeting Chandigarh's energy demands in affordable, technologically advanced, and environment friendly manner.

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